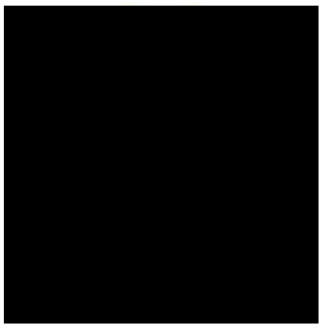
TO STUDY THE PREVALENCE OF SUB-CLINICAL HYPOTHYROIDISM IN PREDIABETICS BASED ON HBA1C



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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DIPLOMATE OF NATIONAL BOARD (DNB)

GENERAL MEDICINE

[redacted]

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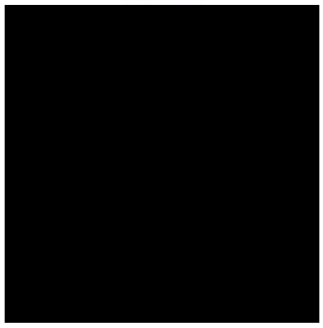

DISSERTATION

[redacted]

DIPLOMATE OF NATIONAL BOARD (DNB)

GENERAL MEDICINE

[redacted]

CERTIFICATE

This is to certify that the thesis entitled **"TO STUDY THE PREVALENCE OF SUB-CLINICAL HYPOTHYROIDISM IN PREDIABETICS BASED ON HBA1C"** [redacted]

GUIDE **CO-GUIDE**

[redacted]

[redacted]

CERTIFICATE

This is to certify that the thesis entitled **"TO STUDY THE PREVALENCE OF SUB-CLINICAL HYPOTHYROIDISM IN PREDIABETICS BASED ON HBA1C"** [redacted]

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DECLARATION CUM UNDERTAKING FOR FRESH THESIS

[redacted] hereby declares that the thesis **"TO STUDY THE PREVALENCE OF SUB-CLINICAL HYPOTHYROIDISM IN PREDIABETICS BASED ON HBA1C"** [redacted]

Place: [redacted]
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Candidate Signature:
Candidate Name: [redacted]
Speciality: [redacted]
Registration Number: [redacted]

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GUIDE **CO-GUIDE**

[redacted]

[redacted]

ACKNOWLEDGMENT

[redacted]

participated in this study.

Date: [redacted]

ABBREVIATIONS

SCH	Subclinical Hypothyroidism
TSH	Thyroid Stimulating Hormone
T3	Triiodothyronine
T4	Thyroxine
Free T4	Free Thyroxine
CI	Confidence Interval
OR	Odds Ratio
IQR	Interquartile Range
SD	Standard Deviation
n	Number of Participants
r	Correlation Coefficient
p	Probability Value
BMI	Body Mass Index
Anti-TPO	Anti-Thyroid Peroxidase Antibody

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ABSTRACT

Background: Prediabetes represents an intermediate metabolic state characterized by impaired glucose regulation and increased risk of progression to type 2 diabetes mellitus. [redacted]

Aim and Objectives: [redacted]

Materials and Methods: [redacted]

Discussion: The study demonstrated a progressive alteration in thyroid parameters with worsening glycemic status. [redacted] These findings indicate a significant association between thyroid dysfunction and impaired glucose metabolism.

Keywords

[redacted]

INTRODUCTION

According to the World Health Organization (WHO), diabetes mellitus is a chronic metabolic disease characterized by elevated levels of blood glucose, which over time leads to serious damage to the heart, blood vessels, eyes, kidneys, and nerves. Diabetes is one of the fastest growing global health emergencies of the 21st century, affecting millions of people worldwide and placing a significant burden on health care systems, particularly in developing countries like India.

[redacted] [1].

[redacted] Elevated HbA1c levels in prediabetic individuals indicate persistent dysglycemia and progressive metabolic dysfunction [4].

Several studies have demonstrated a higher prevalence of sub-clinical hypothyroidism in patients [redacted]

Despite the well-established association between diabetes and thyroid dysfunction, limited data are available regarding the prevalence of sub-clinical hypothyroidism in prediabetic individuals, particularly in the Indian population [7]

Global Epidemiology

Diabetes mellitus represents a major global public health challenge with rapidly increasing prevalence. [2]. Epidemiological studies indicate a higher prevalence of sub-clinical hypothyroidism among individuals with glucose metabolism disorders, particularly those with type 2 diabetes and prediabetes, suggesting a strong association between thyroid dysfunction and dysglycemia [10].

Indian Epidemiology

Studies conducted in Indian diabetic and prediabetic populations have shown an increased frequency of sub-clinical hypothyroidism compared to the general population, emphasizing the need for early screening [12].

REVIEW OF LITERATURE

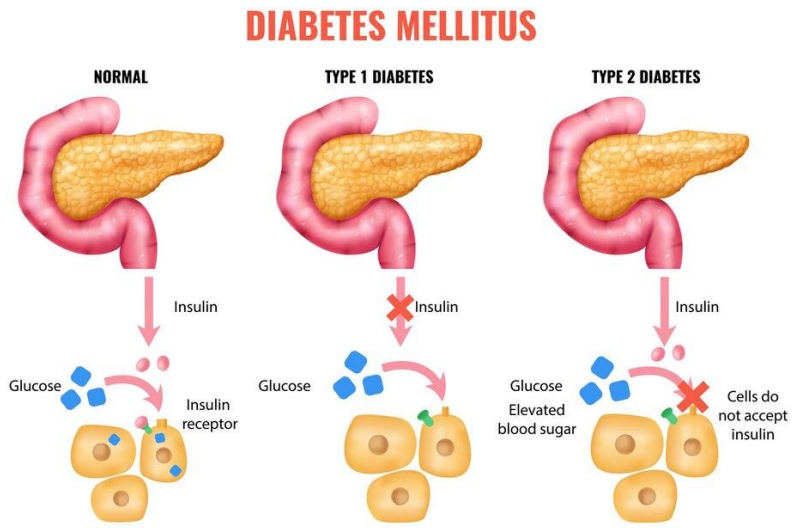


Figure 1: Diabetes Mellitus

[redacted]

It is a major non-communicable disease contributing significantly to global morbidity and mortality [9].

The fundamental abnormality in diabetes mellitus is impaired glucose homeostasis. [redacted]

Diabetes mellitus is broadly classified based on etiology, pathophysiology, and clinical presentation. This classification aids in diagnosis, management, prognostication, and research [6].

Pathophysiology of Type 2 Diabetes Mellitus

[redacted]

[redacted]

[redacted]. This decline in insulin secretory capacity is a key event in the transition from prediabetes to overt diabetes [15].

