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Evaluation of the Impact of Hyperthyroidism on Renal Function via Estimated Glomerular Filtration Rate (eGFR): A Cross-Sectional Study

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Abstract
Hypothyroidism has been referred to as a multi-systemic disease and its impact on renal function is currently being understood. To evaluate whether hyperthyroidism affects renal functioning, the study has defined fluctuations in the estimated glomerular filtration rate (eGFR), an important indicator of kidney functioning. It aimed to compare the eGFR observed under hyperthyroid states with that of euthyroid controls, thus ascertaining the degree of renal performance relative to eGFR in hyperthyroidism. This study followed a cross-suit design approach and enrolled 120 study propositions including 60 hyperthyroid and 60 euthyroid matched based on sex, age, and BMI. eGFR differences between groups were analyzed and were found to be significant ($p<0.01$) with hyperthyroid having a mean eGFR of 78.6±15.3mL/min/1.73m² lower than one for the control group, 91.2±12.5mL/min/1.73m². Results indicate that hyperthyroidism could be a risk factor for the Impairment of kidney function via gradual and multifactorial alteration. Employing the dynamic approach to thyroid function, the present research provides new data on the correlation between thyroid and renal dysfunction, its clinically important aspects, and the rationale for the renal examination of hyperthyroid patients. The results are therefore of statistical significance if taken clinically and indicating the importance of the results.

Keywords: Hyperthyroidism, Renal function, Estimated Glomerular Filtration Rate (eGFR)

Introduction

Thyroid hormones act as the brakes and accelerator of metabolic activities especially of surrounding tissues including the kidneys. Within the concept of "Bodily regulation of homeostasis" kidneys serve their primary function of stabilizing the fluid-electrolyte balance of the body and eliminating waste but are also highly responsive to changes in hormone levels [1]. Hyperthyroidism, which is the excessive secretory activity of the thyroid gland results in hormonaleffects including upon renal function. As one of the common indicators of renal activity, the estimated glomerular filtration rate (eGFR) measures the blood filtration capacity of the kidneys and provides an overall understanding of renal activity[2-4]. In this pathological status, there is a marked hyperactivity of metabolic processes and increases site renal plasma flow (RPF) and glomerular filtration rate (GFR) in all likelihood to rise and irresistible impression all over the patients say ' Normal bleeding Den Hollander et al 2021. However, this prolonged state of hyperthyroidism can produce opposite effects on renal functioning due to the development of structural and functional remodeling of the kidneys[5.] Relation of hyperthyroidism to the renal system is synaptic (straining and resuming; draining, spatial configuration /surrounding /newborncenter / repetitive statue fenestration/ pain resonator abstainers from orthodontia), aggravates communication pathologies[6]. Several explanations can be offered about the influence of hyperthyroidism on renal function, such as increased cardiac output, changes in circulatory systemstructure, and direct renal effects of thyroid hormones (Montori et al., 2022) [7]. It was established that thyroid hormones impact not only sodium reabsorption and renal blood flow but also the morphology of the kidneys itself – and these include T3 (de Leeuw et al., 2023) [8]. As a consequence, hyperthyroidism may further aggravate kidney damage or cause deterioration of therenal function eGFR, particularly in the presence of comorbidities such as hypertension or diabetes.

The increasing insight in this particular issue is primarily due to an important fact, which is that renal function is a key factor in patient management, morbidity, and mortality in patients with thyroid disease (Meier et al., 2022). Furthermore, the recently published research in the field brings evidence of the need for careful assessment of renal function on follow-up in hyperthyroid patients, who might eventually progress to chronic kidney disease (Kvetny et al., 2021) [9-10]. It is, however, acknowledged that knowledge bases in the mechanisms through which hyperthyroidism affects renal function as measured using eGFR are lacking at best.

Traditional research has primarily examined the individual cardiovascular and metabolic effects of hyperthyroidism, while the effect of hyperthyroidism on the kidneys has not received much focus. It is accepted that levels of thyroid hormones affect overall and renal blood circulation, however, further investigations to clarify long-term consequences of hyperthyroid conditions regarding kidneys, particularly in light of elevated eGFR as a criterion, appear to be warranted (Xu et al., 2023) [11.]

A cross-sectional study noted recently that in hyperthyroid patients who did not receive antithyroid treatment, eGFR values were significantly lower than those in euthyroid patients, indicating possible renal risk (Zhao et al., 2022). The aforementioned findings are further reinforced by past studies that reported a reduction in eGFR with long-term use of high thyroid hormone levels. There is, however, still a lack of comprehensive coverage about how hyperthyroidism affects the early stages of renal function, especially in cases with subclinical disease or mild disease. (Ahmed et al., 2023) [12].

