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# Relationship between maternal thyroid hormones and serum magnesium levels in pregnancy

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## Abstract

This study aims to evaluate the relationship between thyroid hormones [thyroid-stimulating hormone (TSH), free T3, free T4] and serum magnesium levels according to trimesters during pregnancy. The data of a total of 75 pregnant women in the 1st, 2nd and 3rd trimesters and 25 non-pregnant women of similar age group who were admitted to a family health center and whose laboratory records included thyroid function tests and serum magnesium levels were retrospectively analyzed. Each group consisted of 25 patients. Thyroid hormones and magnesium levels were compared between the groups, and correlation analyses were performed between thyroid hormones and magnesium levels in the pregnant groups. Free T3, free T4 and magnesium levels were significantly lower in the 2nd and 3rd trimesters of pregnancy compared to non-pregnant women. TSH levels were not significantly different between the groups. Correlation analysis revealed a moderate positive and significant correlation between free T3 and magnesium levels in pregnant women (r=.340, p=.003). No significant correlation was found between TSH or free T4 and magnesium levels. Thyroid hormones and magnesium levels decrease as pregnancy progresses, and especially the positive relationship between free T3 and magnesium suggests the biological importance of magnesium in this process.

**Keywords:** Essential metals, magnesium, micronutrient, thyroid-stimulating hormone, free thyroxine

## Introduction

Pregnancy is a dynamic physiological process involving substantial changes in maternal hormonal and metabolic systems to protect maternal health and support optimal fetal development. Among these endocrine adaptations, alterations in thyroid function are particularly important for maintaining metabolic balance throughout gestation. Thyroid hormones (TH), especially in early pregnancy, play a crucial role in fetal growth and neurodevelopment [1].

During pregnancy, maternal serum Thyroid-Stimulating Hormone (TSH) levels differ from those in non-pregnant individuals due to the combined effects of human chorionic gonadotropin (hCG) and estrogen. Elevated hCG in early gestation stimulates TSH receptors, leading to increased production of thyroxine (T4) and tri-iodothyronine (T3), and consequently suppressing TSH secretion. In parallel, estrogen-induced elevation of thyroxine-binding globulin (TBG) increases total T4 and T3 levels, while free T4 (fT4) concentrations may decrease due to enhanced binding. These changes are most pronounced during the first trimester, after which hormone levels stabilize until term [2].

For the first 12 weeks of gestation, the fetus depends entirely on maternal T4 supplied via the placenta. Fetal TH production begins around the 14th-16th week and remains limited until late in the second trimester. Normal maternal thyroid function is therefore essential during the early and mid-gestational period, as approximately 30% of T4 in cord blood at birth originates from the mother [3,4].

Magnesium (Mg) is the fourth most abundant cation in the human body and serves as a cofactor for numerous enzymatic processes, including the synthesis and peripheral conversion of THs from T4 to T3. Deficiency during pregnancy may negatively impact both maternal thyroid function and fetal development [5-7]. Although previous studies have suggested a link between Mg status and TH metabolism, data on how this relationship evolves

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across pregnancy trimesters remain limited.

This present study investigates the association between TH and serum Mg levels in pregnant and non-pregnant women. Understanding this relationship may contribute to improved nutritional assessment and endocrine monitoring strategies during prenatal care.

## Material and Methods

This retrospective study was conducted on laboratory data of pregnant and non-pregnant women followed up in a Family Health Unit (FHU) in Karaman. The study's sample population comprised 75 pregnant women, for whom thyroid function tests (TSH, fT3, fT4) and serum Mg levels were measured during pregnancy. Pregnant participants were divided into three groups according to gestational weeks: 1st trimester (0-13 weeks), 2nd trimester (14-26 weeks) and 3rd trimester (27 weeks and above). Each trimester group comprised 25 pregnant women. The control group comprised 25 healthy women of similar age who were not pregnant and did not have any chronic systemic disease. Consequently, a total of 100 participants were retrospectively evaluated. The data were scanned from the electronic health records covering the period between April 2023 and May 2025.

