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Article

Prevalence of Hypothyroidism Among the Population of the Fergana Valley

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Abstract: Hypothyroidism is a common endocrine disorder with significant public health implications. However, regional epidemiological data remain limited in many parts of Central Asia, including the Fergana Valley. To assess the prevalence of hypothyroidism among the population of the Fergana Valley and to identify associated demographic and clinical factors. A cross-sectional study was conducted among residents of the Fergana Valley. Data were collected through clinical examination and laboratory assessment of thyroid function, including serum thyroid-stimulating hormone (TSH) and free thyroxine (fT4) levels. Hypothyroidism was defined according to standard diagnostic criteria. Demographic variables such as age, gender, and place of residence were analyzed. The overall prevalence of hypothyroidism was found to be notable, with higher rates observed among females and older age groups. Subclinical hypothyroidism constituted a significant proportion of cases. Urban–rural differences and potential environmental or nutritional factors (including iodine intake) were also observed. Hypothyroidism represents a significant health concern in the Fergana Valley. Targeted screening, early diagnosis, and public health interventions—particularly related to iodine nutrition—are recommended to reduce disease burden. Hypothyroidism: The primary focus of the study was on thyroid hormone deficiency.Fergana Valley (Uzbekistan): The specific geographic and endemic region (Andijan, Namangan, and Fergana).Iodine Deficiency Disorders (IDD): The spectrum of diseases related to low iodine intake in the region.Endemic Goiter: The historically high prevalence of thyroid enlargement in the valley.Subclinical Hypothyroidism: The most prevalent form (16.8%) of thyroid dysfunction identified in the study.Prevalence: The statistical measurement of disease distribution among the population.Environmental Goitrogens: External factors like nitrates in groundwater that impair thyroid function.Iron Deficiency Anemia (IDA): A common comorbidity (64%) that complicates the thyroid-renal axis.Urinary Iodine Concentration (UIC): The biochemical marker used to assess the severity of iodine deficiency.Less-mobile Patients: The specific demographic group with restricted physical activity (immobility).Renal Morphometry: Quantitative measurement of structural changes in the kidneys (e.g., cortical thickness).Thyroid-Renal Interaction: The physiological and pathological link between the thyroid gland and kidney function.

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1. Introduction

The Fergana Valley, a unique intermontane depression in Central Asia shared by Uzbekistan, Kyrgyzstan, and Tajikistan, represents one of the most densely populated and ecologically complex regions in the world. Historically, this territory has been identified by the World Health Organization (WHO) as a classic "iodine-deficiency focus" (endemic zone). Despite decades of salt iodization efforts, the prevalence of thyroid disorders, specifically primary and subclinical hypothyroidism, remains a significant burden on the regional public health system of Uzbekistan.Geographical and Hydrochemical Determinants.The high prevalence of hypothyroidism in the Fergana Valley (Andijan, Namangan, and Fergana regions) is fundamentally rooted in its geochemical profile.

The valley's soil and water resources are characterized by an acute natural deficiency of iodine and selenium—essential micronutrients for thyroid hormone synthesis. Studies conducted over the last 20 years indicate that the median urinary iodine excretion (UIE) in certain rural districts of Fergana remains below the recommended 100 μg/L, placing a large portion of the population at risk for thyroid dysfunction. Epidemiological Trends and Demographic Vulnerability.

Recent epidemiological screenings have shown that the structure of thyroid pathology in the valley is shifting. While visible endemic goiter rates have declined from nearly 80% in the late 1990s to approximately 39.9% in recent years, the incidence of "hidden" or subclinical hypothyroidism is on the rise.Gender and Age Disparity: Data suggests that women in the Fergana Valley are 5 to 7 times more likely to develop hypothyroid states than men, with a peak incidence observed during the reproductive years (20–45 years) and in the elderly population (over 65 years).Morbidity and Comorbidity: A critical concern in this region is the high prevalence of anemia and iron deficiency, which acts synergistically with iodine deficiency to impair thyroid peroxidase (TPO) activity, further complicating the clinical management of hypothyroid patients. Ecological Factors and Endocrine Disruptors

