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The Prevalence of Dyslipidemia in South Indian Type 2 Diabetes Mellitus Patients: A Cross-Sectional Study

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ABSTRACT

Objective: In South India, there's limited research on dyslipidemia in Type 2 diabetes mellitus (T2DM) patients, despite the global burden of T2DM. This study aims to investigate the prevalence of elevated lipid profiles in Type 2 diabetic patients from Coimbatore, South India. The scope of dyslipidemia in this population and its potential implications for cardiovascular health can be better understood by assessing the lipid profiles of these patients.

Methods: To address this knowledge gap, a comprehensive cross-sectional study was conducted, collecting essential patient information, including the following: age, sex, diagnosis, disease duration, fasting blood sugar levels (BSL), post-breakfast BSL, hemoglobin A1c (HbA1c) levels, LDL cholesterol (low density lipoprotein cholesterol), triglyceride levels, and any relevant notes or observations. Conducting a cross-sectional study in Tamil Nadu with 100 T2DM patients, we found a high prevalence of dyslipidemia.

Results: Elevated lipid levels indicate the prevalence of dyslipidemia among the T2DM patients in Coimbatore. This emphasizes the need for effective management to reduce cardiovascular risks in T2DM.

Conclusion: Our findings call for a comprehensive approach, including vigilant lipid profile monitoring alongside glycemic control, to improve patient outcomes. Addressing dyslipidemia alongside glycemic control can substantially reduce the burden of cardiovascular complications, ultimately leading to improved patient outcomes. This study contributes crucial data for region-specific guidelines and interventions in South India.

Main Points

- **Novel Demographic Representation:** This study offers new insights into the prevalence of dyslipidemia in Type 2 diabetes patients from a hospital associated with a public charitable trust in Coimbatore, South India. This setting provides a unique perspective due to its diverse range of patients from various socioeconomic and demographic backgrounds, which enhances the generalizability of the findings.
- **Gap in Existing Research:** There is limited research on dyslipidemia in rural South Indian populations. This study addresses this critical gap by focusing on a previously underrepresented demographic group, rural South Indians, thereby contributing valuable data to the existing body of knowledge on the prevalence and management of dyslipidemia in this region.
- **High Prevalence of Dyslipidemia:** This study reveals a significant prevalence of dyslipidemia among the Type 2 diabetic patients in Coimbatore, highlighting the urgency of integrating effective lipid management strategies alongside diabetes care to mitigate cardiovascular risks and improve patient health outcomes.
- **Implications for Regional Guidelines:** The findings call for tailored regional guidelines and interventions in rural South Indian patients. The data highlights the need for comprehensive lipid profile monitoring in addition to glycemic control to address cardiovascular risks effectively in this specific population.

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Introduction

Type 2 diabetes mellitus (T2DM) is a multifaceted metabolic disorder characterized by insulin resistance and chronic hyperglycemia. It represents a significant global health burden, affecting millions of individuals worldwide. One of the most common complications associated with T2DM is dyslipidemia, the imbalance of lipids such as cholesterol and triglycerides, in the bloodstream, as reported by Wu and colleagues [1]. Cholesterol is a critical lipid molecule involved in various physiological processes, including cell membrane structure, hormone synthesis, and bile acid production. In the context of T2DM, LDL cholesterol levels take on increased importance due to their association with cardiovascular risk. Elevated total LDL-cholesterol levels have been shown to contribute to atherosclerosis, a process where fatty deposits accumulate in arteries, leading to narrowed blood vessels and increased risk of heart disease and stroke [2].

Elevated levels of cholesterol and triglycerides are common features of dyslipidemia, which is also a critical risk factor for cardiovascular diseases (CVD) and plays a pivotal role in the pathogenesis of atherosclerosis and other vascular disorders, as reported by Wu and colleagues [1]. The coexistence of T2DM and dyslipidemia exponentially increases the risk of macrovascular and microvascular complications, leading to substantial morbidity and mortality rates. Understanding the prevalence of elevated lipid profiles among T2DM patients is crucial for early intervention and optimal disease management. In this cross-sectional study, the data were collected at a single point in time and no intervention or treatment was applied to the study participants. In this case, the study aimed to investigate the prevalence of elevated lipid profiles in T2DM patients from Coimbatore, South India, and explore potential associations with clinical parameters such as age, duration of diabetes, blood sugar levels, and HbA1c levels.