Age, gestational week, TSH, fT3, fT4 and serum Mg levels of the individuals included in the study were recorded. Laboratory data were obtained from patients' files and electronic health records. Patients with a history of thyroid disease, thyroid medications (levothyroxine, antithyroid drugs, etc.), Mg supplements or chronic systemic diseases such as kidney disease, diabetes mellitus, hypertension, as well as those with missing laboratory data were excluded from the study.

TSH, fT3, and fT4 were analyzed using the YHLO iFlash 3000 Chemiluminescence Immunoassay Analyzer, and serum Mg levels were analyzed using the Beckman Coulter AU5800 Series Clinical Chemistry Analyzer.

Prior to the initiation of the study, ethical approval was obtained from the Karamanoğlu Mehmet Bey University Faculty of Medicine Ethics Committee on June 4, 2025, reference number 21-2025/10.

### Statistical Analysis

The data obtained in the study were evaluated using IBM SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA) software for statistical analysis. Continuous variables were summarized as mean±standard deviation (SD). The One-way analysis of variance (One-way ANOVA) was used to determine the relationships between age, TSH, fT3, fT4 and Mg levels of the patient groups. Tukey's multiple comparison test (post-hoc) was used to determine between-group differences in variables with significant differences. In addition, Pearson correlation analysis was performed to evaluate the relationship between Mg levels and THs (TSH, fT3 and fT4) among pregnant women. The significance level was accepted as $p<.05$ in all statistical tests.

## Result

A total of 100 participants were retrospectively evaluated in this study. The pregnant cohort consisted of 75 women, with 25 different individuals in each trimester group (1st, 2nd, and 3rd trimesters). The control group included 25 non-pregnant women of similar age. No pregnant participant was followed across multiple trimesters.

The mean age of all participants was 28.4±5.8 years, with no statistically significant difference among the groups. Overall, mean serum Mg, TSH, fT3, and fT4 levels were 1.8±0.2 mg/dL, 1.9±0.9 mU/L, 3.1±0.4 ng/dL, and 1.1±0.2 ng/dL, respectively.

One-way ANOVA revealed no significant differences in age and TSH levels among the groups. In contrast, significant differences were observed in fT3, fT4, and Mg concentrations ($p=.001$, .002, and .001, respectively) (Table 1). For these three parameters, the 2nd and 3rd trimester values were comparable to each other but significantly lower than those of non-pregnant women and women in the 1st trimester (Table 1).

Pearson correlation analysis was performed to assess the relationship between Mg levels and THs in pregnant women. No significant correlation was found between Mg and TSH ($p=.9$) or Mg and fT4 ($p=.1$). However, a moderate, positive, and statistically significant correlation was identified between Mg and fT3 levels ($p=.003$) (Figure-1, Table-2).

**Table 1.** Comparison of age, serum Mg and TH levels (TSH, fT3, fT4) among pregnant trimester groups and non-pregnant controls

| Parameter | Non-Pregnant (n=25) | 1$^{st}$ Trimester (n=25) | 2$^{nd}$ Trimester (n=25) | 3$^{rd}$ Trimester (n=25) | P |
|---|---|---|---|---|---|
| **Age** | 28.4±7.2$^{a}$ | 29±6.4$^{a}$ | 27.8±4$^{a}$ | 28.4±5.5$^{a}$ | NS |
| **TSH** | 1.9±0.7$^{b}$ | 2±1.2$^{b}$ | 1.8±0.9$^{b}$ | 1.9±0.8$^{b}$ | NS |
| **fT3** | 3.3±0.3$^{cd}$ | 3.3±0.3$^{c}$ | 3±0.3$^{de}$ | 2.8±0.3$^{e}$ | .001 |
| **fT4** | 1.1±0.2$^{fg}$ | 1.2±0.1$^{f}$ | 1±0.1$^{g}$ | 1±0.2$^{g}$ | .002 |
| **Mg** | 1.9±0.2$^{h}$ | 1.9±0.1$^{h}$ | 1.8±0.2$^{i}$ | 1.7±0.1$^{i}$ | .001 |

Data reported as mean±SD. Any groups with different superscripts indicate statistically significant differences (P<.05).