The Fergana Valley is also an intensive agricultural hub. The long-term use of nitrogen-based fertilizers has led to high nitrate concentrations in local groundwater. Nitrates act as competitive inhibitors of the sodium-iodide symporter (NIS), effectively blocking iodine uptake by the thyroid gland. This "environmental goitrogenesis" explains why hypothyroidism persists in certain districts even when iodized salt is available. Furthermore, the rising levels of atmospheric pollutants from industrial activities in cities like Fergana and Kokand have been linked to increased autoimmune thyroiditis (AIT), the leading cause of permanent hypothyroidism.The Renal-Endocrine Connection.In the specific context of the Fergana Valley, there is an emerging clinical correlation between hypothyroidism and Chronic Kidney Disease (CKD). In less-mobile and elderly patients within this region, the prevalence of renal functional decline (eGFR <60 ml/min) is significantly higher among those with undiagnosed hypothyroidism. This necessitates a more integrated diagnostic approach that combines endocrinological screening with renal morphometric monitoring.

Objectives of the Study. Given these regional complexities, this study aims to provide a comprehensive analysis of the prevalence of hypothyroidism across the three regions of the Fergana Valley. By examining the interplay between micronutrient deficiencies, ecological stressors, and demographic factors, we seek to establish an updated baseline for targeted preventive measures and hormonal replacement protocols tailored to this specific population.

2. Literatur Review

The Fergana Valley has long been documented as one of the most severe endemic goiter zones in Central Asia. Early research by Ismailov et al. (2010) indicated that despite universal salt iodization (USI) programs initiated in Uzbekistan, the median urinary iodine concentration (UIC) in the Fergana region fluctuated between 45–62 μg/L, significantly below the WHO-recommended threshold of 100 μg/L. This chronic iodine deficiency serves as the foundational cause for the high prevalence of thyroid dysfunctions in the valley’s population. Epidemiological Trends in the Fergana, Andijan, and Namangan Regions. Recent longitudinal studies (2015–2023) show a shifting trend from overt endemic goiter to subclinical hypothyroidism (SH).

Prevalence Rates: According to data from the Republican Specialized Scientific-Practical Medical Center of Endocrinology, the prevalence of thyroid disorders in the Fergana Valley remains 1.5 to 2 times higher than in the Tashkent or Samarkand regions.Andijan District Case Study: Research conducted in the Andijan region revealed that the prevalence of autoimmune thyroiditis (AIT)—the leading cause of permanent hypothyroidism—has risen by 12% over the last decade, particularly among women aged 30–50.Namangan Region Analysis: In rural districts of Namangan, subclinical hypothyroidism was detected in 18.4% of screened pregnant women, which is critical due to its impact on fetal neurodevelopment. The "Double Deficiency" Phenomenon (Iodine and Iron).A specific feature of the literature regarding the Fergana Valley is the focus on

concomitant iron deficiency anemia (IDA). Research by Abdukhakimova (2021) demonstrates that iron deficiency impairs the activity of the heme-dependent enzyme thyroid peroxidase (TPO).

Fact: In the Fergana Valley, approximately 60-70% of hypothyroid patients also suffer from various degrees of anemia. This synergy complicates hormonal replacement therapy (THRT), as iron deficiency prevents the efficient utilization of iodine by the thyroid gland. Environmental and Goitrogenic Factors. Modern literature emphasizes "environmental goitrogenesis" in the valley. The intensive use of nitrogen-based fertilizers in the valley's cotton and fruit sectors has led to nitrate contamination of groundwater. Scientific Evidence: Nitrates act as competitive inhibitors of the sodium-iodide symporter (NIS). Studies in the Journal of Endocrinology of Uzbekistan suggest that even with adequate iodine intake, high nitrate levels in the Fergana and Kokand industrial zones prevent the thyroid from absorbing iodine, leading to "technogenic" hypothyroidism.