Significance and Research Gap

The increasing prevalence of T2DM and its associated complications, including dyslipidemia, represents a significant public health challenge in South India and beyond, as reported by Zimmet and colleagues [2-5]. Early detection and effective management of dyslipidemia can significantly reduce the risk of cardiovascular complications and improve overall patient outcomes. Moreover, understanding the epidemiological trends of dyslipidemia in T2DM patients can aid healthcare providers in formulating targeted interventions and personalized treatment plans for optimal diabetes care. While some studies have investigated the prevalence of dyslipidemia in T2DM patients globally, there is a lack of research focusing on the Coimbatore population. The unique genetic and lifestyle factors in this region may lead to distinct patterns of dyslipidemia in T2DM patients, necessitating region-specific research to develop tailored intervention strategies. This study holds particular relevance for Coimbatore, South India, where the prevalence of T2DM is a significant public health concern. The investigation of dyslipidemia in T2DM patients from this region provides region-specific data that can inform healthcare providers and policymakers in developing targeted intervention strategies. This word can also be extended to other regions in order to facilitate region-specific intervention. By shedding light on the prevalence and potential risk factors associated with dyslipidemia in Coimbatore, this research aims to contribute valuable insights to regional diabetes research and facilitate evidence-based healthcare practices.

Related Work

Diabetes in India

A background literature review was conducted by searching PubMed using the search terms "diabetes in India," "dyslipidemia," and "hyperlipidemia." From the articles found through this search, relevant references were further selected from their reference lists. Past research on the prevalence of dyslipidemia in T2DM patients has yielded varying results, likely influenced by differences in study populations, geographical locations, and healthcare practices. Moreover, there is limited data on the prevalence of elevated lipid profiles in T2DM patients specifically from Coimbatore, South India. This study aims to contribute to the existing body of literature on dyslipidemia in T2DM, with a focus on this particular geographical region.

A significant body of literature on diabetes mellitus and its complications in India highlights the nation's escalating diabetes epidemic and the associated challenges in disease management. Unnikrishnan and colleagues emphasize India's young age of onset for T2DM and its occurrence at lower BMI levels, distinguishing it from other populations [3]. Furthermore, Asian Indian individuals with a specific phenotype characterized by high intra-abdominal fat and insulin resistance despite a low BMI are at an increased risk of T2DM and premature coronary heart disease. Diabetes research in India has grown substantially, exploring various aspects of the disease and its complications. Nonetheless, the delivery of optimal care remains a major challenge, attributed to low awareness, inadequate medical resources, and financial constraints. As the most populous country in the world, as reported by Kc and colleagues, India's diabetes epidemic underscores the need for comprehensive research to address the unique aspects of the disease in this region [4].

Pradeepa and colleagues also delve into the pressing issue of diabetes mellitus in India and the authors emphasize the nation's rapid socioeconomic transition, urbanization, and industrialization as primary drivers of this alarming trend [2]. They highlight the significant increase in the number of people diagnosed with diabetes in India, mirroring the broader global pattern. Moreover, the prevalence of diabetes in India extends not only to urban areas but also to rural regions, affecting a diverse range of populations, including the less privileged and younger individuals. The paper offers an in-depth examination of the complications associated with diabetes, which can be classified into microvascular and macrovascular diseases. These complications, ranging from diabetic retinopathy, diabetic nephropathy, and diabetic neuropathy to cardiovascular disease, cerebrovascular disease, and peripheral vascular disease, contribute to a profound economic burden. The authors argue that diabetes, being a progressive disorder, inflicts a wide range of anatomic, structural, and functional changes that result in multi-organ dysfunction, imposing severe healthcare costs on individuals, families, and society.

The study discussed in this paper serves as a vital contribution that addresses possible research gaps identified by Unnikrishnan and colleagues, Pradeepa and colleagues, and many more diabetic research papers [3]. While the latter provides comprehensive overviews of the prevalence of Type 2 Diabetes and its complications in India, it does not specifically focus on dyslipidemia prevalence and risk factors in T2DM patients from South India [2]. By conducting a cross-sectional analysis on 100 T2DM patients in Coimbatore, the current study fills this research gap by delving into the prevalence of dyslipidemia and its potential correlations with various clinical parameters in this specific geographical region. While the broader paper offers insights into the overall diabetes epidemic in India, the focus on Coimbatore allows for a more localized investigation of dyslipidemia in a unique population with distinct healthcare practices and socioeconomic factors. The study in Coimbatore contributes region-specific data, which is essential for developing targeted interventions and management strategies tailored to the needs of T2DM patients in this area. This crucial information complements the broader understanding provided by the previous paper, offering a more granular perspective on dyslipidemia prevalence and risk factors in a significant geographic subset of India.