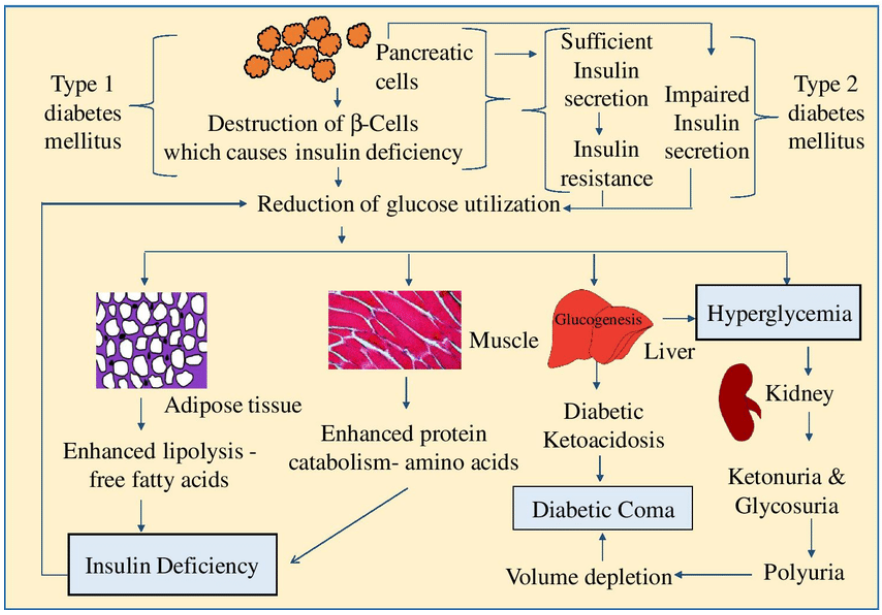


Figure 2: Pathophysiology of Type 1&2 Diabetes Mellitus

Clinical Spectrum and Systemic Effects

[redacted]

[redacted]

Diabetes mellitus has widespread systemic effects due to chronic hyperglycemia, insulin resistance, and metabolic dysregulation. These effects involve microvascular and macrovascular complications as well as metabolic and endocrine abnormalities [16].

Prediabetes

Prediabetes is a metabolic condition characterized by glucose levels that are higher than normal but not sufficiently elevated to meet the diagnostic criteria for diabetes mellitus. [redacted] These criteria help in uniform diagnosis, epidemiological assessment, and therapeutic decision-making [20]. Among these parameters, glycated hemoglobin has gained prominence due to its convenience and ability to reflect long-term glycemic status [20].

Pathophysiological Basis of Prediabetes

Prediabetes develops due to complex metabolic alterations that precede the onset of type 2 diabetes mellitus. [redacted]

Pancreatic beta cells initially compensate for insulin resistance by increasing insulin secretion. This compensatory hyperinsulinemia maintains near-normal glucose levels for a period of time.

However, chronic metabolic stress leads to progressive beta cell exhaustion, impaired insulin secretion, and rising glucose levels [22].

Insulin Resistance and Beta Cell Dysfunction

Insulin resistance and beta cell dysfunction are the two central defects underlying prediabetes. [redacted]

Clinical Significance of Prediabetes

Prediabetes is not merely a risk factor for diabetes but a clinically significant condition associated with adverse health outcomes. [redacted]

Glucose Homeostasis and Insulin Resistance

Normal Glucose Metabolism

Normal glucose metabolism is a tightly regulated physiological process that maintains blood glucose levels within a narrow range despite variations in dietary intake, physical activity, and metabolic demands [24]. [redacted]

Mechanisms of Insulin Resistance

Insulin resistance is defined as a reduced biological response to normal or elevated circulating insulin levels. It represents a central abnormality in the pathogenesis of prediabetes and

type 2 diabetes mellitus. Insulin resistance develops gradually and may be present for years before the onset of overt hyperglycemia [14].

Metabolic Consequences of Impaired Glucose Regulation

[redacted]

Glycated Hemoglobin (HbA1c)

Biochemical Basis and Formation of HbA1c

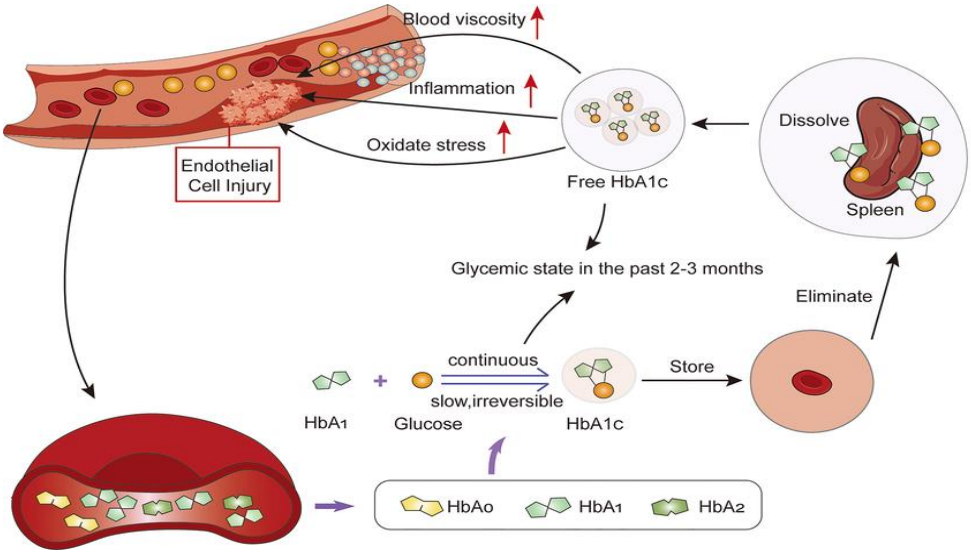


Figure 3: Formation of HbA1c

[redacted]

The formation of HbA1c begins with the reversible binding of glucose to the N-terminal valine of the beta chain of hemoglobin, forming a labile Schiff base. [redacted].

Role of HbA1c in Assessment of Glycemic Status

[redacted]

HbA1c in Diagnosis of Prediabetes

[redacted]

Factors Affecting HbA1c Levels

[redacted]

Limitations of HbA1c as a Diagnostic Tool

[redacted]

[redacted]. Additionally, inter-individual variability in glycation rates can lead to differences in HbA1c values at similar glucose levels [4].