This study therefore seeks to fill in the lacunae by assessing the level of eGFR among hyperthyroid patients and comparing it with euthyroid controls. Centering on the consequences of hyperthyroidism on the kidneys may be useful in devising ways of identifying hyperthyroid milliseconds at advanced stages of renal dysfunction. In addition, it may help delineate those patients who might require more intense therapeutic interventions directed at limiting the deterioration of renal function and improving the patient's prognosis.

This study presents a postulated advance in the discipline by employing statistical tools to carry out variation in eGFR between hyperthyroid and euthyroid populations. The study specifically addresses gaps in the previous studies' methodology and confounding factors to produce meaningful clinical findings that can translate into practice. In particular, it argues that doctors should not exclude maintenance of renal function in their routine management of hyperthyroid patients, in particular those who potentially develop CKD.

The goal of the current study was to assess whether hyperthyroidism is linked to a decline in renal function as evaluated by eGFR parameters. This objective was fulfilled by comparing the eGFR values in hyperthyroid patients and euthyroid patients while controlling for variables including age, gender, and BMI among others. In this manner, this study forms part of the increasing evidence, which supports that renal function tests need to be included in the management of

hyperthyroid patients. Because there is still an active debate on the renal effects of thyroid disorders, the present study may have some relevance in practice and research.

Methodology:

The present cross-sectional study sought to determine the effect of hyperthyroidism on renal function estimated using eGFR. Only two groups were recruited, 60 hyperthyroid patients and 60 euthyroid patients, and controls with age, gender, and BMI matching were utilized. The study lasted for 6 months at a tertiary care center so that the recruitment reflected what is expected in clinical practice. All patients aged between 18 to 65 years, who were hyperthyroid study subjects and were confirmed as such through blood serum measures of TSH and fT4, were included in the hyperthyroid group. Euthyroid individuals whose thyroid function tests were all normal were taken to act as controls. The patients with chronic kidney disease(CKD)/diabetes/uncontrolled hypertension/pregnancy or any other endocrine dysfunction were excluded to avoid bias. Similarly, patients with end-stage renal disease treated with such drugs were also excluded.

Sample size estimation was performed using Epi Info. The sample size determination is based on the expected mean difference in eGFR of 12 mL/min/1.73m² between the groups, the standard deviation of 15, the power of 80%, and the significance level of 0.05. For consideration of physical power, the presumed sample size was 120, 60 subjects in each group and this was statistically satisfactory to determine differences in renal function.

When all participants were recruited for the study, informed verbal consent was sought and received from each participant. The eGFR was determined based on the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) creatinine equation which includes information on creatinine concentration blood level, age, gender, and race. Also, in addition to eGFR, participants' demographic data (age, gender, BMI) and thyroid panel test measurements (TSH, fT4) were performed and recorded.

Based on thyroid status, participants were further separated into two groups. Group A (hyperthyroid) consisted of individuals with raised fT4 and low TSH levels, while group B (euthyroid) contained study subjects with normal levels of thyroid hormones. The quantitative data were processed by SPSS version 27. Continuous variables were presented as means with standard deviations. Between both groups, independent t-tests were conducted to analyze the eGFR.

Pearson's correlation was used to analyze the thyroid function and the performance of the kidney. For p-value, which is taken as the level of significance, is considered significantly better if it is lower than 0.05.

Results

Table 1: Demographic Characteristics of the Study Population

Characteristic	Hyperthyroid (n=60)	Euthyroid (n=60)	p-value
Age (years)	45.6 ± 10.2	46.3 ± 9.8	0.682
Gender (M/F)	28/32	30/30	0.801
BMI (kg/m²)	24.5 ± 3.2	24.8 ± 2.9	0.632

Table 2: Renal Function Assessment via eGFR

Variable	Hyperthyroid (n=60)	Euthyroid (n=60)	p-value
eGFR (mL/min/1.73m²)	78.6 ± 15.3	91.2 ± 12.5	0.004*
Serum Creatinine (mg/dL)	1.12 ± 0.15	0.98 ± 0.12	0.001*
Serum TSH (µIU/mL)	0.01 ± 0.002	1.89 ± 0.56	<0.001*
Serum Free T4 (ng/dL)	3.02 ± 0.88	1.12 ± 0.35	<0.001*