Methodology

Study Design

This comprehensive cross-sectional study investigates the prevalence of dyslipidemia in Type 2 diabetic patients from Coimbatore, South India. The cross-sectional approach is ideally suited for capturing a momentary representation of the population's characteristics, enabling valuable insights into the prevailing dyslipidemia prevalence and potential risk factors. Ethical considerations were paramount throughout the study according

to the Indian Council of Medical Research (ICMR). Informed consent is defined as providing the following information to patients: providing relevant information to potential participants, ensuring the information is comprehended by them, and assuring voluntariness of participation. All three of these categories were followed thoroughly as informed consent was obtained from each participant before enrolling them in the research. Participants were not compensated as the ICMR guidelines states that participants must only be compensated for the following reasons: travel related expenses, inconvenience incurred, direct physical, psychological, social, legal, or economic harm as a result of their participation, or death. Since the patients' data were collected during their regular checkup and all of the tests were conducted as a part of their regular check-in, the patients were not inconvenienced and, therefore, were not given compensation.

Participants were selected from Shanthi Social Services (SSS) hospital who sought treatment from the head of the Diabetes and Endocrinology unit in July 2022. SSS is a registered public charitable trust and charges significantly less than private hospitals in India. Due to this factor, the study has representation of people from diverse demographic and socioeconomic backgrounds. The inclusion criteria encompassed adults with a confirmed diagnosis of Type 2 diabetes mellitus, regardless of their disease duration or treatment modality. A convenience sampling technique was employed to maintain a representative sample. The study size of 100 people was arrived at as this is the maximum number of usable patient data that was gathered in a single day. This method was used to eliminate bias as the patients involved in the study were randomly selected. The only cases in which a patient was not selected was if part of the necessary data (i.e. LDL cholesterol, BSL levels, or HbA1c levels) was not directly available.

Data Collection

The data collection for this cross-sectional study was gathered during the patients' regular check-in visits at Shanthi Social Services hospital in Coimbatore, South India. This study utilized a convenience sampling approach, taking advantage of the patients' routine appointments, which allowed for a more efficient and practical data collection process. Trained personnel were present during the patients' check-in visits to gather essential demographic information such as age, sex, and relevant clinical history (including the duration of diabetes and treatment modalities). Participants' medical records, available at the hospital, were also reviewed to extract additional clinical data, offering a comprehensive understanding of their diabetes management and overall health status. Prior to inclusion in this study, all patients provided informed consent, authorizing the utilization of their data for research purposes.

During the check-in visits, fasting blood sugar levels (BSL) and post-breakfast BSL were measured to evaluate glycemic control. Hemoglobin A1c (HbA1c) levels, an essential indicator of long-term glycemic control, were also recorded during these visits. Comprehensive lipid profiles were obtained from blood samples collected during the check-in appointments to assess dyslipidemia prevalence and potential risk factors. Trained phlebotomists performed blood sample collection using standardized procedures to ensure accuracy. The collected blood samples were then analyzed in the certified laboratory at SSS to obtain measurements of total cholesterol and triglyceride levels, which are the main indicators of lipid abnormalities such as dyslipidemia. The data collection process during the regular check-in visits allowed for seamless integration into the participants' healthcare routine, minimizing disruption and facilitating a higher response rate. The data collected during these visits were recorded manually and entered into a secure database for subsequent analysis.