Thyroid Gland and Thyroid Hormones

Anatomy and Physiology of Thyroid Gland

The thyroid gland is a vital endocrine organ that plays a central role in regulating metabolism, growth, and development. It is a bilobed gland situated in the anterior neck region, lying anterolateral to the upper trachea, just below the cricoid cartilage [31]. [redacted]

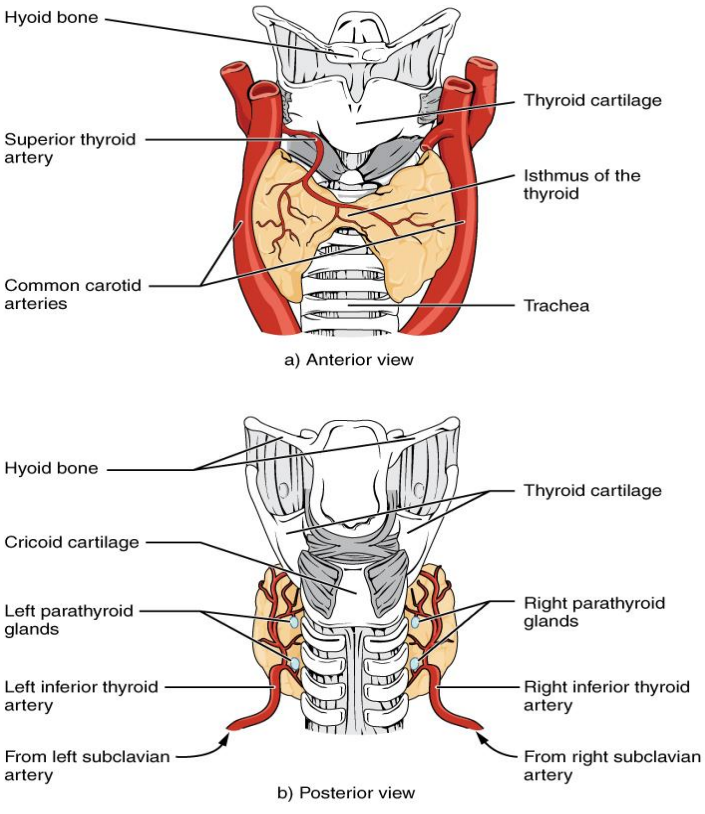


Figure 4: Anatomy of Thyroid Gland

Synthesis, Secretion and Metabolism of Thyroid Hormones

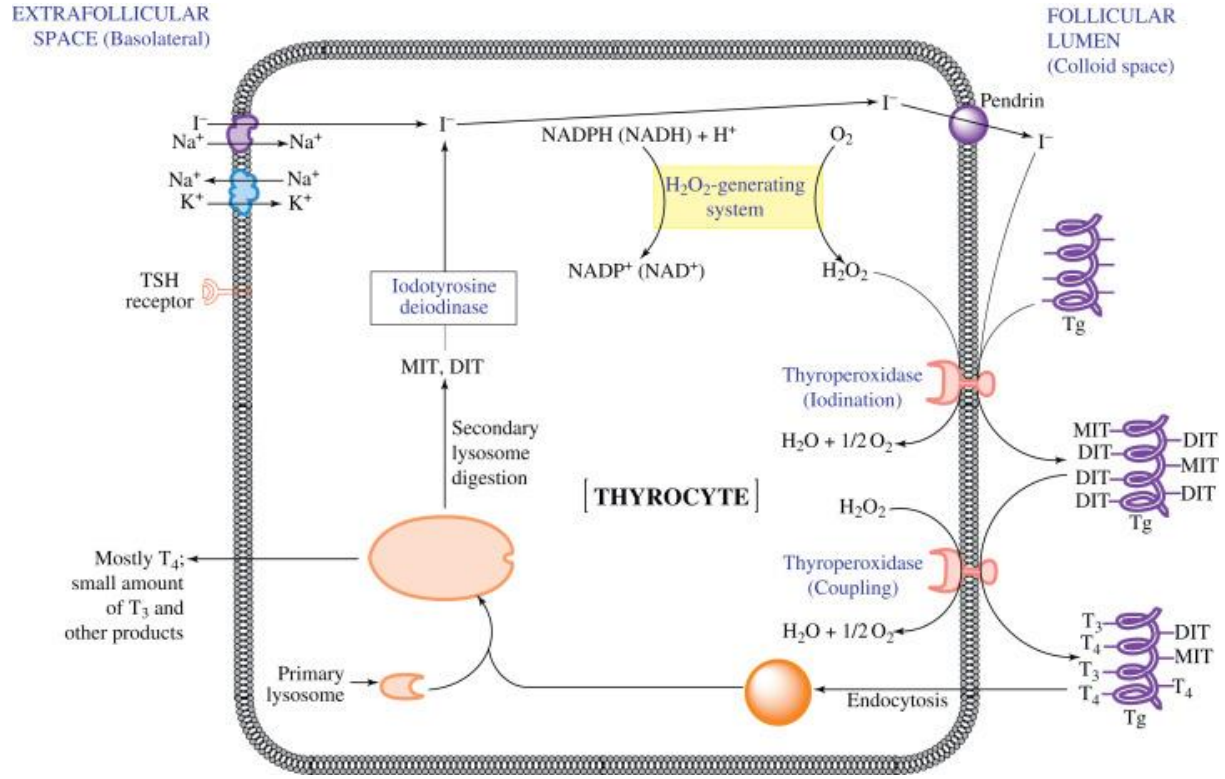


Figure 5: Thyroid Hormone synthesis

[redacted]

Hypothalamic–Pituitary–Thyroid Axis Regulation

The hypothalamic–pituitary–thyroid axis is a tightly regulated neuroendocrine system that maintains circulating thyroid hormone levels within a narrow physiological range. This axis ensures appropriate thyroid hormone availability according to metabolic demands [35].

[redacted]

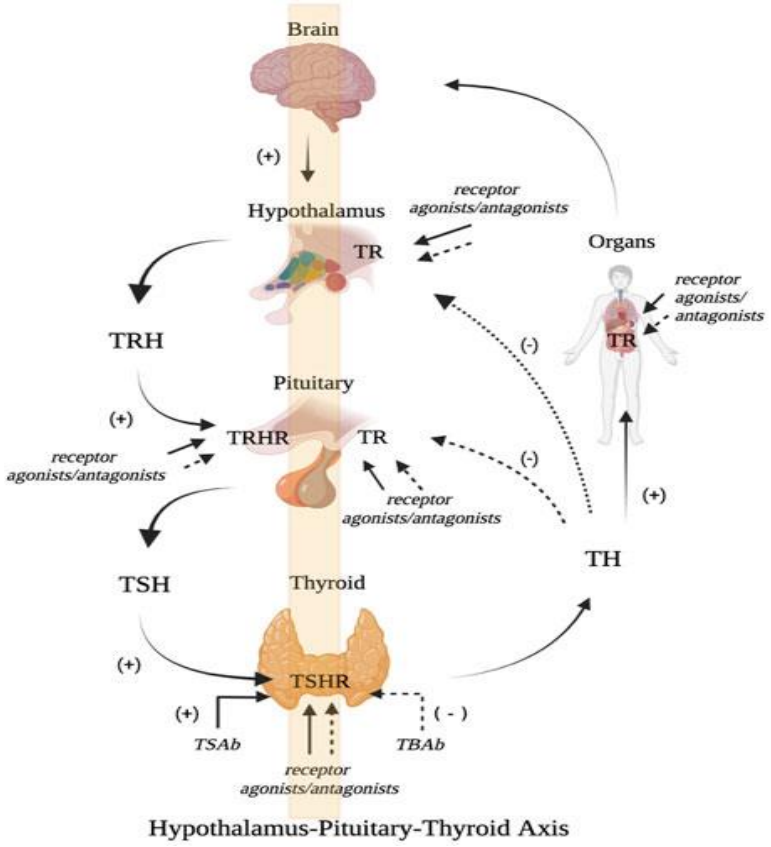


Figure 6: Hypothalamic–Pituitary–Thyroid Axis Regulation

Hypothyroidism

Classification of Hypothyroidism

Hypothyroidism is an endocrine disorder characterized by deficient production or action of thyroid hormones, resulting in a generalized slowing of metabolic processes [36].