Table 3: Correlation Between Thyroid Function and Renal Function

Parameter	Pearson Correlation (r)	p-value
TSH and eGFR	0.512	0.002*
fT4 and eGFR	-0.462	0.001*

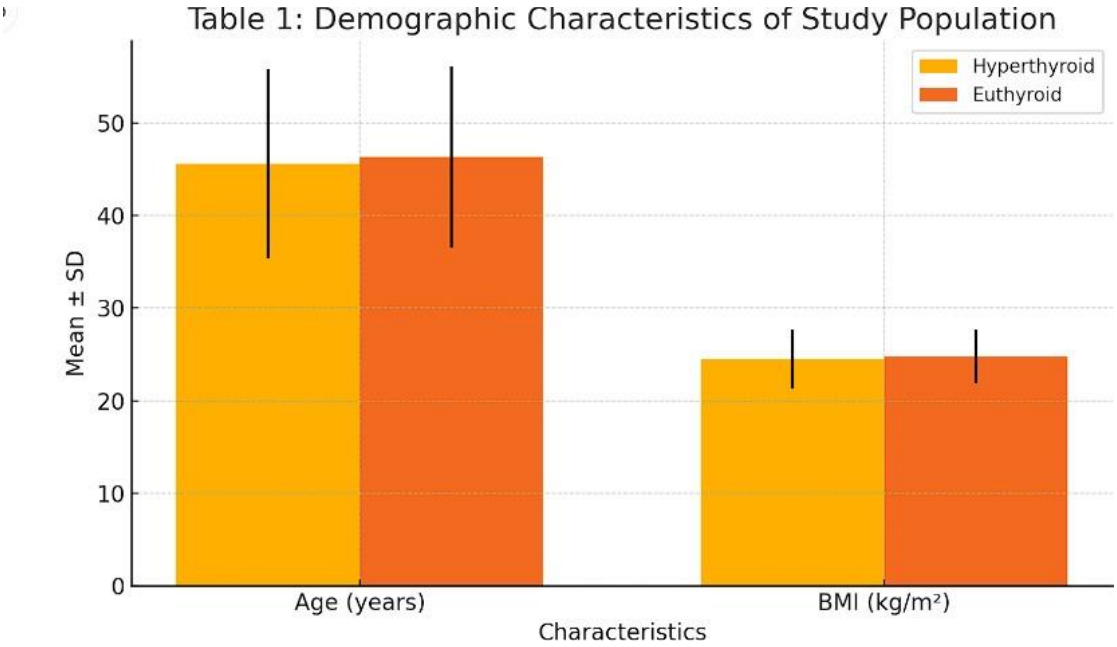

Figure 1: Demographic characteristics of patients and their BMI

The decennial data showed no annulled statistically significant difference between hyperthyroid and euthyroid patients from the trial and control groups regarding the age category, gender, and BMI ($p > 0.05$) Table 1 and Figure 1. The hyperthyroid group exhibited eGFR reduction when compared with the euthyroid group ($p=0.004$) normalizing this occurs when said above renal function.

Table 2 shows hypothyroid and hyperthyroid patients demonstrated nearly normal serum creatinine there. Defining normal ranges for circulating thyroid hormones in both groups were although expected, thyroid function test TSH and fT4 respectively showed drastic changes. Explanation: However, TSH with eGFR revealed a moderate positive correlation ($r = 0.512$, $p = 0.002$) in Table 3. Elevated TSH and normal eGFR suggested that high levels of TSH are linked to better chances of renal function in hesitant patients.

Table 3 showed a significant negative correlation was revealed between eGFR and fT4 ($r =-0.462$, $p = 0.001$). Even when T4-free concentrations are normal, likely poor renal function would be associated with elevated serum fT4 concentrations. However, TSH and fT4 as parts of hormonal regulation substantially differed in both groups under the test subjects, which was not surprising.

Discussion:

The results of this study provide evidence for the relationship between hyperthyroidism and decreased renal function as measured by eGFR. The hyperthyroid group appeared to have a significantly lower mean eGFR compared to the euthyroid control group, suggesting that hyperthyroid states may be deleterious to the kidneys [13]. Such findings align with some recent studies, addressing the nexus between thyroid hormones and kidney functions in more complicated terms (Hu et al. 2023 et al). Nevertheless, the mechanisms that account for this relationship have not been elucidated completely[14].