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**Table 2.** Pearson correlation analysis between serum Mg and TH levels (TSH, fT3, fT4) in pregnant women

| Parameter | Mean±SD | Mg (1.8±0.2) | | |
|---|---|---|---|---|
| | | r | df | P |
| **TSH** | 1.9±1 | 0.019 | 73 | .9 |
| **fT3** | 3.1±0.4 | 0.340 | 73 | .003 |
| **fT4** | 1.1±0.2 | 0.143 | 73 | .1 |

Data reported as mean±SD

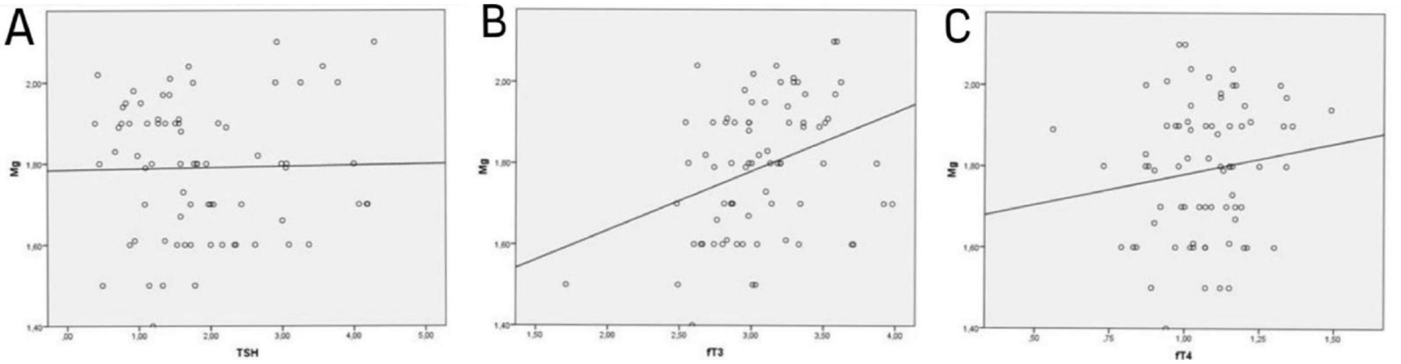


**Figure 1.** The relationship between Mg and TSH levels (A), Mg and fT3 levels (B), and Mg and fT4 levels (C) during pregnancy. fT3 was positively correlated with Mg (p=.003)

## Discussion

In this study, serum THs and Mg levels were evaluated in different trimesters of pregnancy and the findings were compared with non-pregnant control group. The results showed a significant decrease in fT3, fT4 and Mg levels in the 2nd and 3rd trimesters of pregnancy. On the other hand, there was no significant difference in TSH levels between trimesters or compared to the control group. In correlation analyses, a moderate, positive, and statistically significant correlation was found between Mg levels and fT3, while no significant correlation was observed with fT4 or TSH.

It is known that changes in thyroid function during pregnancy are part of physiologic adaptation. Especially increased estrogen levels and the stimulatory effect of hCG on thyroid may cause changes in THs. In the study by Wang et al., which investigated the effect of iron deficiency on THs during pregnancy, fT3 and fT4 levels were shown to be low in the 2nd and 3rd trimesters in normal pregnant women, similar to our study [8]. In a study examining the reference values of THs in healthy pregnant women in Poland, TSH was significantly lower in the first trimester compared to the second and third trimesters, but the values in all trimesters were lower than in the general population. The same study also showed that fT3 and fT4 were significantly lower in the 2nd and 3rd trimesters compared to the 1st trimester [9]. In another study conducted by Khalid et al., TSH increased and fT3 and fT4 decreased as gestational week progressed [10]. In our study, similarly, fT3 and fT4 were found to be low in the 2nd and 3rd trimesters, but TSH levels did not differ significantly between non-pregnant women and pregnant women in any trimester. The decrease in fT3 and fT4 levels in later pregnancy may be explained by increased fetoplacental needs and limited maternal thyroid reserve.