[redacted]

Another important classification is based on the biochemical and clinical severity of the disease. Overt hypothyroidism is characterized by elevated thyroid-stimulating hormone levels with reduced circulating thyroid hormone levels and is usually associated with clear clinical manifestations [38]. [redacted]

Etiopathogenesis of Hypothyroidism

The etiopathogenesis of hypothyroidism involves a variety of mechanisms that lead to reduced synthesis, secretion, or action of thyroid hormones [40]. [redacted]

Pituitary or hypothalamic disorders can impair thyroid-stimulating hormone or thyrotropin-releasing hormone secretion, leading to secondary or tertiary hypothyroidism. These forms are less common but clinically significant [38].

Metabolic Effects of Hypothyroidism

Thyroid hormones play a critical role in regulating basal metabolic rate and energy expenditure. Hypothyroidism results in a global reduction in metabolic activity, affecting carbohydrate, lipid, and protein metabolism. [redacted]

[redacted]

Sub-clinical Hypothyroidism

Sub-clinical hypothyroidism is a biochemical condition characterized by elevated serum thyroid-stimulating hormone levels in the presence of normal circulating free thyroid hormone concentrations [redacted]

Diagnosis is based entirely on laboratory findings, as clinical examination may be unremarkable. Thyroid-stimulating hormone is the most sensitive indicator of thyroid function and rises early in response to subtle reductions in thyroid hormone activity [45].

Biochemical Profile in Sub-clinical Hypothyroidism

[redacted]

Free thyroxine and free triiodothyronine levels are typically normal, though they may be at the lower end of the reference range. [redacted]

Regular monitoring of biochemical parameters is essential to detect progression to overt hypothyroidism and to assess metabolic impact.

Pathophysiological Mechanisms

The pathophysiology of sub-clinical hypothyroidism involves early dysfunction of the thyroid gland with preserved hormone output due to compensatory mechanisms. [redacted]

Clinical and Metabolic Implications

[redacted]

Interrelationship Between Thyroid Function and Glucose Metabolism

Effect of Thyroid Hormones on Carbohydrate Metabolism

Thyroid hormones play a fundamental role in regulating carbohydrate metabolism by influencing glucose production, absorption, utilization, and storage. [redacted]. In peripheral tissues such as skeletal muscle and adipose tissue, thyroid hormones facilitate glucose uptake and utilization by regulating glucose transporter expression and mitochondrial oxidative capacity [49].

Influence of Thyroid Dysfunction on Insulin Sensitivity

[redacted]

[44].

[redacted]

Chronic low-grade inflammation and altered adipokine secretion may also contribute to insulin resistance in this state [39].

Impact of Dysglycemia on Thyroid Function

[redacted]

Sub-clinical Hypothyroidism in Prediabetes

Pathophysiological Link Between Prediabetes and Sub-clinical Hypothyroidism

[redacted]

[redacted]

Effect of Sub-clinical Hypothyroidism on Glycemic Control

[redacted]

Reduced thyroid hormone action leads to decreased glucose utilization in peripheral tissues, particularly skeletal muscle and adipose tissue. [redacted] These metabolic disturbances can result in higher fasting and postprandial glucose levels, thereby increasing HbA1c values over time [50].

Relationship Between TSH, T3, T4 and HbA1c Levels

[redacted]

[redacted]

Metabolic and Cardiovascular Implications

Dyslipidemia and Metabolic Syndrome

Dyslipidemia is a common metabolic abnormality observed in both prediabetes and thyroid dysfunction and represents a key link between glucose dysregulation and cardiovascular disease [54]. [redacted]. Insulin resistance serves as the central pathophysiological mechanism linking dyslipidemia, hypertension, central obesity, and impaired glucose regulation [56].

Endothelial Dysfunction and Atherosclerosis

Endothelial dysfunction is an early and critical event in the pathogenesis of atherosclerosis and is commonly observed in individuals with impaired glucose regulation. [redacted]

[redacted]

Cardiovascular Risk in Prediabetes with Thyroid Dysfunction

Cardiovascular disease remains the leading cause of morbidity and mortality in individuals with metabolic disorders. Prediabetes is independently associated with an increased risk of cardiovascular events due to early vascular changes, insulin resistance, and metabolic abnormalities. [redacted]

Clinical Evaluation and Biochemical Assessment

Clinical Assessment of Prediabetic Patients

Clinical assessment of prediabetic patients plays a crucial role in early identification of metabolic risk and prevention of progression to overt diabetes mellitus [25]. [redacted]

[redacted]

Thyroid Function Tests and Interpretation

Thyroid function tests are essential for evaluating thyroid status in individuals with metabolic disorders, including prediabetes. [redacted] Elevated thyroid-stimulating hormone with normal free hormone levels indicates sub-clinical hypothyroidism [63].

HbA1c-Based Risk Stratification

[redacted]

Importance of Early Detection and Screening

[redacted]

Clinical Implications of Early Diagnosis

Early diagnosis of thyroid dysfunction in prediabetic individuals has important clinical implications for disease management, prevention, and long-term outcomes. [redacted]

Therapeutic and Preventive Perspectives

Lifestyle Interventions

Lifestyle interventions form the cornerstone of management in individuals with prediabetes and associated endocrine abnormalities such as sub-clinical hypothyroidism [39]. [redacted]

Role of Thyroid Hormone Replacement

[redacted]

Impact on Prevention of Progression to Diabetes

[redacted]

Rationale and Justification for the Present Study

[redacted]

However, prediabetes is often under-recognized and inadequately evaluated beyond glycemic parameters alone. [redacted]

Research Studies

[redacted]

[redacted] investigated the association between thyroid dysfunction and markers of glucose and lipid metabolism. [redacted]

[redacted]

[redacted] presented a detailed review of subclinical hypothyroidism, focusing on its definition, diagnostic criteria, epidemiology, and systemic metabolic effects. [redacted]. The evidence presented supports the clinical importance of identifying subclinical hypothyroidism in individuals with early metabolic abnormalities, such as those detected using HbA1c-based criteria [39].

