

Establishment of Trimester-Specific Thyroid Reference Intervals in Singleton and Twin Pregnancies

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Abstract

Background

Maternal thyroid function is essential for fetal development, and thyroid hormone concentrations undergo substantial physiological changes throughout pregnancy. These changes are influenced by gestational hormones and other physiological adaptations. Establishing trimester- and pregnancy-type-specific reference intervals may therefore improve the interpretation of thyroid function during pregnancy.

Methods

This retrospective study included women with singleton and twin pregnancies who received prenatal care at the West China Second University Hospital between January 2023 and March 2025. A total of 1169 pregnant women were enrolled after excluding pregnancies without thyroid function testing or with pre-existing thyroid disorders, including 728 singleton and 441 twin pregnancies. Serum T3, T4, TSH, FT3, and FT4 were collected across the first, second, and third trimesters. Reference intervals were defined as the central 95% range between the 2.5th and 97.5th percentiles.

Results

trimester-specific reference intervals for T3, T4, TSH, FT3, and FT4 were established separately according to pregnancy type. Significant differences between singleton and twin pregnancies varied by gestational stage. Twin pregnancies showed higher T3 and TSH but lower FT4 levels in the first trimester, higher T3 and FT3 levels in the second trimester, and higher T3, T4, TSH, and FT3 levels in the third trimester (all $P < 0.01$).

Conclusions

Thyroid hormone profiles differ between singleton and twin pregnancies in a gestational-stage-dependent manner. Trimester- and pregnancy-type-specific reference intervals may improve the interpretation of thyroid function, particularly in twin pregnancies, and reduce potential misclassification of gestational thyroid dysfunction.

Background

Thyroid hormones play essential roles in fetal growth, neurological development, and maternal metabolic adaptation during pregnancy. Because the fetal thyroid gland is not fully functional during early gestation, the fetus depends primarily on maternal thyroid hormones to support normal development(1). After 18–20 weeks of gestation, as the fetal hypothalamic-pituitary-thyroid axis matures, the fetus

begins to secrete thyroid hormones autonomously, and dependence on maternal thyroid hormones decreases significantly(2).

Maternal thyroid function undergoes substantial physiological adaptation during pregnancy. Changes in thyroid-binding globulin (TBG), human chorionic gonadotropin (hCG), iodine metabolism, and thyroid hormone metabolism contribute to changes in circulating thyroid hormone concentrations(3). In particular, the increase in hCG during early pregnancy can influence maternal thyroid function, while changes in thyroid-binding globulin affect the distribution of total thyroid hormones(4). Owing to the increased iodine requirements and altered renal iodine handling may further contribute to changes in thyroid physiology(5).

Abnormal thyroid hormone concentrations during pregnancy are associated with adverse maternal and fetal consequences, making accurate interpretation of thyroid function clinically important, such as hyperthyroidism(6). However, thyroid hormone concentrations vary according to gestational stage, analytical method, and physiological characteristics of the pregnant population. Therefore, the use of a single non-pregnant reference range may result in inappropriate classification of thyroid function.

Twin pregnancies may present an additional challenge because increased placental mass is associated with greater endocrine activity, including higher hCG concentrations. Consequently, the maternal thyroid response may differ from that observed in singleton pregnancies. Establishing trimester-specific reference intervals separately for singleton and twin pregnancies may therefore improve the assessment of thyroid function and reduce potential misclassification. However, most studies report reference ranges only for TSH and FT4, as these two parameters are the most central, stable, and clinically relevant thyroid function markers, while the other three hormones are influenced by several factors more easily (7). Moreover, the reference intervals differ with using different assay methods, as shown in Table 1 and Table 2, so establishing local reference ranges with specific assay methods is essential.

In this study, we analyzed thyroid function parameters in singleton and twin pregnancies across the three trimesters and established trimester-specific reference intervals for T3, T4, TSH, FT3, and FT4. We further compared thyroid hormone levels between singleton and twin pregnancies at corresponding gestational stages.

Table 1
Pregnancy-specific reference intervals for thyroid function in singleton pregnancies according to different assay methods

Assay platform/method	Gestational week	TSH reference interval (mIU/L)	FT4 reference interval (pmol/L)	Reference
Siemens ADVIA Centaur	4–12 weeks	0.11–3.26	12.01–19.49	(8)
Abbott Architect	11–13 + 6 weeks	0.16–3.43	-	(9)
Roche Elecsys	14–16 weeks	0.34–3.81	11.35–17.35	(10)
Abbott Architect	First trimester	0.03–3.78	10.42–15.96	(11)
Roche Cobas	First trimester	-	11.46–19.05	
ID-LC–MS/MS	First trimester	-	8.75–18.27	