Hypothyroidism and Renal Comorbidity. Recent reviews have begun to link regional thyroid prevalence with renal health. In the Fergana Valley, where chronic kidney disease (CKD) rates are influenced by hot climates and water mineralisation, the presence of hypothyroidism accelerates GFR decline. Literature confirms that in the Fergana population, subclinical hypothyroidism is present in 23% of patients undergoing hemodialysis, which is higher than the national average.

3. Research Methodology

A multi-center, cross-sectional epidemiological study was conducted across the three major regions of the Fergana Valley (Andijan, Namangan, and Fergana). The study aimed to assess the current prevalence of hypothyroidism and its biochemical predictors. Urban Sites: Regional Centers of Endocrinology in the cities of Fergana, Namangan, and Andijan.Rural Sites: Distant districts such as Uchkuprik (Fergana), Izboskan (Andijan), and Pop (Namangan), chosen due to their historically higher rates of endemic goiter and agricultural intensity. Population and Sampling Technique: The study included a stratified random sample of 3,200 individuals (Aged 18–75 years).Inclusion Criteria: Permanent residents of the Fergana Valley (residing for >10 years).Exclusion Criteria: Patients on glucocorticoids or other drugs known to interfere with TSH levels, and those with recent acute renal failure.Groups: The cohort was subdivided by gender, age, and lifestyle (Active vs. Less-mobile). Laboratory and Clinical Assessment. Diagnostic protocols followed the standard WHO guidelines for IDD (Iodine Deficiency Disorders) monitoring: Hormonal Screening: Fasting blood samples were analyzed for Thyroid-Stimulating Hormone (TSH) and Free Thyroxine (fT4) using the chemiluminescence immunoassay (CLIA) method. Subclinical Hypothyroidism was defined as TSH > 4.2 mIU/L with normal fT4. Overt Hypothyroidism was defined as TSH > 10.0 mIU/L with decreased fT4. Iodine Status: Median Urinary Iodine Concentration (UIC) was measured using the Sandell-Kolthoff reaction in a subset of 500 participants to evaluate the degree of current iodine deficiency.

Anemia Screening: Hemoglobin and Serum Ferritin levels were measured to assess the impact of concomitant iron deficiency on thyroid status. Instrumental and Environmental Analysis.Thyroid Ultrasonography (USG): Performed using a 7.5 MHz linear transducer. Thyroid volume was calculated using the Brunn formula. Goiter was diagnosed if the volume exceeded 18 mL in women and 25 mL in men. Water Quality Assessment: Analysis of nitrate and mineral content in local groundwater sources (wells and tap water) in rural districts to evaluate environmental goitrogenic pressure. Renal Function Monitoring (The Connectivity Factor). For patients diagnosed with hypothyroidism, additional renal morphometry was performed.

Calculation of eGFR (CKD-EPI), Ultrasound measurement of Renal Cortical Thickness to detect structural changes associated with long-term hormone deficiency. Data Processing and Ethics. Statistical analysis was performed using SPSS Statistics v.26. The Chi-square test was used to compare prevalence rates between urban and rural populations. Odds Ratios (OR) were calculated to identify the risk of developing hypothyroidism in relation to age and sedentary lifestyle. All participants provided informed consent, and the study was approved by the Institutional Ethics Committee.

Advantages of this methodology: Territorial coverage: both urban and remote rural districts of the valley (Uchkoprik, Izboskan, Pop) are included.Comprehensive approach: Not only hormones, but also iodine content in urine and water quality (nitrates) were taken into account.Anemia Factor: Added a valley-specific iron deficiency check.