[redacted] evaluated the relationship between subclinical hypothyroidism and insulin resistance in normoglycemic adults, providing insight into metabolic alterations that precede the onset of dysglycemia. [redacted]. The observed link between elevated TSH and insulin resistance provides strong physiological justification for evaluating thyroid function in individuals identified with early dysglycemia using HbA1c, particularly for timely risk stratification and prevention strategies [67].

[redacted]

[redacted] evaluated the association between thyroid function parameters and the future risk of developing prediabetes and type 2 diabetes mellitus. [redacted] The study provides strong epidemiological evidence supporting the evaluation of thyroid function in individuals at early stages of glucose intolerance, particularly those identified using HbA1c-based criteria [8].

[redacted] examine the relationship between thyroid dysfunction and the risk of developing type 2 diabetes mellitus. Subclinical hypothyroidism was consistently associated with an increased risk of diabetes compared with euthyroid status. [redacted]

[redacted] summarized epidemiological evidence regarding prediabetes, emphasizing its global burden, metabolic characteristics, and clinical implications. [redacted]

AIMS AND OBJECTIVES

Aim:

[redacted]

Objectives:

[redacted]

[redacted]

MATERIALS AND METHODS

Study Design:

Study Area:

Study Duration:

Study Population:

Inclusion Criteria:

Exclusion Criteria:

10. Haematological malignancies

[redacted]

Methods: [redacted]. Clinical signs suggestive of insulin resistance or thyroid dysfunction were specifically looked for and documented.

All clinical details were recorded in a pre-designed and pre-tested proforma.

Laboratory Investigations

HbA1c Estimation

[redacted]

Thyroid Function Tests

[redacted]

Sub-clinical Hypothyroidism

Sub-clinical hypothyroidism was defined as elevated serum TSH levels (>5.45 mIU/L) with normal circulating FT3 and FT4 levels, in accordance with standard biochemical criteria.

Outcome Measures

[redacted]

Statistical Analysis

All collected data were entered into a spreadsheet and analyzed using appropriate statistical software. [redacted]

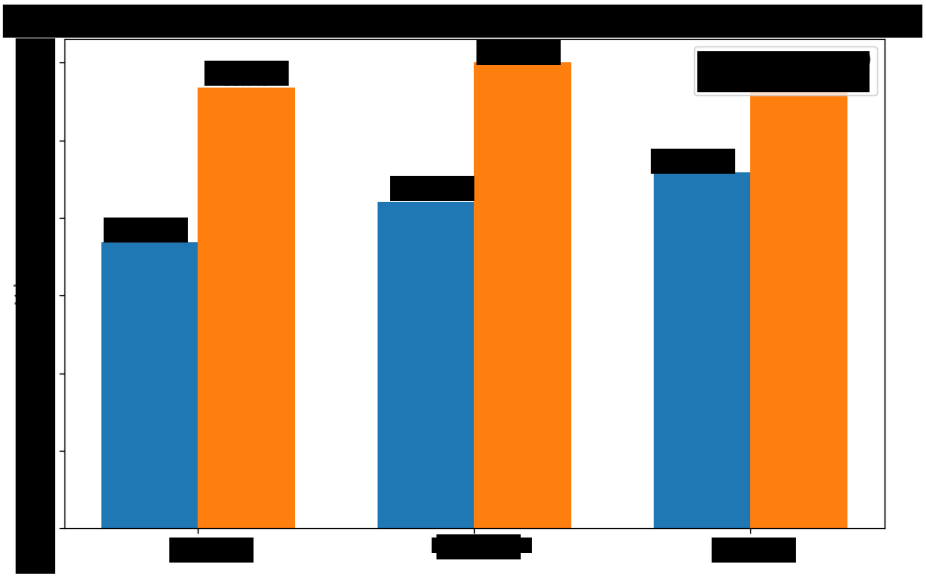
RESULTS

Table 1. Comparison of Demographic Characteristics Among Study Groups

Variable	Control (n=60)	Prediabetes (n=60)	Diabetes (n=60)	p-value
Age (years), Mean ± SD	[redacted]	[redacted]	[redacted]	[redacted]
Male, n (%)	[redacted]	[redacted]	[redacted]	[redacted]

Age compared using independent t-test. Sex distribution compared using Chi-square test. $p < 0.05$ significant.

[redacted]



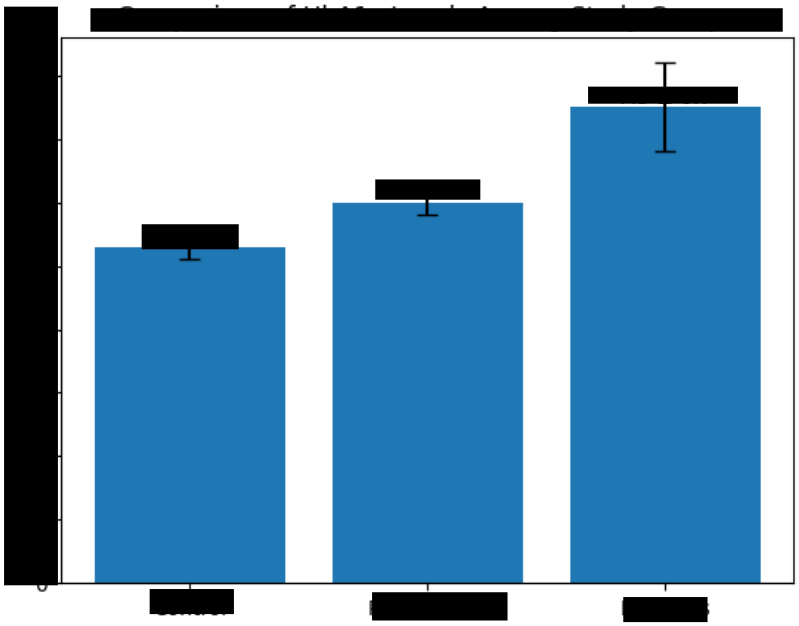
Graph 1. Comparison of Demographic Characteristics Among Study Groups

Table 2. Distribution of HbA1c Levels Among Study Groups

Group	HbA1c Mean ± SD	Range
Control (<5.7%)	[redacted]	[redacted]
Prediabetes (5.7–6.4%)	[redacted]	[redacted]
Diabetes (≥6.5%)	[redacted]	[redacted]

Groups classified according to ADA HbA1c criteria.