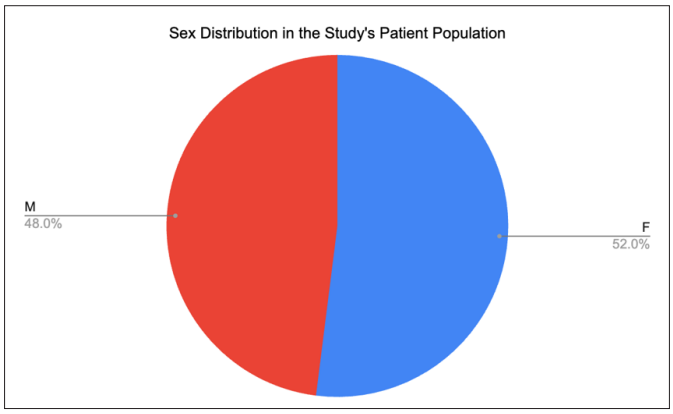

Figure 1: This Figure Shows the Relatively Even Distribution of Sexes in the Patient Population of this Study

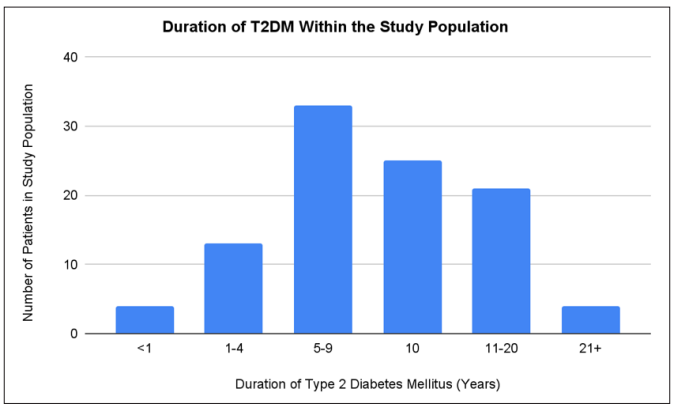

Figure 2: This Figure Shows the Varying Durations of T2DM within the Study Population, Highlighting the Diverse Range of the Data

The rigorous data collection efforts during the patients' check-in visits yielded a comprehensive dataset for analysis. This approach ensured accurate and reliable data that were collected through verified laboratory test results, enhancing the validity of the study's findings and providing valuable insights into the prevalence of dyslipidemia and its potential associations with various clinical parameters among Type 2 diabetic patients in Coimbatore, South India. The data collected during these regular clinic visits are crucial in informing evidence-based diabetes management strategies and contribute to the growing body of knowledge in the field of diabetes research, particularly in the context of dyslipidemia prevalence in this specific geographical region.

Data Analysis

The data analysis in this study involves rigorous examination of various clinical parameters in a well-defined cohort of patients diagnosed with T2DM in Coimbatore, South India. The study enrolled 100 participants, representing a diverse age range from 28 to 84 years. The mean age is 59 and the standard deviation value is 11.81. Among the participants, the gender distribution was relatively balanced with 48% being male and 52% female (Figure 1). A key strength of this dataset lies in the confirmed diagnosis of T2DM in all enrolled patients, ensuring the homogeneity of the disease cohort. The duration of T2DM exhibited considerable

variability within the patient population, ranging from early-onset cases as early as one month to long-standing chronic conditions lasting up to 25 years (Figure 2). The diverse representation of patients with varying ages, genders, and disease durations in the dataset provides a rich and comprehensive sample for studying the multifaceted nature of T2DM.

The assessment of blood sugar levels, an essential component in diabetes management, revealed notable variations. Fasting blood sugar levels (BSL) demonstrated a wide distribution, ranging from 71 to 619 mg/dL, while post-breakfast blood sugar levels similarly exhibited diverse values, spanning from 64 to 830 mg/dL. These results underscore the heterogeneity in glucose regulation and metabolic control within the T2DM cohort, warranting further investigations into potential factors contributing to the observed variations. The dataset also encompasses measurements of glycated hemoglobin (HbA1c) levels, serving as an essential indicator of long-term glucose management. Lipid profile measurements also represent a cornerstone in assessing the cardiovascular risk associated with T2DM. The participants' cholesterol levels exhibited a considerable range, with values spanning from 98 to 363 mg/dL. Similarly, triglyceride levels showed an even wider distribution, ranging from 54 to 851 mg/dL.

Lipid Profile Measurements

Analyzing the data collected from individuals with T2DM, cholesterol levels varied across the study population. For example, a 49-year-old female with T2DM exhibited fasting and post-breakfast blood sugar levels (BSL) of 71 and 123, respectively, and had a cholesterol level of 191 mg/dL. In contrast, a 65-year-old male with T2DM had fasting and post-breakfast BSL of 209 and 329, respectively, and showed a higher cholesterol level of 242 mg/dL. Furthermore, a 58-year-old male with T2DM exhibited fasting and post-breakfast BSL of 386 and 576, respectively, with a cholesterol level of 181 mg/dL and triglyceride level of 284 mg/dL. These statistics highlight that there is no correlation between cholesterol level and age in the T2DM population. However, the lipid levels measured are significantly higher than normal, according to measurements from Langstead and colleagues, highlighting the importance of the prevalence of elevated lipid levels within the South Indian population [6].

