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Mind and Metabolism: The Confluence of Psychiatric and Metabolic Disorders in South India

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Abstract

Metabolic disorders such as Type 2 Diabetes Mellitus (T2DM), hypertension (HT), and thyroid dysfunction (TD) are key universal public health issues, posing to increased cardiovascular threat and further harsh health difficulties. T2DM, characterized by insulin resistance or deficiency, affects over 460 million people globally and is linked to cardiovascular diseases, neuropathy, retinopathy, and kidney disease. HT, affecting over 1 billion people, habitually presents no symptoms until noteworthy scratch occurs, making it a "silent killer." TD, including hypothyroidism and hyperthyroidism, interrupts metabolic balance and influences energy levels and weight. In India, particularly South India, the occurrence of these disorders is mounting due to urbanization, lifestyle changes, and hereditary factors. This study investigates the physiological and biochemical changes in individuals with psychiatric disorders such as stress, depression, and anxiety, and their relationship with T2DM, HT, and TD, aiming to augment the management and treatment of these interrelated conditions through a cross-sectional study of patients from a tertiary healthcare center in Madurai, Tamil Nadu.

Keywords: Metabolic Disorders, Psychiatric Disorders, India Prevalence

Introduction

Metabolic disorders, including Type 2 Diabetes Mellitus (T2DM), Hypertension (HT), and Thyroid dysfunction (TD) are significant public health concerns worldwide (Biondi *et al.,* 2019). These conditions are characterized by disruptions in normal metabolic processes, leading to various complications and an increased risk of cardiovascular diseases, stroke, and other serious health issues (Asghar *et al.,* 2023). Type 2 Diabetes Mellitus (T2DM) is a chronic condition characterized by insulin resistance or insufficient insulin production, leading to elevated blood glucose levels. It affects over 460 million people globally, with numbers projected to rise significantly in the coming decades. T2DM is linked to serious complications such as cardiovascular diseases, neuropathy, retinopathy, and kidney disease (Dhatariya *et al.,* 2020). Hypertension, or high blood pressure, is a condition where blood consistently exerts excessive force against artery walls, increasing the risk of heart disease, stroke, and other health issues. Affecting over 1 billion people worldwide, it is often called a "silent killer" because it usually has no symptoms until significant damage occurs. Thyroid dysfunction includes conditions like hypothyroidism (underactive thyroid) and hyperthyroidism (overactive thyroid), resulting in metabolic imbalances that can impact energy levels, weight, and overall metabolic rate (Shahid *et al.,* 2023).

India is experiencing a rapid rise in the prevalence of metabolic disorders, driven by urbanization, lifestyle changes, and genetic predispositions. The situation is particularly concerning in South India, where the burden of these conditions is high. India is often referred to as the "diabetes capital of the world," with an estimated 77 million people living with diabetes (Wells *et al.,* 2016). South India has high prevalence rates due to genetic factors, a high-carb, high-fat diet, and low physical activity (Sami *et al.,* 2017). Hypertension affects an estimated 200 million people in India, with South India experiencing high rates due to high salt intake, stress, and lifestyle factors. Limited awareness and control measures worsen the issue (Anchala *et al.,* 2014). Thyroid disorders affect around 42 million people in India, with South India showing high rates of hypothyroidism linked to iodine deficiency. The condition often remains undiagnosed due to its nonspecific symptoms (Unnikrishnan *et al.,* 2011).

Metabolic disorders like T2DM, hypertension, and thyroid dysfunction are major public health concerns globally and in South India. Addressing these issues requires comprehensive strategies, including lifestyle changes, better healthcare access, and public

awareness campaigns to reduce their impact and enhance affected individuals' quality of life (Saklayen *et al.*, 2018).

Psychiatric disorders like stress, depression, and anxiety are widespread and present significant public health challenges. They affect mental well-being and are linked to various physiological and biochemical changes in the body. Understanding these changes is essential for creating comprehensive treatment approaches that address both mental and physical health (National Collaborating Centre for Mental Health, 2011).

Stress, depression, and anxiety often co-occur with physiological conditions like Type 2 Diabetes Mellitus (T2DM), hypertension (HT), and thyroid dysfunction (TD). These conditions have a bidirectional relationship with psychiatric disorders: the presence of one can worsen the other. For example, chronic stress may elevate blood pressure and glucose levels, while depression and anxiety can disrupt insulin and thyroid hormone regulation (Alzoubi *et al.*, 2018).