[redacted]

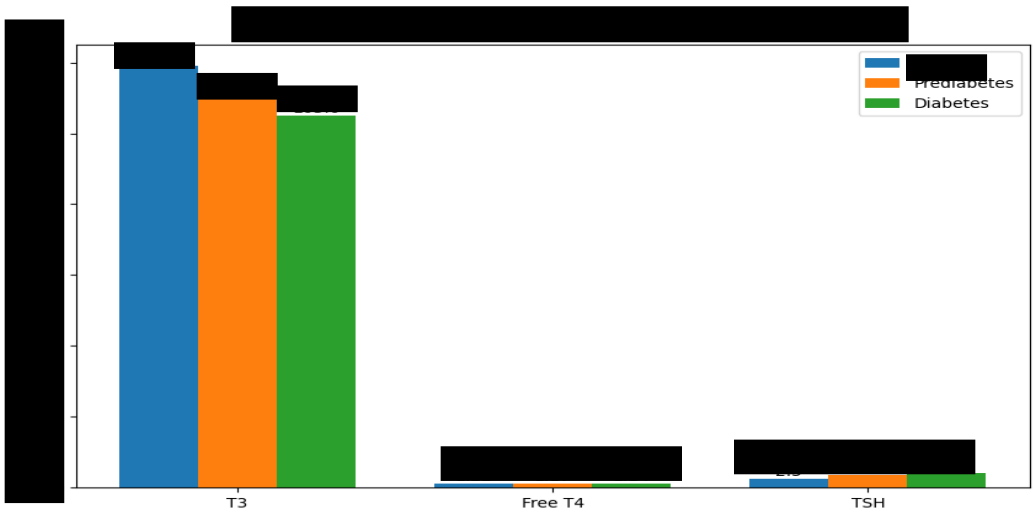


Graph 2. Distribution of HbA1c Levels Among Study Groups

Table 3. Comparison of Thyroid Function Parameters Among Control, Prediabetes, and Diabetes Groups

Parameter	Control	Prediabetes	Diabetes	p-value
T3 (ng/dL), Mean ± SD	[redacted]	[redacted]	[redacted]	[redacted]
Free T4 (ng/dL), Mean ± SD	[redacted]	[redacted]	[redacted]	[redacted]
TSH (mIU/L), Median (IQR)	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]

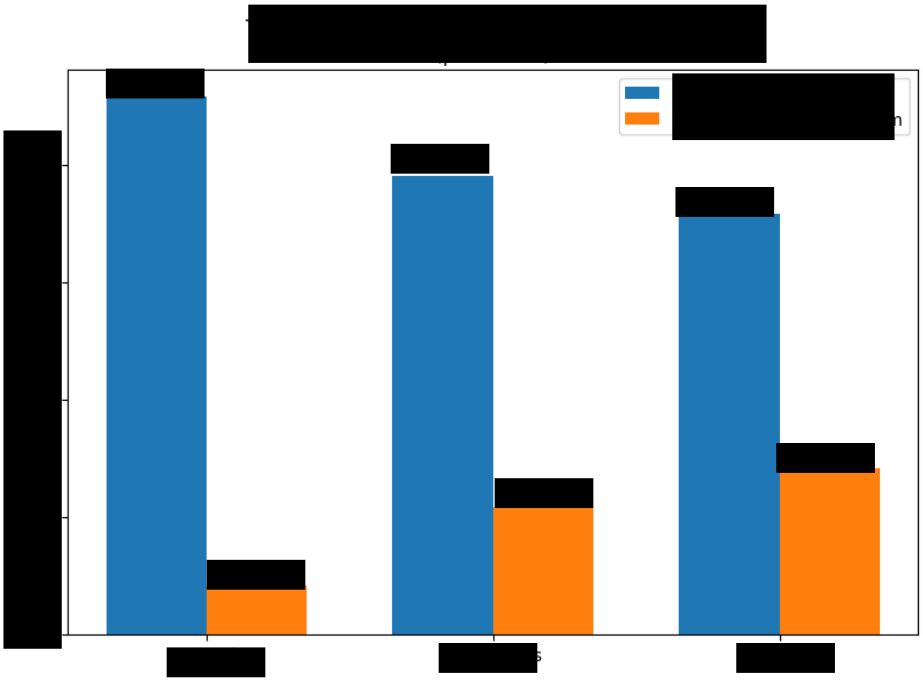


Graph 3. Comparison of Thyroid Function Parameters Among Control, Prediabetes, and Diabetes Groups

Table 4. Prevalence of Subclinical Hypothyroidism Among Study Groups

Thyroid Status	Control n (%)	Prediabetes n (%)	Diabetes n (%)	p-value
Euthyroid	[redacted]	[redacted]	[redacted]	[redacted]
Subclinical Hypothyroidism	[redacted]	[redacted]	[redacted]	

[redacted]



Graph 4. Prevalence of Subclinical Hypothyroidism Among Study Groups

Table 5. Prevalence of Subclinical Hypothyroidism Among Prediabetic Participants

Total Prediabetes (n)	SCH (n)	Prevalence (%)	95% Confidence Interval
60	[redacted]	[redacted]	[redacted]

[redacted]

Table 6. Odds of Subclinical Hypothyroidism in Prediabetes and Diabetes Compared to Controls

Comparison	Odds Ratio	95% CI	p-value
Prediabetes vs Control	[redacted]	[redacted]	[redacted]
Diabetes vs Control	[redacted]	[redacted]	[redacted]

[redacted]

Graph 5. Odds of Subclinical Hypothyroidism in Prediabetes and Diabetes Compared to Controls

Table 8. Correlation Between HbA1c and Thyroid Function Parameters (Spearman's Correlation)

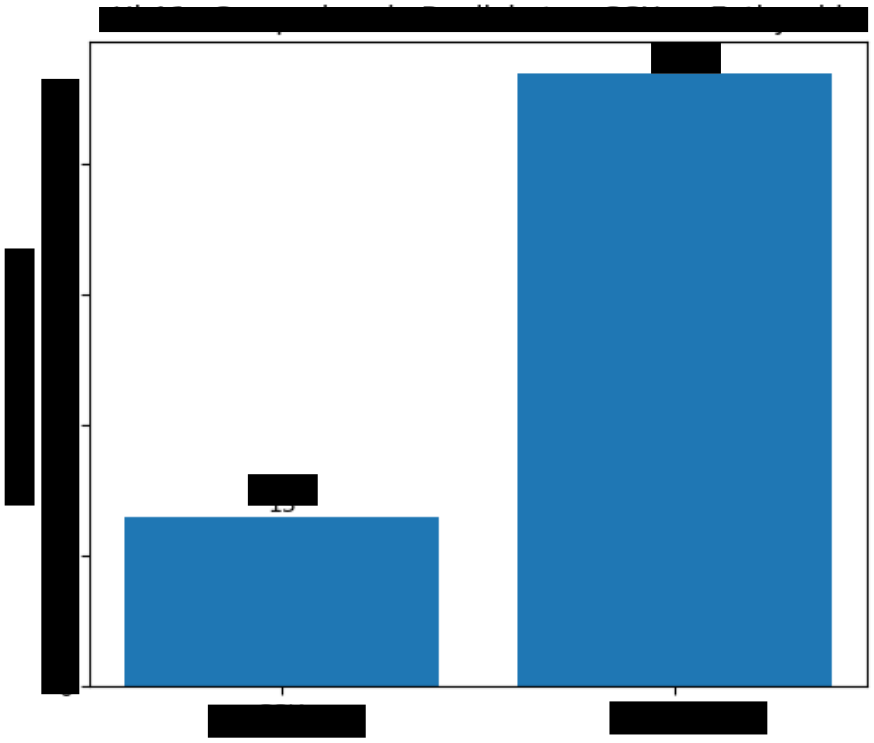
Variable Pair	Spearman's r	p-value
HbA1c vs TSH	[redacted]	[redacted]
HbA1c vs Free T4	[redacted]	[redacted]
HbA1c vs T3	[redacted]	[redacted]

