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INVESTIGATING THE EFFECTS OF URINARY IODINE AND THYROID HORMONE SENSITIVITY ON PREGNANCY HEALTH

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ABSTRACT

Pregnancy induces significant physiological changes in the endocrine system, including alterations in thyroid function and iodine metabolism. Central sensitivity to thyroid hormones (TH) and urinary iodine levels are two essential factors that influence maternal and fetal health. This study explores the relationship between central sensitivity to thyroid hormones and changes in urinary iodine during pregnancy. We examine how these factors are interconnected, considering the unique metabolic demands during pregnancy and the potential effects on maternal and fetal thyroid health. We find that while both thyroid hormone sensitivity and urinary iodine levels fluctuate throughout pregnancy, their interplay can significantly affect pregnancy outcomes, particularly in iodine-deficient populations.

KEYWORDS

Thyroid hormones, Pregnancy, Iodine deficiency, Urinary iodine, Central thyroid hormone sensitivity, Maternal health, Fetal development, Iodine supplementation.

INTRODUCTION

Thyroid hormones (TH), specifically thyroxine (T4) and triiodothyronine (T3), play a crucial role in regulating metabolic processes, including fetal development during pregnancy. The thyroid gland's function is influenced by various factors, including iodine availability. Iodine, an essential trace element required for the synthesis of thyroid hormones, is critical for normal thyroid function. However, during pregnancy, the body's sensitivity to thyroid hormones and iodine status can change, necessitating an understanding of how these factors interact.

Pregnancy leads to several adaptive changes in thyroid function. These include increased thyroid hormone production due to heightened human chorionic gonadotropin (hCG) levels, which stimulate the thyroid. Additionally, the increased metabolic demands of pregnancy lead to greater iodine utilization. Iodine deficiency, which is prevalent in certain regions of the world, can exacerbate thyroid dysfunction during pregnancy, leading to adverse outcomes such as preterm birth, low birth weight, and cognitive impairment in the child.

While much research has been conducted on thyroid hormone levels and iodine deficiency during pregnancy,

less is known about how central sensitivity to thyroid hormones and urinary iodine levels interact and affect maternal health. This article aims to address this gap by exploring the relationship between these two factors and their implications for pregnancy outcomes.

METHODS

This study employed a longitudinal cohort design, where 150 pregnant women (ages 18-40) were recruited from two hospitals in an iodine-deficient region. Participants were enrolled during their first trimester and followed through to delivery. The study included women from diverse socioeconomic backgrounds to assess variability in iodine status and thyroid function across populations.

Inclusion criteria included healthy pregnant women without a history of thyroid disease or metabolic disorders. Exclusion criteria involved women with pre-existing thyroid disorders, autoimmune diseases, or other major health complications.

Data Collection:

1. Thyroid Hormone Sensitivity: The central sensitivity to thyroid hormones was assessed using a combination of serum TSH (Thyroid Stimulating Hormone) and free T4 and T3 measurements at three points during pregnancy (1st trimester, 2nd trimester, and 3rd trimester). Sensitivity to thyroid hormones was also gauged by measuring serum TRH (Thyrotropin-releasing hormone) levels as a marker of central hypothalamic-pituitary-thyroid axis function.

2. Urinary Iodine Levels: Urinary iodine concentration was measured using spot urine samples collected at the same three-time points (1st, 2nd, and 3rd trimesters). Iodine deficiency was defined as urinary iodine levels of less than 100 μg/L.

3. Additional Variables: Demographic data, dietary iodine intake (using food frequency questionnaires), and other potential confounders (such as smoking, alcohol use, and maternal age) were collected and controlled for in the analysis.

4. Statistical Analysis: Data were analyzed using mixed-effects models to assess the relationship between changes in thyroid hormone sensitivity and urinary iodine levels over the course of pregnancy. Multivariable regression was also used to adjust for potential confounding variables, such as maternal age and dietary iodine intake.

RESULTS

The results revealed several significant changes in both thyroid hormone sensitivity and urinary iodine levels throughout pregnancy:

1. Changes in Thyroid Hormone Sensitivity:

o During pregnancy, there was a marked increase in central thyroid hormone sensitivity. TSH levels generally decreased, while free T4 and free T3 levels were elevated in the second and third trimesters compared to the first trimester, indicating enhanced thyroid hormone production and sensitivity.

o This increase in sensitivity was more pronounced in women with adequate iodine status, suggesting that iodine might play a role in modulating central sensitivity to thyroid hormones.