Table 2
Pregnancy-specific reference intervals for thyroid function in twin pregnancies according to different assay methods

Assay platform/method	Gestational week	TSH reference interval (mIU/L)	FT4 reference interval (pmol/L)	Reference
Siemens ADVIA Centaur	4–12 weeks	0.01–3.35	12.45–23.34	(8)
Abbott Architect	11–13 + 6 weeks	0.02–2.95	-	(92)

Methods

Study design and population

This retrospective cohort study included women with singleton and twin pregnancies who received prenatal care at the West China Second University Hospital between January 2023 and March 2025. A total of 1169 pregnant women were included after excluding pregnancies without thyroid function testing or with pre-existing thyroid disorders. Among them, 728 had singleton pregnancies and 441 had twin pregnancies.

Data collection

Basic maternal information, including age and gestational age, was collected. Serum thyroid function indicators, including T3, T4, TSH, FT3, and FT4, were detected from different pregnancy stages. Thyroid hormone measurements were performed using a magnetic particle-based chemiluminescence assay.

The data of singleton and twin pregnancies were divided into three stages according to the gestational age (12).

Statistical analysis

Continuous variables were presented as mean $\pm$ SD. The difference between a data value and its adjacent value (D) was divided by the range of the data (R) was D/R value. when $D/R \geq 1/3$, the value was considered an outlier and removed. Reference intervals were established using a non-parametric approach by calculating the 2.5th (P2.5) and 97.5th (P97.5) percentiles. The same approach was applied separately to singleton and twin pregnancies in the corresponding gestational periods. Comparisons between singleton and twin pregnancies were conducted using the Mann–Whitney U test for non-normally distributed data or the t-test for normally distributed data. Statistical analyses were performed using R version 4.5.1. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

Results

1. Demographic characteristics of singleton and twin pregnancies

A total of 1169 pregnant women were included in this study, consisting of 728 singleton pregnancies and 441 twin pregnancies. We collected and compared the age and gestational age between two groups in three trimesters. Maternal age was comparable between the two groups in the first and second trimesters ($P = 0.2873$ and $P = 0.1200$, respectively), whereas women with twin pregnancies were significantly older in the third trimester (32.50 ± 3.75 vs. 30.65 ± 3.79 years, $P < 0.0001$). Gestational age differed significantly between singleton and twin pregnancies in the first and second trimesters (both $P < 0.0001$), but no significant difference was observed in the third trimester ($P = 0.4776$). (Table 3)

Table 3
Demographic characteristics of singleton and twin pregnancies

Age (years)	singleton	twin	<i>P</i>
1st	30.76 $\pm$ 3.33	31.23 $\pm$ 3.32	0.2873
2nd	31.00 $\pm$ 3.53	31.53 $\pm$ 4.11	0.1200
3rd	30.65 $\pm$ 3.79	32.50 $\pm$ 3.75	<0.0001
Gestational age (week)			
1st	9.77 $\pm$ 3.38	4.86 $\pm$ 3.40	<0.0001
2nd	18.64 $\pm$ 4.84	20.73 $\pm$ 4.48	<0.0001
3rd	32.71 $\pm$ 2.71	32.66 $\pm$ 2.52	0.4776

2. Trimester-specific thyroid reference intervals in singleton pregnancies

After excluding diseases influencing thyroid hormones, a total of 728 singleton pregnancies were included in this study. We use a magnetic particle-based chemiluminescence assay to detect five thyroid hormones. Owing to the inadequate sample volume, certain hormone levels were unavailable. During data processing, certain outliers were excluded following the D/R test. Trimester-specific reference intervals were established for T3, T4, TSH, FT3, and FT4 in singleton pregnancies using the 2.5th and 97.5th percentiles. What's more, to compare the hormone alteration in different pregnant stages, we also calculated the Mean $\pm$ SD of data.

During the first trimester, the reference intervals were 0.7385–1.773 ng/mL for T3, 74.289–183.772 nmol/L for T4, 0.2209–3.5115 μ IU/mL for TSH, 2.218–3.982 pg/mL for FT3, and 9.4165–19.9307 pmol/L for FT4. The corresponding reference intervals during the second trimester were 0.6982–1.77 ng/mL for T3, 64.078–169.5782 nmol/L for T4, 0.1642–4.1148 μ IU/mL for TSH, 2.116–4.224 pg/mL for FT3, and 5.7625–15.3608 pmol/L for FT4. For the third trimester, the reference intervals were 0.7228–1.6235 ng/mL for T3, 74.9948–146.8485 nmol/L for T4, 0.5293–4.0816 μ IU/mL for TSH, 2.0583–3.6662 pg/mL for FT3, and 6.1875–14.1573 pmol/L for FT4. (Table 4)

As for the median level of hormones, the T3 hormone level decreased in the third trimester, while T4 and FT4 decreased in the second trimester, and there was almost no significant change in the third trimester. Serum FT3 levels declined in the second trimester and continued to decrease in the third trimester. Conversely, TSH concentrations were elevated during the second trimester, with a further increase observed in the third trimester (Fig. 1). These alterations of hormones were in accordance with the physiological changes observed during pregnancy, and were consistent with the findings of other studies (11, 13, 14).