[redacted]

Table 9. Comparison of HbA1c Levels Between Subclinical Hypothyroid and Euthyroid Prediabetic Participants

Thyroid Status	n	HbA1c Mean ± SD	p-value
SCH	[redacted]	[redacted]	[redacted]
Euthyroid	[redacted]	[redacted]	

[redacted]

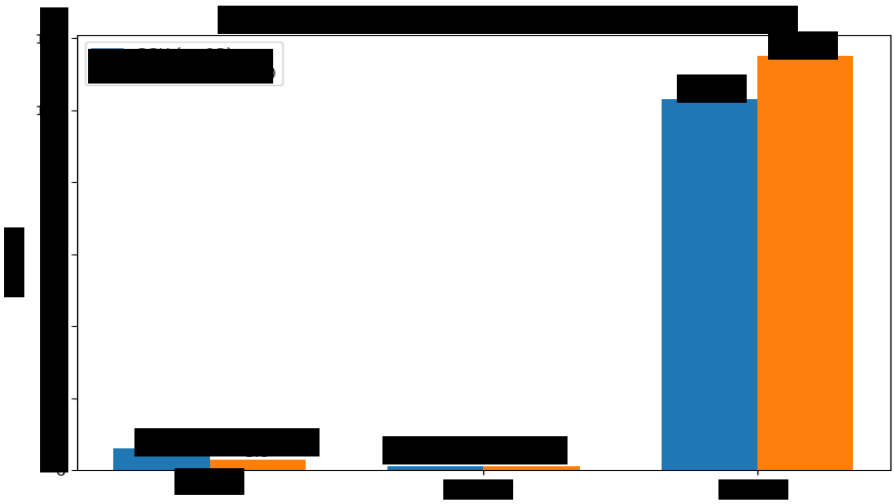


Graph 7. Comparison of HbA1c Levels Between Subclinical Hypothyroid and Euthyroid Prediabetic Participants

Table 10. Comparison of Thyroid Function Parameters Between Subclinical Hypothyroid and Euthyroid Prediabetic Participants

Parameter	SCH (n=13)	Euthyroid (n=47)	p-value
TSH (mIU/L), Median (IQR)	[redacted]	[redacted]	[redacted]
Free T4 (ng/dL), Mean ± SD	[redacted]	[redacted]	[redacted]
T3 (ng/dL), Mean ± SD	[redacted]	[redacted]	[redacted]

[redacted] group and 115 ± 20 in the euthyroid group, with a p-value of 0.04*.

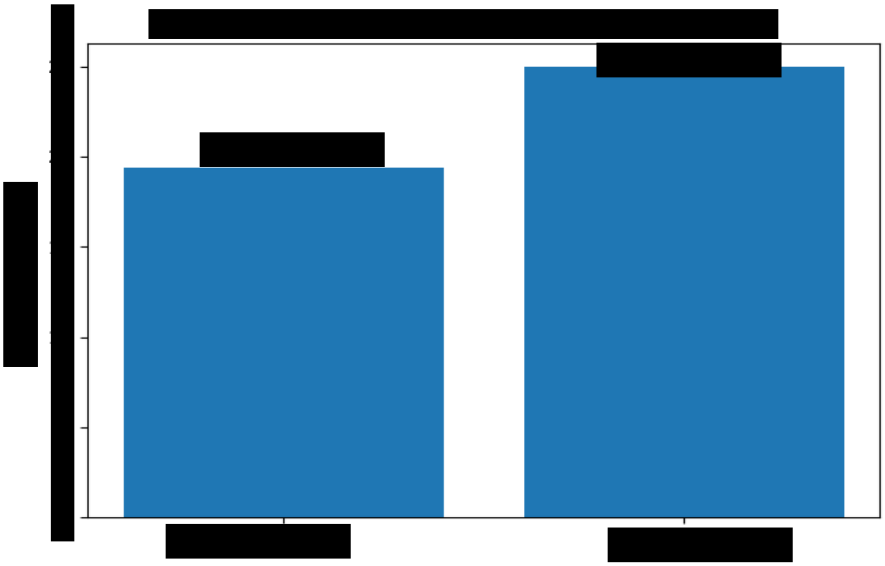


Graph 8. Comparison of Thyroid Function Parameters Between Subclinical Hypothyroid and Euthyroid Prediabetic Participants

Table 11. Association of Sex with Subclinical Hypothyroidism Among Prediabetic Participants

Sex	Total (n)	SCH n (%)	p-value
Male	[redacted]	[redacted]	[redacted]
Female	[redacted]	[redacted]	

[redacted]



Graph 9. Association of Sex with Subclinical Hypothyroidism Among Prediabetic Participants

DISCUSSION

Prediabetes represents an intermediate metabolic state between normoglycemia and diabetes and is characterized by impaired glucose regulation with an increased risk of progression to type 2 diabetes mellitus. [redacted]

Participant Screening and Final Enrollment

In the present study, 214 participants were screened, of whom [redacted] were excluded, resulting in 180 participants who were finally enrolled and analyzed. [redacted] In addition, [redacted] discussed the limitations of HbA1c as a diagnostic marker in conditions affecting erythrocyte turnover, reinforcing the importance of excluding such cases [69].

Comparison of Demographic Characteristics Among Study Groups

In the present study, the demographic characteristics of the participants were compared among the control, prediabetes, and diabetes groups. [redacted]

[redacted] Similarly, [redacted] observed that individuals with higher age groups had a significantly increased risk of progression from prediabetes to diabetes when defined using HbA1c or fasting plasma glucose criteria [3].

Distribution of HbA1c Levels Among Study Groups

[redacted]. These observations closely resemble the distribution observed in the present study.

[redacted]

[redacted]

Comparison of Thyroid Function Parameters Among Control, Prediabetes, and Diabetes Groups

[redacted] These findings suggest a trend toward reduced thyroid hormone levels with increasing glycemic dysregulation, accompanied by a compensatory rise in TSH.

[redacted] Their findings support the present observation of significantly higher TSH levels among individuals with prediabetes and diabetes.