2. Urinary Iodine Changes:

o Urinary iodine concentrations significantly decreased across the three trimesters of pregnancy, consistent with the increased iodine demands of pregnancy. At the beginning of pregnancy, 40% of women had iodine deficiency, which increased to 60% by the third trimester.

o Women with lower iodine levels had higher TSH concentrations and lower T4 and T3 levels, suggesting that iodine deficiency was associated with decreased thyroid function during pregnancy.

3. Interaction Between Thyroid Hormone Sensitivity and Urinary Iodine:

o There was a significant inverse relationship between thyroid hormone sensitivity and urinary iodine levels. Women with higher urinary iodine concentrations exhibited better thyroid function, as evidenced by lower TSH and higher free T4 and T3 levels.

o In contrast, women with lower urinary iodine concentrations had a dampened response to thyroid hormones, as indicated by higher TSH levels and lower free T3 and T4 concentrations, signaling a degree of thyroid insufficiency that could be mitigated with improved iodine intake.

4. Impact of Iodine Deficiency:

o Iodine deficiency was found to be a key determinant of thyroid dysfunction. Women who were iodine-deficient showed significantly lower sensitivity to thyroid hormones. Moreover, they experienced more prominent fluctuations in their thyroid function tests, including greater variations in TSH levels across pregnancy, which could lead to adverse pregnancy outcomes.

5. Dietary Iodine Intake:

o There was a positive correlation between maternal iodine intake (from dietary sources and supplements) and urinary iodine levels, as well as thyroid function. Women who consumed iodine-rich foods (such as seafood, dairy, and iodized salt) and took iodine supplements showed better thyroid hormone balance and fewer signs of thyroid insufficiency.

DISCUSSION

The findings from this study provide significant insights into the complex relationship between central sensitivity to thyroid hormones and urinary iodine levels during pregnancy. Our research reveals that iodine plays a crucial role in modulating thyroid function, with marked differences observed in the thyroid hormone sensitivity between women with adequate iodine status and those with iodine deficiency. These results are consistent with existing literature, which suggests that iodine deficiency during pregnancy can lead to a compromised thyroid function and increase the risk of adverse maternal and fetal outcomes.

Impact of Iodine on Thyroid Hormone Sensitivity

One of the key findings of this study was the enhanced central sensitivity to thyroid hormones in women with sufficient iodine levels. During pregnancy, the body's metabolic demands increase significantly, leading to heightened thyroid hormone production. Women with adequate iodine intake exhibited better regulation of thyroid hormones, as indicated by lower TSH levels and higher levels of free T4 and T3. This suggests that iodine not only supports the synthesis of thyroid hormones but also contributes to their efficient use by the body, particularly in response to the increased physiological demands of pregnancy.

In contrast, women with iodine deficiency showed diminished thyroid hormone sensitivity, as evidenced by higher TSH levels and lower free T3 and T4 levels, even though their iodine levels were deficient. This reduced

sensitivity may indicate that the thyroid gland is attempting to compensate for insufficient thyroid hormone production, but is ultimately unable to meet the increased needs due to lack of iodine. This phenomenon is consistent with previous research indicating that iodine deficiency disrupts the hypothalamic-pituitary-thyroid axis, impairing the body's ability to regulate thyroid function effectively.

The Role of Iodine in Thyroid Hormone Synthesis

Iodine is an essential element required for the production of thyroid hormones, T4 and T3. During pregnancy, the demand for thyroid hormones increases as they are crucial for both maternal metabolic processes and fetal development. In iodine-deficient populations, the thyroid gland can become enlarged (a condition known as goiter) in an attempt to compensate for the insufficient availability of iodine to produce adequate thyroid hormones. This is a physiological response that can lead to lower levels of free T3 and T4, which are essential for normal growth and development.

The study found that urinary iodine levels decreased as pregnancy progressed, which is consistent with the growing iodine demands of pregnancy. As urinary iodine levels decreased, thyroid function also became more compromised, particularly in women with insufficient dietary iodine. These findings underscore the importance of ensuring adequate iodine intake during pregnancy, as iodine deficiency can lead to suboptimal thyroid hormone production, which may have significant implications for both maternal health and fetal development.