Table 4
Trimester-specific thyroid reference intervals in singleton pregnancies

stage	hormones	T3(ng/mL)	T4(nmol/L)	TSH(μ IU/mL)	FT3(pg/mL)	FT4(pmol/L)
1st	N	218	219	219	219	218
	Mean $\pm$ SD	1.1792 $\pm$ 0.2752	120.3500 $\pm$ 27.5432	1.3767 $\pm$ 0.8963	3.0605 $\pm$ 0.4605	14.14440 $\pm$ 2.6843
	2.5th percentile	0.7385	74.289	0.2209	2.2180	9.4165
	97.5th percentile	1.773	183.772	3.5115	3.9820	19.9307
2nd	N	252	254	257	253	254
	Mean $\pm$ SD	1.2063 $\pm$ 0.2897	111.9724 $\pm$ 26.8781	1.7714 $\pm$ 2.0507	2.9732 $\pm$ 0.5955	10.388 $\pm$ 2.5623
	2.5th percentile	0.6982	64.078	0.1642	2.116	5.7625
	97.5th percentile	1.77	169.5782	4.1148	4.224	15.3608
3rd	N	252	252	252	252	252
	Mean $\pm$ SD	1.1087 $\pm$ 0.2276	109.1392 $\pm$ 20.5001	1.9427 $\pm$ 0.9327	2.79 $\pm$ 0.4531	10.1806 $\pm$ 2.116
	2.5th percentile	0.7328	74.9948	0.5293	2.0583	6.1875
	97.5th percentile	1.6235	146.8485	4.0816	3.6662	14.1573

3. Trimester-specific thyroid reference intervals in twin pregnancies

Using the same criteria, a total of 441 twin pregnant pregnancies were included in the study. Reference intervals were also established independently for twin pregnancies. During the first trimester, the reference intervals were 0.85–1.868 ng/mL for T3, 69.696–177.39 nmol/L for T4, 0.1082–11.9312 μ IU/mL for TSH, 2.374–4.166 pg/mL for FT3, and 6.146–19.17 pmol/L for FT4. During the second trimester, the corresponding reference intervals were 0.783–1.9442 ng/mL for T3, 67.9565–193.2268 nmol/L for T4, 0.0248–22.1026 μ IU/mL for TSH, 2.1558–5.0517 pg/mL for FT3, and 4.63–18.41 pmol/L for FT4. And the reference intervals in the third trimester were 0.7755–1.689 ng/mL for T3, 83.1185–172.1025 nmol/L for T4, 0.2442–5.2898 μ IU/mL for TSH, 2.13–4.1015 pg/mL for FT3, and 6.571–13.6875 pmol/L for FT4. (Table 5) As for the hormone alterations in three trimesters, the level of T3 and FT3 decreased in the third trimester, while FT4 decreased in the second trimester. And the T4 increased in the third trimester. Respectively, the TSH levels increased during the second trimester but showed a downward trend in the third trimester (Fig. 2).

Table 5
Trimester-specific thyroid reference intervals in twin pregnancies

stage	hormones	T3(ng/mL)	T4(nmol/L)	TSH(μ IU/mL)	FT3(pg/mL)	FT4(pmol/L)
1st	N	113	113	113	113	113
	Mean $\pm$ SD	1.2700 $\pm$ 0.2699	117.4785 $\pm$ 27.2023	2.7057 $\pm$ 3.4013	3.0955 $\pm$ 0.521	12.725 $\pm$ 3.0925
	2.5th percentile	0.85	69.696	0.1082	2.374	6.146
	97.5th percentile	1.868	177.39	11.9312	4.166	19.17
2nd	N	184	184	185	184	181
	Mean $\pm$ SD	1.3096 $\pm$ 0.3098	116.2443 $\pm$ 31.4133	3.1722 $\pm$ 5.3602	3.1697 $\pm$ 0.7198	10.2927 $\pm$ 3.4783
	2.5th percentile	0.783	67.9565	0.0248	2.1558	4.63
	97.5th percentile	1.9442	193.2268	22.1026	5.0517	18.41
3rd	N	143	143	143	143	143
	Mean $\pm$ SD	1.1887 $\pm$ 0.2397	122.9803 $\pm$ 24.194	2.3237 $\pm$ 1.3111	2.9727 $\pm$ 0.5007	10.1273 $\pm$ 2.0001
	2.5th percentile	0.7755	83.11185	0.2442	2.13	6.571
	97.5th percentile	1.689	172.1025	5.2898	4.1015	13.6875