This study aims to investigate the physiological and biochemical changes in individuals with psychiatric disorders like stress, depression, and anxiety, focusing on their interplay with T2DM, HT, and TD. By examining these relationships, the study seeks to provide insights that could enhance the management and treatment of these interconnected conditions.

Objectives of the study

The main objectives of the study are:

1) To collect the socio-demographic details from the study participants.
2) To gather the physiological parameters of the participants.
3) To evaluate the symptoms of stress, depression, and anxiety among the participants.
4) To compare the impact of stress, depression, and anxiety between the patient group and the normal population.

Materials and Methods

Methodology

Research Design

This is a cross-sectional study to assess the relationships between physiological diseases such as Type 2 Diabetes Mellitus (T2DM), Hypertension (HT), Thyroid dysfunction

(TD) and psychiatric disorders like Depression (D), Anxiety (A) and Stress (S). The data was collected from tertiary health care centre patients diagnosed with these conditions. The sampling was carried out during the period from 2020-2022.

Sampling

Universe sample: Those participants who were suffering from T2DM, HT and TD and were receiving treatment from a hospital, which is based in the heart of Madurai city, Tamil Nadu, India were considered as Universe samples.

The study's sampling was conducted at Alpha Hospital and Research Centre, Institute of Diabetes & Endocrinology, the only tertiary healthcare centre in Madurai without COVID-19 wards, chosen for its accessibility to patients from surrounding districts. A pilot study with 40 T2DM patients, revealing a 27.5% prevalence of DAS symptoms, informed the sample size calculation for the main study using the Central Limit Theorem. The formula $n = z^2p(1-p) / d^2$ determined a minimum sample size of 307 for each of the three conditions: T2DM, HT, and TD, leading to a total of 921 participants.

The study recruited 307 patients each with T2DM, HT, and TD, who were either follow-up or new cases at the centre. Participants first consulted a physician and underwent routine physiological and biochemical tests. Researchers approached patients during their wait for test results, obtained consent, and ensured no dropouts. Participants were informed their biochemical test reports would be ready post-interview. Researchers recorded relevant medical information, patient history, and biochemical test reports.

Originally planned as a cross-sectional study, patient data were provided separately for each disease, leading to a purposive sampling technique. This approach involved interviewing all 921 patients with a single disease at a time to maintain consistency and adhere to the protocol. The sequence of interviews began with 307 T2DM patients, followed by 307 HT patients, and finally 307 TD patients, with each patient interviewed once and no follow-ups conducted. During the study, some T2DM patients developed HT, categorized as a diabetic complication, while chronic HT patients developed diabetes as a hypertensive complication. Similarly, prolonged TD patients exhibited T2DM and HT, also considered complications.

Table: 1 Sample Selection criteria

Inclusion Criteria	Exclusion Criteria
All gender	Clinical evidence of any current psychiatric disorder besides depression, anxiety, and stress.
Aged from 18 to above 60 years old	Impaired consciousness
Who have given their consent to take part in the study	History of Substance Use Disorders (SUD) or is currently abusing or dependent on psychoactive substances.

Data Collection

Clinical Assessment Tools

The study utilized a validated semi-structured interview questionnaire to collect sociodemographic and clinical data from participants with Type 2 diabetes, hypertension, and thyroid dysfunction. It covered socioeconomic details, clinical history, diabetes metrics, comorbid conditions, and lifestyle factors including smoking, alcohol use, and sleep issues**.**

Mental Health Status Assessment

The assessment of Depression, Anxiety, and Stress was conducted using three scales: the Hamilton Depression Rating Scale (HAM-D), the Hamilton Anxiety Rating Scale (HAM-A), and the Perceived Stress Scale (PSS). HAM-D was used to measure the presence and severity of depression over the last week. This scale is considered the gold standard for measuring depression (Carrozzino *et al*., 2020) and has been widely used in India (Kuruvilla *et al*., 2009). HAM-D is an observer-rated scale used to measure depressive symptoms.