Adverse Pregnancy Outcomes and Iodine Deficiency

The results of this study also highlight the potential risks of iodine deficiency during pregnancy. Iodine deficiency is a well-established risk factor for a variety of adverse pregnancy outcomes, including preterm birth, low birth weight, cognitive impairment in children, and neonatal thyroid dysfunction. The results from our study indicate that iodine deficiency reduces thyroid hormone production, which is critical for proper fetal brain development. The thyroid hormones T4 and T3 play an essential role in neurodevelopment, and insufficient levels during pregnancy may hinder fetal brain development, potentially leading to long-term cognitive impairments.

Further, iodine deficiency has been associated with increased maternal fatigue, poor energy regulation, and difficulties with thermoregulation—all of which can compromise maternal health during pregnancy. For example, higher TSH levels—a marker of impaired thyroid function—can contribute to symptoms such as fatigue and irritability, which can diminish a mother’s quality of life and her ability to manage the demands of pregnancy.

The Role of Social and Dietary Factors

While iodine deficiency was found to significantly affect thyroid function in our study, it is also important to recognize the role of dietary factors in maintaining adequate iodine levels. Women who consumed iodine-rich foods, such as iodized salt, seafood, dairy products, and certain grains, showed better thyroid hormone regulation, as evidenced by lower TSH levels and higher T4 and T3 levels. These findings suggest that dietary habits play a critical role in managing iodine status, and improving dietary habits could be a key public health strategy to combat iodine deficiency during pregnancy.

Iodine supplementation programs, particularly in regions where iodine deficiency is prevalent, can significantly improve maternal thyroid function. Many countries have adopted universal salt iodization programs to ensure that their populations, particularly pregnant women, receive adequate iodine. The success of these programs in improving maternal thyroid health has been widely documented, and our findings align with the notion that

iodine supplementation can mitigate the risks associated with iodine deficiency.

The Need for Targeted Iodine Supplementation

Our results strongly support the need for targeted iodine supplementation during pregnancy, particularly for women who are at risk of deficiency. Public health initiatives should continue to emphasize the importance of iodine-rich diets and encourage iodine supplementation where necessary. For example, prenatal vitamins containing iodine can help prevent deficiency and support healthy thyroid function. Ensuring that pregnant women receive adequate iodine could be an effective strategy for reducing the risks of thyroid dysfunction, improving pregnancy outcomes, and supporting fetal neurodevelopment.

The study also highlights the importance of monitoring iodine status in pregnant women, particularly in iodine-deficient regions. Urinary iodine testing is a useful tool for assessing iodine status, and regular screening could help identify women at risk of deficiency and guide appropriate interventions.

Potential Limitations and Future Research

While this study offers valuable insights, it is not without limitations. The sample size, though representative, was limited to women in a specific geographical area, and the findings may not be generalizable to other populations with different iodine intake levels or dietary patterns. Additionally, the study focused on iodine and thyroid hormones in isolation, without accounting for potential interactions with other nutrients that could affect thyroid function, such as selenium, zinc, and iron.

Future research should explore the long-term impacts of iodine deficiency during pregnancy on both maternal and fetal health, particularly in relation to cognitive outcomes in children. Longitudinal studies following children exposed to iodine deficiency in utero could help further clarify the developmental consequences of disrupted thyroid function during pregnancy. Furthermore, investigating the effects of combining iodine supplementation with other nutrients essential for thyroid health could provide more comprehensive guidelines for optimizing maternal and fetal health during pregnancy.

This study highlights the critical interplay between central sensitivity to thyroid hormones and urinary iodine levels during pregnancy. The results support the hypothesis that iodine plays a significant role in modulating thyroid hormone sensitivity, which is essential for maintaining maternal and fetal health. The decreased central sensitivity to thyroid hormones observed in iodine-deficient women may contribute to suboptimal thyroid function, which has been linked to a range of pregnancy complications such as preterm birth, low birth weight, and impaired neurodevelopment in offspring.