4. Comparison of thyroid hormone levels between singleton and twin pregnancies

After clarifying the respective reference intervals and trend for singleton and twin pregnancies, we also compared the hormone differences between singleton and twin pregnancies in three trimesters. During the first trimester, significant differences were observed between singleton and twin pregnancies for T3, TSH, and FT4 (Fig. 3). Both T3 and TSH concentrations were also significantly higher in twin pregnancies ($P < 0.01$), whereas FT4 concentrations were significantly lower ($P < 0.0001$). During the second trimester, twin pregnancies showed significantly higher T3 and FT3 concentrations than singleton pregnancies ($P < 0.01$) (Fig. 4). As for the third trimester, twin pregnancies showed significantly higher concentrations of T3, T4, TSH, and FT3 than singleton pregnancies ($P < 0.01$) (Fig. 5).

Discussion

Pregnancy-related changes in thyroid function are a result of intricate physiological adjustments involving the hypothalamic-pituitary-thyroid axis, thyroid hormone-binding proteins, and peripheral thyroid hormone metabolism. In the present study, TSH, FT4 and FT3 exhibited distinct patterns across gestation. TSH tended to decrease during early pregnancy and subsequently increase during the second and third trimesters, which is consistent with the thyrotropic effect of hCG during early gestation. Because hCG can weakly activate the TSH receptor, the marked increase in circulating hCG during early pregnancy stimulates maternal thyroid hormone production and consequently suppresses pituitary TSH secretion (15, 16). In contrast, FT4 and FT3 generally showed a progressive decline with advancing gestational age. This pattern may reflect increased maternal thyroid hormone requirements, enhanced placental thyroid hormone metabolism, and alterations in peripheral deiodinase activity during pregnancy (17). These show that gestational age is a significant factor in determining maternal thyroid function and support the interpretation of thyroid function tests during pregnancy using reference intervals specific to the trimester or gestational age rather than non-pregnant reference ranges. Furthermore, owing to more consumption of hormones and stronger stimulation of hCG, the thyroid hormone is different between singleton and twin pregnancies (18, 19).

In this study, we established trimester-specific reference intervals for five thyroid function parameters in singleton and twin pregnancies and demonstrated that thyroid hormone profiles differ between the two pregnancy types in a gestational-age-dependent manner. The most prominent differences were observed for TSH and FT4 during the first trimester and for T3, T4, and FT3 during later pregnancy.

In singleton pregnancies, thyroid hormone concentrations changed across gestation, consistent with the physiological adaptation of maternal thyroid function during pregnancy. The reference interval for FT4 decreased from the first to the second trimester and remained relatively lower during the third trimester, whereas the TSH distribution shifted across gestational stages. These findings emphasize the importance of trimester-specific reference intervals rather than applying a single range throughout pregnancy.

Twin pregnancies showed substantially wider distributions for several thyroid parameters, particularly TSH. The upper reference limit of TSH reached 9.2105 μ IU/mL in the first trimester and 22.1026 μ IU/mL in the second trimester, compared with 3.507 and 4.1181 μ IU/mL, respectively, in singleton pregnancies. This broader distribution suggests greater heterogeneity in maternal thyroid adaptation among twin gestations.

The direct comparisons further demonstrated that differences between singleton and twin pregnancies varied according to gestational stage. During the first trimester, twin pregnancies had higher T3 and TSH and lower FT4 than singleton pregnancies. However, the trend of TSH is not accordance with physiological alteration. Because twin pregnancies generally have greater placental mass, enhanced placental hormone production may contribute to stronger effects on maternal thyroid regulation in early pregnancy. The reason may be owing to the gestational week of twin pregnancies is significantly earlier than singleton pregnancies. Early in pregnancy, maternal hCG concentrations rise quickly and often peak

between weeks 8 and 11, which is also when serum TSH is at its lowest (20, 21). Therefore, women with twin pregnancies sampled at an earlier gestational age may not yet have reached the period of maximal hCG-mediated thyroid stimulation and consequent TSH suppression.

The clinical implication of these findings is that reference intervals derived primarily from singleton pregnancies may not adequately represent thyroid physiology in twin pregnancies. Applying singleton-based thresholds to twin gestations could increase the likelihood of misclassification, particularly when hormone concentrations fall outside a conventional singleton range but remain compatible with the physiological distribution observed in twin pregnancy. The trimester- and pregnancy-type-specific intervals established in this study may therefore provide a more appropriate framework for interpreting thyroid function in twin pregnancies.