Hsu et al. showed that maternal Mg levels were significantly lower in the 2nd and 3rd trimesters compared to the 1st trimester [11]. In another study comparing non-pregnant women with pregnant women grouped according to gestational week, no significant difference was found in serum Mg levels during the first 12 weeks of pregnancy, but Mg levels decreased in the following weeks, consistent with our findings [12]. Similarly, in a study conducted in Turkey, Mg levels measured in non-pregnant women and in the first three trimesters of pregnancy were compared, and Mg levels were shown to decrease over time in pregnancy compared to non-pregnant women [13]. In a study examining maternal Mg and blood glucose levels in pregnancy, only Mg values in the three different trimesters were compared without a control group, and no significant difference was observed between the groups [14]. Although serum Mg is expected to decrease in pregnancy due to hemodilution and increased requirements, differences in studies among pregnant women from different regions have been attributed to various factors, including lifestyle, environmental exposure, nutritional status, and dietary habits.

In our analysis evaluating the relationship between Mg and TH in pregnant patients, a moderate, positive, and significant correlation was observed between serum fT3 and Mg levels, while no correlation was found between Mg levels and either fT4 or TSH. These findings align with some studies in the literature. For example, Schwarz et al. compared Mg levels in patients with low, normal, and high TSH values and found no significant difference between the groups [6]. In another study, maternal Mg levels correlated negatively with maternal TSH and positively with fT3 and fT4 during pregnancy [15]. These findings highlight the potential role of Mg in TH metabolism. Mg acts as a co-factor in the peripheral conversion of T4 to T3 and is especially required for the function of the enzyme triiodothyrosinase (5′ deiodinase), which converts T4 to its more active form, T3. Therefore, low Mg levels may indirectly reduce fT3 production and affect thyroid function. The positive correlation between fT3 and Mg in this study supports this hypothesis. However, results regarding fT4 and TSH vary in the literature, possibly due to methodological differences, population characteristics, and dietary habits.

From a clinical perspective, these findings suggest that routine monitoring of Mg levels during pregnancy—particularly in women at risk of thyroid dysfunction—may provide an additional tool for early detection and prevention strategies. Identifying Mg deficiency could guide timely nutritional interventions or supplementation, which in turn may help maintain optimal TH balance and support healthy fetal development. Incorporating Mg assessment into standard prenatal care protocols could therefore enhance the overall quality of maternal endocrine management.

There are some limitations to this study. First of all, the retrospective design may affect data quality. Since the data were obtained from the health information system, potential exclusion criteria such as dietary habits, use of supplemental Mg, and history of thyroid disease may have been overlooked. Secondly, TH and Mg levels of the same individuals in the pre-pregnancy, pregnancy, and postpartum periods could not be monitored, preventing intra-individual comparisons. Since different pregnant women were evaluated for each trimester, the study did not allow the analysis of dynamic, individual-based changes during pregnancy. This limits the ability to observe personal changes in thyroid function and Mg levels over time. Another limitation is that, since the study was conducted in a single center, the effects of regional or socioeconomic differences could not be considered.

## Conclusion

Monitoring Mg levels during pregnancy may be a complementary parameter in the evaluation of thyroid function. Especially in high-risk pregnant women, Mg monitoring may contribute to the early detection of possible thyroid dysfunctions. Encouraging the consumption of Mg-rich foods in the follow-up of pregnant women in family health centers, and initiating replacement therapy when deficiency is detected, may help support endocrine functions and improve maternal well-being.

**Conflict of Interests**
*The authors declare that there is no conflict of interest in the study.*

**Financial Disclosure**
*The authors declare that they have received no financial support for the study.*

**Ethical Approval**
*The study received ethical approval from the Karamanoğlu Mehmet Bey University Faculty of Medicine Ethics Committee on June 4, 2025, with the document number 21-2025/10.*

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