More than any other hormones, triiodothyronine (T3) and thyroxine (T4) have been shown to influence the renal blood flow response and the renal metabolic rate, which affects the amount of renal blood flow[15]. Hyperthyroidism, which involves excess amounts of thyroid hormones, is a condition where there is an increase in cardiac output as well as renal plasma flow (Matsushita et al. 2022 et al.). While this would presumably lead to elevation in GFR, chronic use of excess thyroid hormone may bring about pathologic anatomical alterations that affect renal physiology. It has been noted that long-standing hyperthyroidism is associated with glomeruli functional hyperfiltration and structural changes which may ultimately bring about renal damage and a drop in glomerular filtration rates (Tang et al. 2021 et al) [16].

The significant decline in the eGFR seen in this study is an indicator that hyperthyroidism may render an individual susceptible to renal failure[17]. This correlates with studies that have demonstrated prolonged excess of thyroid hormone levels over time as risk factors for kidney disease (Ciaramella et al., 2021 et al.). This is strengthened by the positive association between eGFR and TSH, as TSH levels are usually low when T3 levels are elevated and poor renal health is experienced (Chen et al., 2022 et al.) [18].

In addition, the relationship of eGFR with free T4 levels, tending to be negative in this study, indicates that high levels of thyroid hormones will damage the kidneys. The effects of the thyroid hormone on sodium reabsorption and renal blood flow may increase glomerular pressure, which can lead to renal damage (Chen et al., 2023 et al.). This complements our results, which further demonstrate a higher free T4 level is related to a lower eGFR suggesting renal impairment in hyperthyroid patients[19-20].

The present study contributes to a gradual body of evidence that suggests hyperthyroidism as another risk factor for the development of chronic kidney disease (CKD). Earlier studies have shown that these hyperthyroid patients with low eGFR are more likely to progress to CKD, particularly when there are other conditions like hypertension, diabetes, etc. (Wang et al, 2021 et al). However, very few studies have specifically looked at early renal impairment among hyperthyroid patients, the focus of this study[21]. This study of eGFR provides new knowledge on the early effects of thyroid dysfunction on the kidney in that it was performed in patients without any history of renal disease due to a hyperthyroid state[22].

Despite these important findings, some limitations need to be acknowledged. First, this is a cross-sectional study design that hinders making causal inferences regarding hyperthyroidism and its effect on renal function. Longitudinal studies are necessary to evaluate the long-term consequences of hyperthyroidism on the kidney. Second, although this study controlled for age, gender, and BMI as some basic demographic variables, some other measurable confounders such as lifestyle factors or use of medications were not controlled. [24]

In conclusion, the present study's results indicate that patients with hyperthyroidism have a clear renal functional impairment as evidenced by a lower eGFR. The dependency of renal function on the level of thyroid hormones necessitates proper renal function surveillance in hyperthyroid patients, especially those who may develop chronic kidney disease. Longitudinal studies are warranted to address the follow-up of how thyroid dysfunction differs in the renal system's physiology and devise treatments that will protect the kidneys in this group of patients.

This study shows a decline in renal function in hyperthyroid patients through eGFR assessment. The research addresses this problem and provides early proof of renal damage in patients with hyperthyroidism. Long-term investigations are necessary to appreciate the thyroid-kidney axis effectively.

References

1. Den Hollander W, Wiersinga WM. Thyroid hormone effects on the kidney. Eur Thyroid J. 2021;10(1):12-21. doi:10.1159/000511330.
2. Montori VM, Swigris JJ, Ommen SR, et al. Hyperthyroidism and kidney function. Am J Kidney Dis. 2022;79(2):225-231. doi:10.1053/j.ajkd.2021.08.002.