Conclusion

In conclusion, maternal thyroid hormone profiles differ between singleton and twin pregnancies and vary across gestational stages. The establishment of trimester- and pregnancy-type-specific reference intervals may improve the interpretation of thyroid function during twin pregnancy and reduce potential misclassification of gestational thyroid dysfunction.

Abbreviations

T3 Total triiodothyronine

T4 Tetraiodothyronine

FT3 Free triiodothyronine

FT4 Free thyroxine

TSH Thyroid-stimulating Hormone

Declarations

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Authors' contributions

The study was designed by Jia Mai and Hongjian Xie. All authors contributed to the data collection. Data curation, visualization and the original draft of the manuscript were carried out by Min Wang. Jia Mai contributed to the manuscript revision. Project administration and coordination were led by Hongjian Xie and Xiaojuan Liu.

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Data availability

The data presented in this study are available on request from the corresponding author.

Ethics approval and consent to participate

The study was approved by the Institutional Review Board of West China Second University Hospital (ethics approval no. 2023-405). Patient consent was waived due to the retrospective nature of the study as approved by the Research Ethics Committee. All procedures adhered to the ethical standards outlined in the Declaration of Helsinki.

Competing interests

The authors declare no conflicts of interest.

References

1. Moog NK, Entringer S, Heim C, Wadhwa PD, Kathmann N, Buss C. Influence of maternal thyroid hormones during gestation on fetal brain development. *Neuroscience*. 2017;342:68–100.
2. Walsh JP. Thyroid Function across the Lifespan: Do Age-Related Changes Matter? *Endocrinology and metabolism (Seoul, Korea)*. 2022;37(2):208 – 19.
3. Nathan N, Sullivan SD. Thyroid disorders during pregnancy. *Endocrinol Metab Clin North Am*. 2014;43(2):573–97.
4. Alexander EK, Pearce EN, Brent GA, Brown RS, Chen H, Dosiou C, et al. 2017 Guidelines of the American Thyroid Association for the Diagnosis and Management of Thyroid Disease During Pregnancy and the Postpartum. *Thyroid: official J Am Thyroid Association*. 2017;27(3):315–89.
5. Andersen SL, Laurberg P. Iodine Supplementation in Pregnancy and the Dilemma of Ambiguous Recommendations. *Eur thyroid J*. 2016;5(1):35–43.
6. Puthiyachirakal MA, Hopkins M, AlNatsheh T, Das A. Overview of thyroid disorders in pregnancy. *Maternal health neonatology Perinatol*. 2025;11(1):9.
7. Zgliczynska M, Ostrowska M, Szymusik I, Ciebiera M, Kosinska-Kaczynska K. Maternal thyroid function in multiple pregnancies - a systematic review. *Front Endocrinol*. 2022;13:1044655.
8. Jiang YX, Sun WJ, Zhang Y, Huang Y, Huang YY, Lu GZ, et al. Thyroid function of twin-pregnant women in early pregnancy. *Chin Med J*. 2019;132(17):2033–8.
9. Šálek T, Dhaifalah I, Langova D, Havalová J. Maternal thyroid-stimulating hormone reference ranges for first trimester screening from 11 to 14 weeks of gestation. *J Clin Lab Anal*. 2018;32(6):e22405.