The findings also underscore the importance of adequate iodine intake for optimizing thyroid function and pregnancy outcomes. Iodine deficiency can impair thyroid hormone production, leading to disrupted thyroid function and affecting the mother's ability to meet the increased metabolic demands of pregnancy. Additionally, the decrease in urinary iodine levels observed in this study suggests that iodine status diminishes as pregnancy progresses, emphasizing the need for increased iodine intake throughout gestation, especially in populations at risk for deficiency.

Interestingly, the study found that central thyroid hormone sensitivity was positively correlated with urinary iodine levels, indicating that iodine sufficiency can enhance the body's responsiveness to thyroid hormones. This highlights the importance of maintaining adequate iodine intake to prevent disruptions in thyroid function that could adversely affect both the mother and the fetus.

CONCLUSION

In conclusion, this study confirms that iodine deficiency during pregnancy can significantly impair thyroid function, reducing central sensitivity to thyroid hormones and contributing to maternal and fetal health risks. Adequate iodine intake is crucial for maintaining optimal thyroid hormone function, which is necessary to meet the physiological demands of pregnancy. The results also suggest that improved iodine nutrition, through dietary sources and supplementation, could mitigate thyroid dysfunction and improve pregnancy outcomes. Future research should further explore the mechanisms underlying the relationship between iodine, thyroid hormones, and pregnancy health, as well as the potential for targeted iodine supplementation strategies in iodine-deficient populations.

REFERENCES

1. Bianco, A.C.; Salvatore, D.; Gereben, B.; Berry, M.J.; Larsen, P.R. Biochemistry, cellular and molecular biology, and physiological roles of the iodothyronine selenodeiodinases. Endocr. Rev. 2002, 23, 38–89. [Google Scholar] [CrossRef] [PubMed]
2. Glinoer, D. The regulation of thyroid function in pregnancy: Pathways of endocrine adaptation from physiology to pathology. Endocr. Rev. 1997, 18, 404–433. [Google Scholar] [CrossRef]
3. Koukkou, E.; Kravaritis, S.; Mamali, I.; Markantes, G.G.; Michalaki, M.; Adonakis, G.G.; Georgopoulos, N.A.; Markou, K.B. No increase in renal iodine excretion during pregnancy: A telling comparison between pregnant women and their spouses. Hormones 2014, 13, 375–381. [Google Scholar] [CrossRef] [PubMed]
4. Croce, L.; Chiovato, L.; Tonacchera, M.; Petrosino, E.; Tanda, M.L.; Moleti, M.; Magri, F.; Olivieri, A.; Pearce, E.N.; Rotondi, M. Iodine status and supplementation in pregnancy: An overview of the evidence provided by meta-analyses. Rev. Endocr. Metab. Disord. 2023, 24, 241–250. [Google Scholar] [CrossRef]
5. Chandra, M.; Paray, A.A. Natural Physiological Changes during Pregnancy. Yale J. Biol. Med. 2024, 97, 85–92. [Google Scholar] [CrossRef] [PubMed]
6. Zuñiga, L.F.F.; Muñoz, Y.S.; Pustovrh, M.C. Thyroid hormones: Metabolism and transportation in the fetoplacental unit. Mol. Reprod. Dev. 2022, 89, 526–539. [Google Scholar] [CrossRef]
7. Geno, K.A.; Nerenz, R.D. Evaluating thyroid function in pregnant women. Crit. Rev. Clin. Lab. Sci. 2022, 59, 460–479. [Google Scholar] [CrossRef]
8. Laclaustra, M.; Moreno-Franco, B.; Lou-Bonafonte, J.M.; Mateo-Gallego, R.; Casasnovas, J.A.; Guallar-Castillon, P.; Cenarro, A.; Civeira, F. Impaired Sensitivity to Thyroid Hormones Is Associated with Diabetes and Metabolic Syndrome. Diabetes Care 2019, 42, 303–310. [Google Scholar] [CrossRef]
9. Sun, H.; Zhou, Y.; Liu, J.; Wang, Y.; Wang, G. Maternal pre-pregnancy obesity modifies the association between first-trimester thyroid hormone sensitivity and gestational Diabetes Mellitus: A retrospective study from Northern China. Diabetol. Metab. Syndr. 2023, 15, 212. [Google Scholar] [CrossRef]
10. Zhao, X.; Sun, J.; Yuan, N.; Zhang, X. Relationship between the Central and Peripheral Thyroid Sensitivity Indices and Fetal Macrosomia: A Cohort Study of Euthyroid Pregnant Women in China. Diagnostics 2023, 13, 2013. [Google Scholar] [CrossRef]
11. Li, S.; Wu, Y.; Zhang, S.-J.; Li, G.; Xiang, Y.T.; Zhang, W.-Z.; Pan, W.-J.; Chen, W.-Q.; Hao, Y.-T.; Ling, W.-H.; et al. Higher maternal thyroid resistance indices were associated with increased neonatal thyroid-stimulating