4. Analysis and Result

Overall Prevalence of Thyroid Dysfunction. Out of the 3,200 participants screened across the Fergana Valley, thyroid abnormalities were detected in 42.3% of the population. The distribution of hypothyroidism types was as follows: Subclinical Hypothyroidism (SH): 16.8% (n=537). Overt Hypothyroidism: 4.2% (n=134).Euthyroid Goiter (Endemic): 21.3% (n=681). Regional Distribution (Andijan, Namangan, Fergana)The prevalence varied significantly between the three regions, with the highest rates observed in rural districts of the Fergana and Namangan regions. Gender and Age-Specific Incidence. The study confirmed a strong gender bias in the prevalence of hypothyroidism:Females: 22.4% (SH and Overt combined). Males: 4.8%.Age Factor: The highest incidence was recorded in the 45–60 years age group, where the prevalence of subclinical hypothyroidism reached 24.5% among females. Correlation with Mobility and Renal FunctionA specific analysis was performed on the "connectivity" between thyroid status and renal markers in the local population: Sedentary/Less-Mobile Group: In hypothyroid patients with low physical activity, the eGFR was significantly lower (62.4 ± 5.8 ml/min) compared to active hypothyroid patients (76.8 ± 4.2 ml/min, $p < 0.01$).

Morphometric Predictor: Less-mobile patients from rural Fergana showed a 15% reduction in renal cortical thickness, correlating with TSH levels above 10 mIU/L. Impact of Environmental Factors (Nitrates and Anemia).Nitrate Exposure: In the rural districts of Namangan (Pop and Chust), where groundwater nitrate levels exceeded 45 mg/L, the risk of developing hypothyroidism was 2.1 times higher (OR=2.1, 95% CI 1.4-3.2) regardless of salt iodization.Concomitant Anemia: 64% of hypothyroid patients in the valley were diagnosed with Iron Deficiency Anemia (IDA). Patients with both IDA and hypothyroidism showed more severe structural changes in the kidneys (higher RRI values) compared to those without anemia. Summary of Key Findings. Fergana region has the highest prevalence of subclinical hypothyroidism (18.7%) and the lowest iodine saturation (62.1 μg/L). The "Double Burden" of iodine deficiency and iron deficiency is present in over 60% of the valley's cases. Hypokinesia (lack of movement) significantly worsens renal morphometric indicators in hypothyroid residents of the valley.

5. Conclusion and Recommendations

The epidemiological and clinical analysis of the Fergana Valley population confirms that hypothyroidism remains a significant public health challenge in Eastern Uzbekistan. The following key conclusions can be drawn:Persistent Endemicity: Despite universal salt iodization, the Fergana Valley (particularly the Fergana and Namangan regions) exhibits a moderate iodine deficiency with a median urinary iodine concentration of 71.0 μg/L.Prevalence Trends: The prevalence of subclinical hypothyroidism (16.8%) is notably high, with a clear gender bias towards females (22.4% vs. 4.8% in males).Environmental Synergism: The high nitrate levels in groundwater and the widespread prevalence of iron deficiency anemia (64%) act as synergistic factors that impair thyroid hormone synthesis and exacerbate renal complications.Renal Impact in Less-Mobile Groups: In sedentary and less-mobile hypothyroid patients of the valley, a significant decline in eGFR and a 15% reduction in renal cortical thickness were observed, confirming that immobility accelerates kidney structural damage in hypothyroid states.

Recommendations. To mitigate the burden of hypothyroidism and its renal complications in the Fergana Valley, the following measures are proposed: Dual Supplementation: Implementation of combined Iodine and Iron supplementation programs for women of reproductive age in rural districts (e.g., Uchkuprik, Pop, and Izboskan). Water Quality Monitoring: Regional healthcare authorities should monitor nitrate levels in local wells, as high nitrates act as potent goitrogens even in the presence of iodized salt.Integrated Screening: Hypothyroid patients, especially the elderly and less-mobile, should undergo routine Renal Doppler Ultrasound to detect early morphometric predictors of kidney failure.Quality Control of Salt: Strengthening the

monitoring of iodized salt stability at the household level to ensure effective iodine intake in the valley's rural population.

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