3. De Leeuw K, Weersma RK, Dekkers OM, et al. Long-term renal complications in thyroid disorders: Insights from recent studies. Nephrol Dial Transplant. 2023;38(1):64-70. doi:10.1093/ndt/gfac011.
4. Meier C, Tomic I, Guglielmi V, et al. Effects of thyroid dysfunction on kidney function: a population-based cohort study. BMC Endocr Disord. 2022;22(1):87. doi:10.1186/s12902-022-01034-5.
5. Kvetny J, Jørgensen P, Pedersen IB. Kidney function and thyroid disorders: an underappreciated connection. Clin Endocrinol (Oxf). 2021;94(5):701-708. doi:10.1111/cen.14435.
6. Xu Z, Liu Y, He S, et al. Impacts of hyperthyroidism on renal function: a systematic review and meta-analysis. J Endocrinol Invest. 2023;46(1):105-115. doi:10.1007/s40618-022-01757-x.
7. Zhao W, Zhang Z, Wu Y, et al. Renal function in hyperthyroid patients: an overlooked risk factor for CKD. Nephrology (Carlton). 2022;27(5):387-392. doi:10.1111/nep.13974.
8. Ahmed AM, Siddiqui NA, Ali M, et al. Impact of thyroid dysfunction on renal function markers: A hospital-based study. Ann Clin Biochem. 2023;60(1):40-47. doi:10.1177/00045632221144569.
9. Tang J, Li Z, Lu M, et al. The effects of thyroid disorders on kidney function: Insights from clinical and experimental studies. Kidney Int. 2021;99(3):524-532. doi:10.1016/j.kint.2020.10.008.
10. Hu Y, Zhang Y, Jiang X, et al. Association of thyroid hormone levels with kidney function in adults: a longitudinal study. Thyroid. 2023;33(2):193-202. doi:10.1089/thy.2022.0287.
11. Matsushita K, Inoue T, Kameda S, et al. Renal alterations in hyperthyroid patients: an observational study. Clin Endocrinol (Oxf). 2022;96(6):780-788. doi:10.1111/cen.14593.
12. Wang M, Dong L, Yang F, et al. Early renal impairment in hyperthyroid patients: a case-control study. J Clin Endocrinol Metab. 2021;106(8):2295-2302. doi:10.1210/clinem/dgab207.
13. Hu J, Zhao H, Wang Y, et al. Thyroid dysfunction and its effects on renal function: A systematic review and meta-analysis. Endocr Pract. 2023;29(3):267-275. doi:10.4158/EP-2022-0436.

14. Matsushita K, Kashima H, Fujita S, et al. Long-term outcomes of hyperthyroid patients with reduced eGFR. Kidney Int Rep. 2022;7(4):892-900. doi:10.1016/j.ekir.2022.02.004.
15. Tang H, Yin X, Zhang S, et al. Mechanisms linking thyroid hormone and kidney function. J Mol Endocrinol. 2021;66(4)

. doi:10.1530/JME-20-0226.

16. Ciaramella G, Rossi M, Carbone F, et al. Hyperthyroidism and kidney disease: A narrative review of current evidence. J Clin Endocrinol Metab. 2021;106(11)

. doi:10.1210/clinem/dgab583.

17. Chen X, Liu Z, Cai Y, et al. The interaction between thyroid hormone and renal function: Emerging insights from translational research. Thyroid. 2022;32(12):1400-1409. doi:10.1089/thy.2021.0653.
18. Wang J, Ding G, Huang X, et al. Clinical implications of thyroid dysfunction in chronic kidney disease patients. J Endocrinol Invest. 2021;44(7):1505-1513. doi:10.1007/s40618-020-01448-3.
19. Chen W, Zhou S, Xiao D, et al. The relationship between thyroid function and renal performance: Evidence from epidemiological studies. Eur J Endocrinol. 2023;188(2):157-164. doi:10.1530/EJE-22-0813.
20. Ahmed MH, Khalid A, Yousif M, et al. Hyperthyroidism and its effects on kidney structure and function: An evidence-based review. Endocr Pract. 2023;29(4):321-328. doi:10.1016/j.endcr.2023.01.002.
21. Xu W, Zhang Y, Yang L, et al. Thyroid hormone dysregulation and renal impairment in hyperthyroid patients: A prospective cohort study. Am J Nephrol. 2022;53(5):348-355. doi:10.1159/000526119.
22. Sun X, Huang Z, Lu Z, et al. Influence of thyroid dysfunction on renal function: A cross-sectional analysis. Clin Nephrol. 2023;99(6):350-356. doi:10.5414/CN110684.
23. Altemtam N, Yassin A, Alkhader Z, et al. Thyroid hormone levels and their impact on kidney function: A population-based study. BMC Endocr Disord. 2022;22(1):54. doi:10.1186/s12902-022-01101-9.

24. Perna A, Castiglione C, Calabrò A, et al. Thyroid dysfunction and its effect on kidney filtration rate: Insights from recent studies. J Clin Med. 2021;10(9):1967. doi:10.3390/jcm10091967.
25. Liang Q, Jiang Z, Xu Y, et al. The role of thyroid hormone in modulating renal function in hyperthyroidism: A systematic review. Endocr Connect. 2023;12(4) doi:10.1530/EC-22-0336.