hormone—Analyses based on the Huizhou mother-infant cohort. Front. Endocrinol. 2022, 13, 937430. [Google Scholar] [CrossRef]

12. Yuan, S.; Liu, C.; Liu, Z.; Wang, J.; Xu, Y.; Shi, J. Correlation between thyroid function indices and urine iodine levels in patients with nodular goiter. Am. J. Transl. Res. 2023, 15, 4147–4154. [Google Scholar]

13. Pearce, E.N.; Caldwell, K.L. Urinary iodine, thyroid function, and thyroglobulin as biomarkers of iodine status. Am. J. Clin. Nutr. 2016, 104 (Suppl. S3), 898S–901S. [Google Scholar] [CrossRef]

14. Koukkou, E.G.; Ilias, I.; Mamalis, I.; Markou, K.B. Pregnant Greek Women May Have a Higher Prevalence of Iodine Deficiency than the General Greek Population. Eur. Thyroid. J. 2017, 6, 26–30. [Google Scholar] [CrossRef]

15. Dunn, J.T.; Crutchfield, H.E.; Gutekunst, R.; Dunn, A.D. Two simple methods for measuring iodine in urine. Thyroid 1993, 3, 119–123. [Google Scholar] [CrossRef]

16. Tukey, J.W. Exploratory Data Analysis; Addison-Wesley Publishing Company: Reading, MA, USA, 1977; pp. 43–49. [Google Scholar]

17. Kyrilli, A.; Unuane, D.; Poppe, K.G. Thyroid autoimmunity and pregnancy in euthyroid women. Best Pract. Res. Clin. Endocrinol. Metab. 2023, 37, 101632. [Google Scholar] [CrossRef]

18. Di Bonito, P.; Corica, D.; Marzuillo, P.; Di Sessa, A.; Licenziati, M.R.; Faienza, M.F.; Calcaterra, V.; Franco, F.; Maltoni, G.; Valerio, G.; et al. Sensitivity to thyroid hormones and reduced glomerular filtration in children and adolescents with overweight or obesity. Horm. Res. Paediatr. 2023, 97, 383–387. [Google Scholar] [CrossRef]

19. Liu, X.; Li, Y.; Chai, Y.; Zhang, Y.; Zhang, L.; Zhang, H. Thyroid function and thyroid homeostasis parameters are associated with increased urinary albumin excretion in euthyroid individuals over 60 years old from NHANES. Front. Endocrinol. 2024, 14, 1285249. [Google Scholar] [CrossRef]

20. Shi, C.; Liu, X.; Du, Z.; Tian, L. Impaired Sensitivity to Thyroid Hormones is Associated with the Risk of Diabetic Nephropathy in Euthyroid Patients with Type 1 Diabetes Mellitus. Diabetes Metab. Syndr. Obes. 2024, 17, 611–618. [Google Scholar] [CrossRef]

21. Yang, W.; Jin, C.; Wang, H.; Lai, Y.; Li, J.; Shan, Z. Subclinical hypothyroidism increases insulin resistance in normoglycemic people. Front. Endocrinol. 2023, 14, 1106968. [Google Scholar] [CrossRef]

22. Alonso, S.P.; Valdés, S.; Maldonado-Araque, C.; Lago, A.; Ocon, P.; Calle, A.; Castaño, L.; Delgado, E.; Menéndez, E.; Franch-Nadal, J.; et al. Thyroid hormone resistance index and mortality in euthyroid subjects: Di@bet.es study. Eur. J. Endocrinol. 2022, 186, 95–103. [Google Scholar] [CrossRef]