Results

Lipid profile measurements provided valuable insights into participants' cardiovascular health. The total cholesterol levels varied widely, with values ranging from 83 mg/dL to 665 mg/dL. Elevated total cholesterol levels were observed in some cases, indicating dyslipidemia and increased cardiovascular risk. 61 individuals showed elevated cholesterol levels and 83 individuals had elevated triglyceride levels among the 100 participants in the study. These elevated levels indicate the prevalence of dyslipidemia among the T2DM patients in Coimbatore. However, it is important to note that elevated cholesterol and triglyceride levels are still well-known indicators of dyslipidemia. Triglyceride levels also exhibited significant variability, with values ranging from 64 mg/dL to 851 mg/dL. Elevated triglyceride levels were evident in several individuals, suggesting potential lipid abnormalities and metabolic implications. Additionally, HbA1c measurements were available for most participants and ranged from 5•2% to 17•5%. While the data showed some individuals had well-controlled HbA1c levels (around six to seven percent), others exhibited higher values, indicating suboptimal diabetes management. Furthermore, the study collected data on fasting blood glucose levels, which varied from 71 mg/dL to 408 mg/dL, and post-breakfast blood glucose levels, which ranged from 64 mg/dL to 830 mg/dL. These data indicate fluctuations in glycemic control among the individuals with T2DM, with some experiencing higher blood glucose levels post-breakfast, potentially reflecting impaired postprandial glucose regulation. The analysis also included other metabolic parameters, such as age, sex, and diabetes duration, which could potentially influence the observed variations in lipid and glycemic profiles.

Characteristic	Smallest Value	Largest Value
Age (Years)	28 Years	84 Years
Duration (Years)	2 Months	25 Years
Blood Sugar Level (BSL) Fasting (mg/dL)	63 mg/dL	619 mg/dL
BSL Post-Breakfast (mg/dL)	69 mg/dL	550 mg/dL
HbA1c (%)	5•2%	17•5%
Cholesterol (mg/dL)	83 mg/dL	665 mg/dL
Triglyceride (mg/dL)	64 mg/dL	851 mg/dL

Figure 3: This Chart Highlights the Diverse Range of Data within the Study Population

Overall, the results highlight the heterogeneity in the lipid and glycemic profiles of individuals with T2DM, indicating the need for personalized diabetes management strategies and regular monitoring of cardiovascular risk factors.

Discussion

Summary of Key Results

The study revealed a notable prevalence of dyslipidemia among the Type 2 diabetic patients in Coimbatore. Elevated levels of total cholesterol and triglycerides were observed in most cases, indicating the presence of dyslipidemia, a condition characterized by abnormal lipid levels in the bloodstream. Dyslipidemia is a critical risk factor for cardiovascular diseases and can lead to atherosclerosis and other vascular disorders. The analysis of HbA1c measurements provided insights into long-term glycemic control among the participants, highlighting the need for personalized diabetes management strategies. The observed fluctuations in fasting and post-breakfast blood glucose levels reflected potential impaired postprandial glucose regulation, reinforcing the importance of regular monitoring of cardiovascular risk factors in individuals with Type 2 diabetes. The study's comprehensive evaluation of lipid and glycemic profiles underscored the heterogeneity in dyslipidemia and diabetes management among the participants. Tailored interventions and lifestyle modifications are essential for effectively managing dyslipidemia and optimizing glycemic and lipid control in individuals with Type 2 diabetes.

Interpretation and Generalisability

The study revealed a notable prevalence of dyslipidemia among the Type 2 diabetic patients in Coimbatore. The lipid profile measurements provided valuable information on cholesterol and triglyceride levels in this population. Variations in cholesterol levels indicate that individual management strategies may be necessary to mitigate cardiovascular risks based on patient-specific lipid profiles. The effect of cholesterol and triglyceride levels on cardiovascular health in T2DM cannot be understated, as emphasized by Basa and colleagues [7]. The observed variations in triglyceride levels (Figure 3) indicated potential lipid abnormalities and metabolic implications.