10. Dorizzi RM, Spiazzi G, Rolli N, Maltoni P, Mingolla L, Sgarzani C, et al. Trimester-specific reference intervals for thyroid function parameters in pregnant Caucasian women using Roche platforms: a prospective study. *J Endocrinol Investig.* 2023;46(12):2459–69.
11. Hernández JM, Soldevila B, Velasco I, Moreno-Flores F, Ferrer L, Pérez-Montes de Oca A et al. Reference Intervals of Thyroid Function Tests Assessed by Immunoassay and Mass Spectrometry in Healthy Pregnant Women Living in Catalonia. *J Clin Med.* 2021;10(11).
12. Committee Opinion 700. Methods for Estimating the Due Date. *Obstet Gynecol.* 2017;129(5):e150–4.
13. Zhang X, Yao B, Li C, Mao J, Wang W, Xie X, et al. Reference Intervals of Thyroid Function During Pregnancy: Self-Sequential Longitudinal Study Versus Cross-Sectional Study. *Thyroid: official J Am Thyroid Association.* 2016;26(12):1786–93.
14. Ekinci EI, Lu ZX, Sikaris K, Bittar I, Cheong KY, Lam Q, et al. Longitudinal assessment of thyroid function in pregnancy. *Ann Clin Biochem.* 2013;50(Pt 6):595–602.
15. Hershman JM. Physiological and pathological aspects of the effect of human chorionic gonadotropin on the thyroid. *Best practice & research Clinical endocrinology & metabolism.* 2004;18(2):249 – 65.
16. Nwabuobi C, Arlier S, Schatz F, Guzeloglu-Kayisli O, Lockwood CJ, Kayisli UA. hCG: Biological Functions and Clinical Applications. *Int J Mol Sci.* 2017;18(10).
17. Moleti M, Trimarchi F, Vermiglio F. Thyroid physiology in pregnancy. *Endocrine practice: official journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists.* 2014;20(6):589–96.
18. Korevaar TIM, Leung AM, Alexander EK, Bliddal S, Boelaert K, Brenta G, et al. American Thyroid Association 2026 Guidelines for Thyroid Disease in Preconception, Pregnancy, and Postpartum. *Thyroid: official J Am Thyroid Association.* 2026;36(5):481–544.
19. Chen S, Yu M, Yao Y, Li Y, He A, Zhou Z, et al. Thyroid Hormone Biomonitoring: A Review on Their Metabolism and Machine-Learning Based Analysis on Effects of Endocrine Disrupting Chemicals. Volume 2. *Environment & health;* 2024. pp. 350–72. (Washington, DC). 6.
20. Larraín D, Caradeux J. β -Human Chorionic Gonadotropin Dynamics in Early Gestational Events: A Practical and Updated Reappraisal. *Obstet Gynecol Int.* 2024;2024:8351132.
21. Braunstein GD, Hershman JM. Comparison of serum pituitary thyrotropin and chorionic gonadotropin concentrations throughout pregnancy. *J Clin Endocrinol Metab.* 1976;42(6):1123–6.

Figures

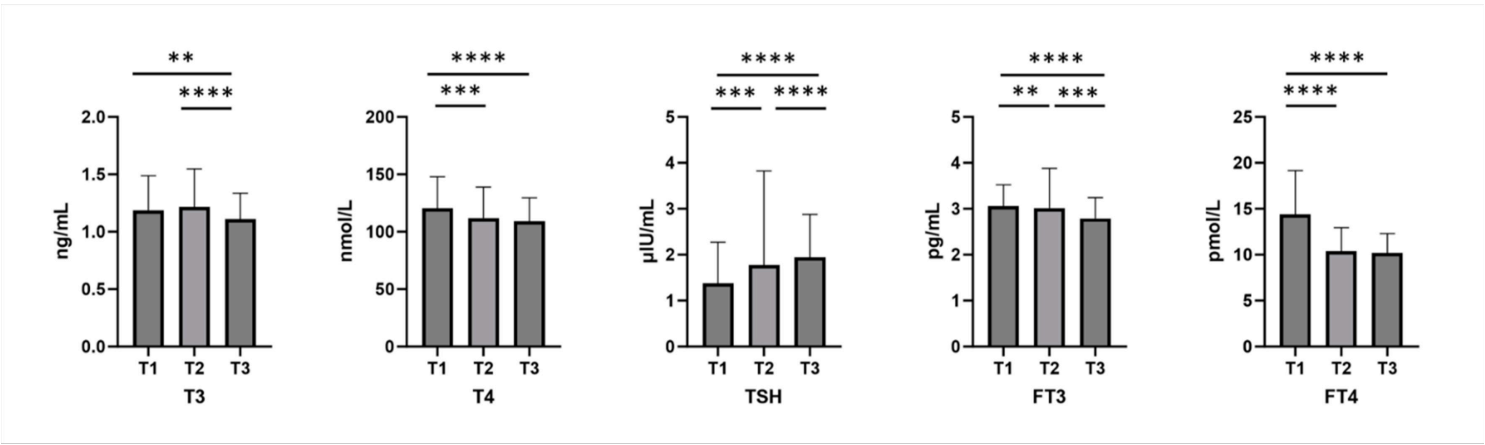


Figure 1

Alteration of hormone levels of singleton pregnancies in three trimesters.