[redacted]

. Reduced thyroid hormone activity may therefore contribute to impaired glucose regulation.

Prevalence of Subclinical Hypothyroidism Among Study Groups

In the present study, the prevalence of subclinical hypothyroidism (SCH) showed a progressive increase across the study groups.

individuals, highlighting the close relationship between glucose metabolism and thyroid function [5]. Their study also observed that subclinical hypothyroidism was among the most common thyroid abnormalities detected in diabetic patients.

which demonstrated a significant association between thyroid dysfunction and type 2 diabetes [10]. The authors reported that individuals with thyroid dysfunction, particularly subclinical hypothyroidism, had a higher risk of developing diabetes compared with euthyroid individuals.

[redacted]

Prevalence of Subclinical Hypothyroidism Among Prediabetic Participants

In the present study, among 60 individuals with prediabetes, 13 participants were found to [redacted] Their findings indicate that subtle thyroid dysfunction may precede or coexist with impaired glucose metabolism, which is consistent with the elevated prevalence of SCH observed in the present study.

Odds of Subclinical Hypothyroidism in Prediabetes and Diabetes Compared to Controls

[redacted] These findings indicate that individuals with prediabetes and diabetes have a significantly increased likelihood of developing subclinical hypothyroidism compared with normoglycemic individuals.

[redacted]

Furthermore, [redacted]. [redacted] reported that insulin resistance and metabolic disturbances are commonly associated with subclinical hypothyroidism, which may explain the increased risk of thyroid dysfunction among individuals with impaired glucose metabolism observed in the present study [47].

Correlation Between HbA1c and Thyroid Function Parameters

[redacted]. Likewise, [redacted] reported in a meta-analysis that thyroid dysfunction was significantly associated with disturbances in glucose metabolism and increased risk of diabetes [10].

Comparison of HbA1c Levels Between Subclinical Hypothyroid and Euthyroid Prediabetic Participants

[redacted] Their findings are consistent with the present study, where HbA1c levels were higher among prediabetic individuals with SCH.

Comparison of Thyroid Function Parameters Between Subclinical Hypothyroid and Euthyroid Prediabetic Participants

In the present study, thyroid function parameters were compared between prediabetic individuals with subclinical hypothyroidism (SCH) and those who were euthyroid. [redacted],

[redacted] This pattern closely resembles the findings observed in the present study. Similarly, [redacted] observed that patients with subclinical hypothyroidism exhibited significantly higher TSH concentrations compared with euthyroid subjects, while free T4 levels were often within the normal reference range [74]. Their findings support the biochemical pattern observed in the present study.

Association of Sex with Subclinical Hypothyroidism Among Prediabetic Participants

[redacted] Furthermore, Bermúdez et al. ([redacted]) also reported that subclinical hypothyroidism can occur in both sexes in association with metabolic syndrome and glucose metabolism disturbances [73].

STRENGTHS OF THE STUDY

- **Focused study population:**
- **Use of HbA1c for classification**
- **Comparative study groups:**
- **Evaluation of multiple thyroid parameters:**

5. **Assessment of prevalence and association:** The study not only estimated the prevalence of subclinical hypothyroidism in prediabetes but also evaluated its association with HbA1c and thyroid hormone levels, strengthening the clinical relevance of the findings.
6. **Use of appropriate statistical methods:** .
7. **Calculation of odds ratios and confidence intervals:** Estimating odds ratios with 95% confidence intervals helped quantify the risk of subclinical hypothyroidism among prediabetic and diabetic individuals.

- **Exclusion of confounding conditions**

LIMITATIONS OF THE STUDY

Relatively small sample size:

2. **Single-center study:** .
3. **Cross-sectional design:** The study design does not allow determination of causal relationships between thyroid dysfunction and prediabetes.

Lack of thyroid antibody assessment:

No follow-up evaluation:

6. **Limited assessment of metabolic factors** .
7. **Potential selection bias:** Since participants were recruited from hospital settings, the study population may differ from community-based populations.

Lifestyle factors not evaluated:

SUMMARY

The present study was conducted to determine the prevalence of subclinical hypothyroidism among individuals with HbA1c-defined prediabetes and to evaluate the relationship between thyroid function parameters [redacted]. [redacted]

These findings highlight a clear association between thyroid dysfunction and impaired glucose metabolism.

CONCLUSION

The present study was conducted to determine the prevalence of subclinical hypothyroidism (SCH) among individuals with HbA1c-defined prediabetes and to evaluate the relationship between thyroid function parameters (T3, Free T4, and TSH) and HbA1c levels [redacted] These findings suggest that thyroid dysfunction may influence glycemic control even in the early stages of glucose dysregulation.

Overall, the present study highlights a notable prevalence of subclinical hypothyroidism among individuals with prediabetes and demonstrates a significant association between thyroid dysfunction and glycemic status. [redacted]

REFERENCES

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2. Echouffo-Tcheugui, J. B. & Selvin, E. Pre-Diabetes and What It Means: The Epidemiological Evidence. *Annu. Rev. Public Health* 42, 59 (2021).

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ANNEXURES

STUDY PROFORMA

Name:-	Age/Sex:-
[redacted]	[redacted]
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GENERAL PHYSICAL EXAMINATION:-

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

[redacted]	[redacted]	[redacted]	[redacted]

SYSTEMIC EXAMINATION:-

PATIENT LABORATORY INVESTIGATIONS PROFILE

PATIENT'S PROFILE	PARAMETERS& RESULTS	PARAMETERS & RESULTS
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PARTICIPANT INFORMED CONSENT FORM (PICF)

Patient's identification no: -

TITLE: - **"TO STUDY THE PREVALENCE OF SUB-CLINICAL HYPOTHYROIDISM IN PREDIABETICS BASED ON HbA1c"**

[redacted]

The context of information sheet dated……...that was provided have been read carefully

[redacted]

(Signature/Left Thumb Impression) Date Place:

Name of the Participant: _____
Son/Daughter/Spouse of: _____
complete postal address: _____
[redacted]

Date: Place:

Signature of Principal Investigator:

[redacted]

प्रतिभागी सूचना पत्रक

[redacted]

[redacted]

[redacted] लूनावथ साई कृष्णा, डीएनबी स्नातकोत्तर छात्र, सामान्य चिकित्सा विभाग, [redacted]

[redacted] **HbA1c के आधार पर प्रीडायबिटिक्स में सबक्लिनिकल हाइपोथायरॉडिज्म की व्यापकता का अध्ययन करना "** [redacted]

किससे संपर्क करें:

[redacted]

PARTICIPANT INFORMATION SHEET (PIS)

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प्रतिभागी सूचना पत्र (पीआईएस)

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i) अध्ययन/परियोजना का शीर्षक

ii) शोध के उद्देश्य और तरीके।

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177	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
178	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
179	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
180	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]