Elevated triglyceride levels, indicative of hypertriglyceridemia common in dyslipidemia, suggest diverse lipid metabolic phenotypes in T2DM patients in this population. Understanding factors behind lipid profile heterogeneity has implications for tailoring individualized treatment strategies to manage dyslipidemia and cardiovascular risk in T2DM. Triglycerides, the most abundant fat form, play a key role as a major energy source. In T2DM, dysregulation of triglyceride metabolism, associated with insulin resistance, often coexists with low HDL-C levels and increased small, dense LDL particles, contributing to atherogenic dyslipidemia.

Persistent hyperglycemia in diabetes triggers oxidative stress and inflammation, leading to endothelial dysfunction, an early event in atherosclerosis development. Elevated cholesterol and triglyceride levels worsen this process, promoting infiltration of cholesterol-rich LDL particles into arterial walls and initiating fatty plaque formation. Over time, unstable plaques can rupture blood vessels, causing thrombosis and potentially life-threatening cardiovascular events. Hypertriglyceridemia is linked to an increased risk of acute pancreatitis, particularly risky in individuals with diabetes susceptible to various complications. High triglyceride levels also contribute to insulin resistance, furthering T2DM pathogenesis.

The interplay between cholesterol and triglyceride levels in T2DM is complex and multifactorial. Factors such as obesity, physical inactivity, diet, genetics, and glycemic control can influence lipid metabolism. In conclusion, the lipid profile measurements in patients with T2DM play a crucial role in predicting cardiovascular risk and assessing metabolic health. Cholesterol and triglyceride levels are vital indicators of lipid metabolism and can significantly impact the progression of atherosclerosis and cardiovascular disease in individuals with diabetes. The observed heterogeneity in lipid and glycemic profiles emphasizes the need for personalized diabetes management strategies. Tailored interventions and regular monitoring of cardiovascular risk factors for Indian patients are essential for effectively managing dyslipidemia and mitigating the risk of cardiovascular complications in individuals with Type 2 diabetes [8,9].

Research Limitations and Future Directions

Understanding the prevalence of dyslipidemia in T2DM and its association with cholesterol and triglyceride levels is crucial for developing targeted interventions and optimal disease management strategies. The results of this study highlight the need for comprehensive lipid profiling and regular cardiovascular risk monitoring in individuals with Type 2 diabetes. The study has several limitations that warrant consideration.

Future studies should emphasize comprehensive lipid profiling, encompassing all relevant lipid parameters, to enhance the accuracy of risk assessment and facilitate tailored treatment strategies for dyslipidemia management. Conducting the study at a single healthcare facility through convenience sampling may introduce selection bias and limit the generalizability of the findings. Future research should consider employing more rigorous sampling methods, such as random sampling, to enhance external validity and ensure broader representation of the target population. Future research endeavors could also focus on longitudinal studies and interventional trials to monitor dynamic changes in lipid and glycemic profiles over time and evaluate the effectiveness of personalized treatment approaches in improving diabetes outcomes and cardiovascular health.

Conclusion

This study sheds light on the significant prevalence of dyslipidemia in Type 2 diabetic patients from Coimbatore, South India, and its association with elevated cholesterol and triglyceride levels. The findings highlight the importance of addressing dyslipidemia as a critical risk factor in diabetes management, necessitating personalized interventions and regular cardiovascular risk monitoring. Optimal glycemic control also emerges as a crucial aspect of diabetes care, essential for reducing long-term complications. While the study reveals valuable insights, future research should focus on comprehensive lipid profiling, longitudinal studies, and multicenter collaborations to enhance our understanding of dyslipidemia's impact on cardiovascular health and refine tailored management strategies for individuals with Type 2 diabetes [10-23].

Statements and Declarations

Competing Interests: Dr. Gurumoorthi Ponnuswamy is employed/affiliated with Shanthi Social Services Hospital, where the research described in this manuscript was conducted. The employment/affiliation does not pose a competing interest, as the research was conducted independently, the patients were chosen without bias at a single point in time, and the findings are reported objectively without bias.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process: During the preparation of this work the author(s) used Chat GPT in order to reduce the word limit in two sections. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Ethics Committee Approval

In the region in which this study took place, ethics approval is not required for data collected from cross sectional studies. Therefore, there is no decision/protocol number or approval date of ethics committee approval. The data was collected with informed consent from the patients.

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