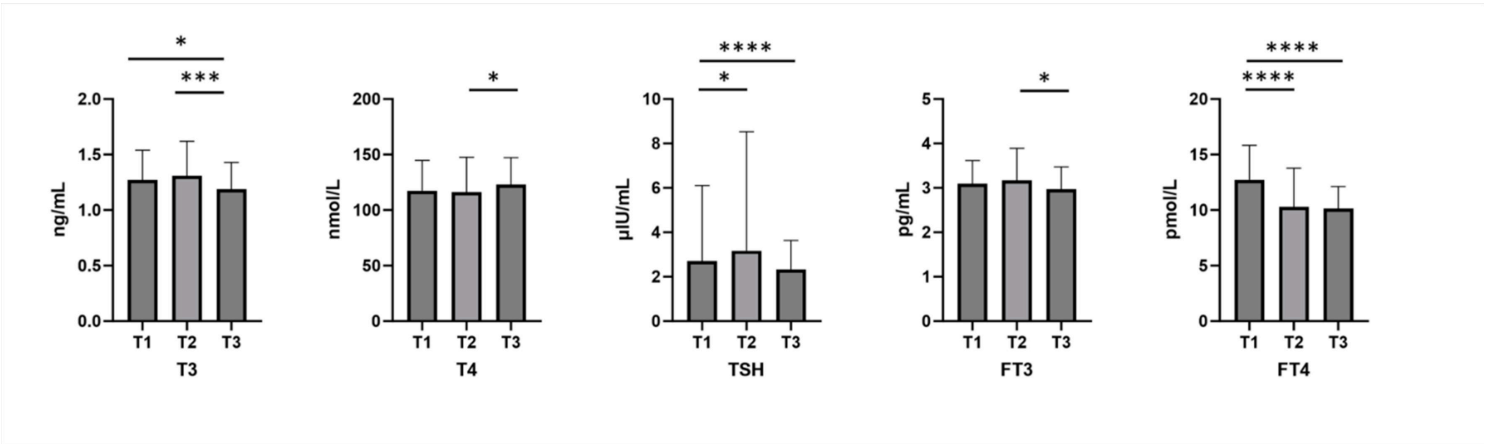


Figure 2

Alteration of hormone levels of twin pregnancies in three trimesters.

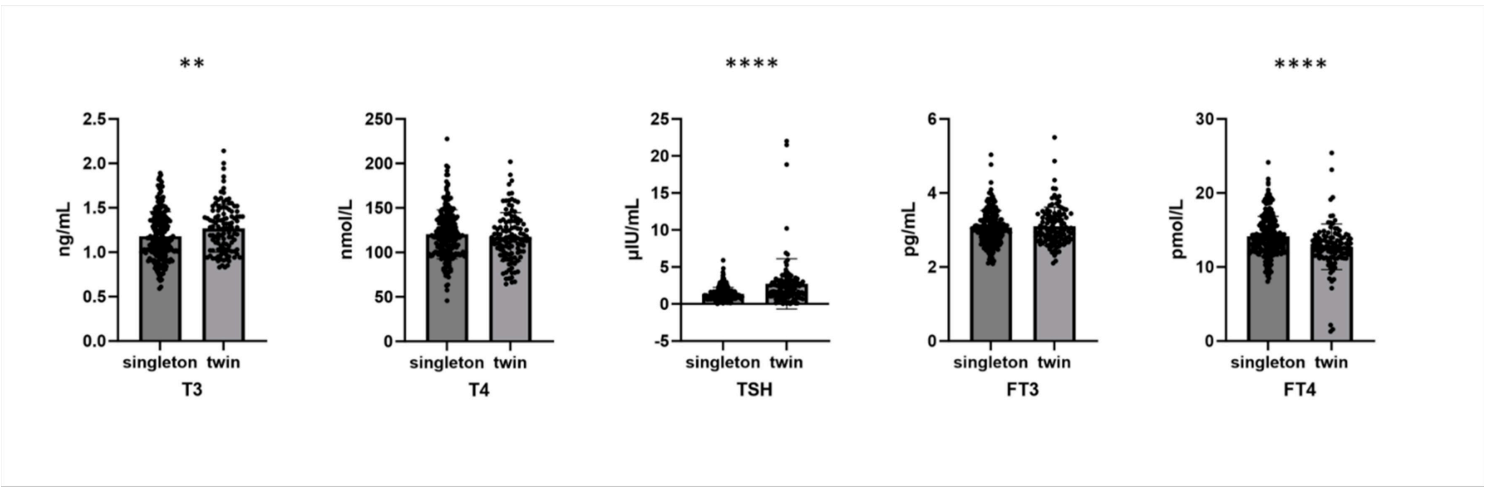


Figure 3

Comparison of thyroid hormone levels between singleton and twin pregnancies in the first trimester.

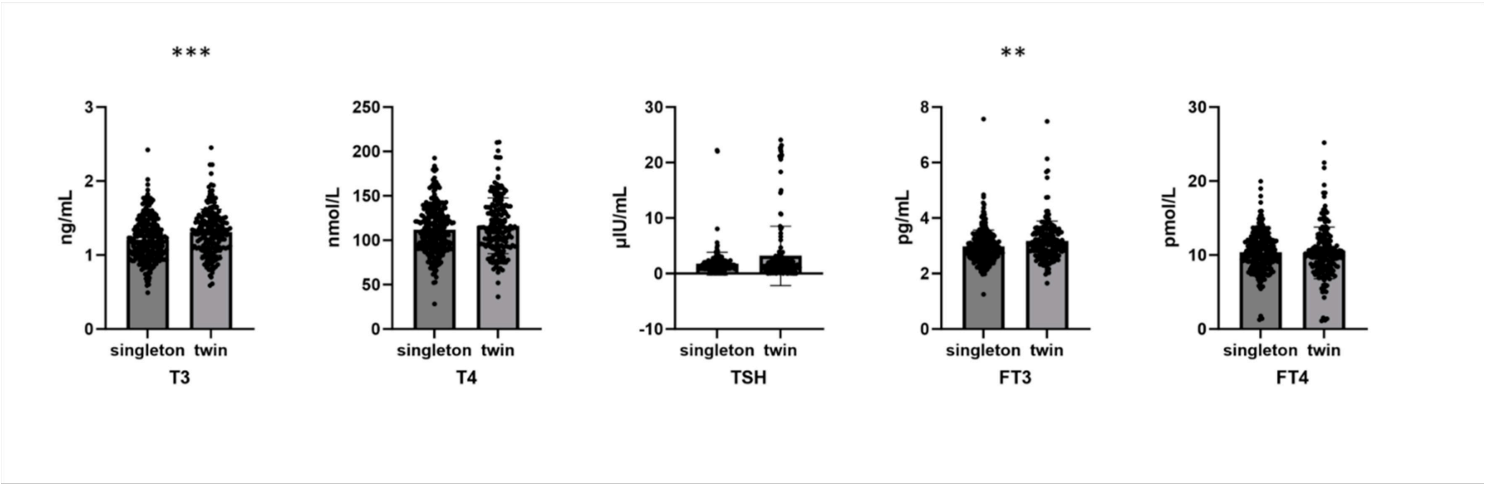


Figure 4

Comparison of thyroid hormone levels between singleton and twin pregnancies in the second trimester.

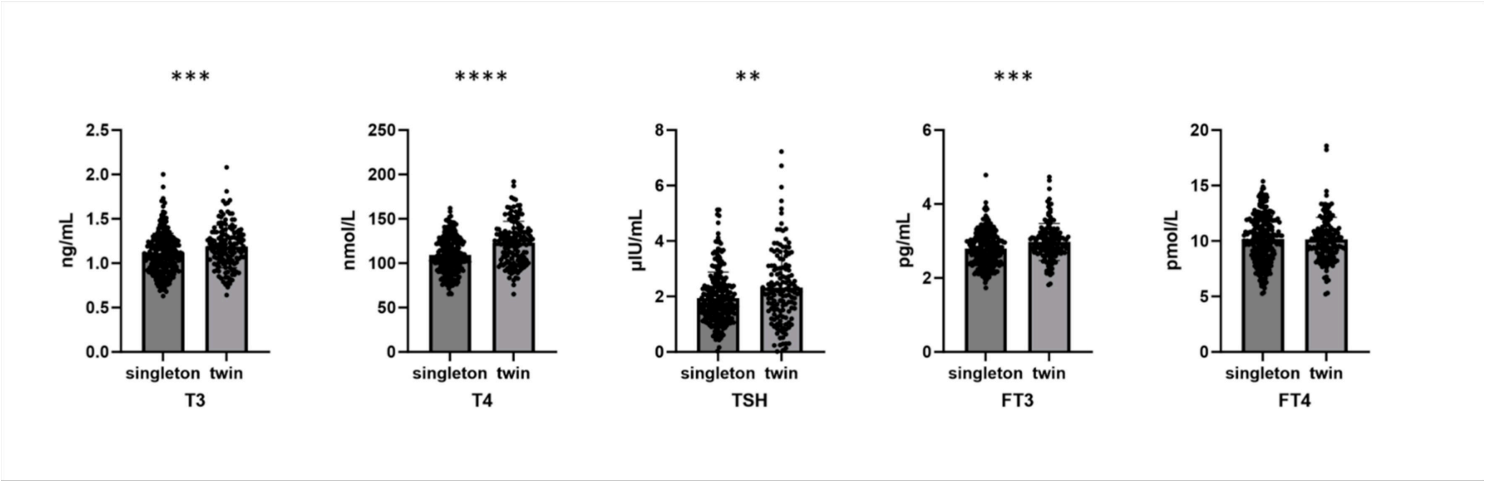


Figure 5

Comparison of thyroid hormone levels between singleton and twin pregnancies in the third trimester.