It is important to note that the HAM-D scale, which is used to measure depression, originally has 21 items. However, we used a shortened version that only had 17 items (Pulido-Criollo *et al*., 2009). Out of these 17 items, 9 were rated on a scale of 0-4 to assess the severity of the symptoms, while the remaining 8 items were rated on a scale of 0-2, as they were difficult to assess accurately. The highest possible score on the HAM-D scale is 52, with higher scores indicating more severe depression. On the 17-item scale, the maximum score is 54. A score between 0 and 7 indicates normalcy, 8-13 indicates mild depression, 14-18 indicates moderate depression, and a score of 19 or higher indicates severe depression (Hamilton, 1967). A study found that Cronbach's alpha for the HAM-D 17 items was 0.92, indicating a high internal consistency level (Dedeken *et al*., 2020).

HAM-A is a tool that measures anxiety symptoms through 14 different items. It consists of two subscales: psychic and somatic. The psychic subscale (items 1-6 and 14) evaluates subjective cognitive and affective symptoms like anxious mood, tension, fears, and difficulty concentrating. This subscale is particularly useful in assessing the severity of general anxiety disorder. The somatic subscale (items 7-13) emphasizes features of general anxiety disorder, such as autonomic arousal, respiratory, gastrointestinal, and cardiovascular symptoms (Tovilla-Zárate *et al*., 2012). Scores range from 0 to 56, with a score of less than 17 indicating mild severity, 18-24 indicating mild to moderate severity, and 25-30 indicating moderate to severe conditions. The scale has a high internal consistency of Cronbach's alpha 0.893 (HAMILTON, 1959).

Perceived stress levels (PSS) were assessed using the Perceived Stress Scale (Cohen *et al*., 1983). The PSS-10 measures perceived stress by assessing feelings of unpredictability, uncontrollability, and overload over the past month. Using a five-point Likert scale (0-4), it gauges the frequency of stress-related thoughts and feelings. Higher scores reflect greater perceived stress, with the scale showing good internal consistency. (Cronbach's alpha 0.85) (Rajaa *et al*., 2022).

The study opted to use these three standard questionnaires–HAM-D (17 items), HARS (14 items), and PSS (10 items) because of three main reasons. 1. These questionnaires were easy for patients to comprehend due to their simple format. 2. Patients were able to complete all three questionnaires during face-to-face interviews in just 7-10 minutes. 3. The main advantage of these questionnaires is that they are easily accessible to the public.

Biochemical and Physiological Measurements

For diabetes testing

1. 5 ml of blood was collected under strict aseptic conditions. Fasting blood sugar (FBS) and postprandial plasma glucose (PPG) levels were measured using the glucose oxidase-peroxidase endpoint method.
2. Glycemic control was assessed by measuring HbA1c via high-performance liquid chromatography with the Medica EasyRa. According to the Indian Council of Medical Research (2018), HbA1c levels above 8% are considered unsatisfactory and indicate the need for improved diabetes management.

For hypertension

1. Diastolic blood pressure (DBP) and systolic blood pressure (SBP) readings were taken using a calibrated aneroid sphygmomanometer (Diamond BP Monitor IS3390, 2022) on the patient's right arm while seated for at least 5 minutes at a constant room temperature. DBP ranged from 70 to 90 mmHg, and SBP ranged from 100 to 170 mmHg. Hypertension was diagnosed as either: a BP of ≥140 mmHg (systolic) or ≥90 mmHg (diastolic) on at least two separate occasions; current use of antihypertensive medications; or a BP of ≥160 mmHg (systolic) or ≥100 mmHg (diastolic) on a single day with two readings.

For Thyroid dysfunction

1. Thyroid-stimulating hormone (TSH) assay: This was done in all blood samples as a screening test for thyroid disease. TSH assay was performed using electrochemiluminescence immunoassay on the Elecys 2010 Analyzer (Roche Diagnostics). It is a sandwich assay and the method has been standardized against the 2nd IRP WHO Reference Standard 80/558 (Velayutham *et al*, 2015).

2. Thyroxine (T4) and Triiodothyronine (T3) test: A free T4 test directly measures the amount of free T4 in your blood. Medical experts believe this test provides more accurate information than a total T4 test, so it's used more often. Serum-based immunoassays and LC-MS/MS techniques are used for measuring total and free thyroid hormones, [Thyroxin (T4) and Triiodothyronine (T3)] (Spencer *et al*., 2017).

Anthropometric measurements

Body composition or Body mass index (BMI) was assessed by Bioelectrical impedance analysis (body composition analyzer Pentagon ISO 9001,2008) which is commonly used method for assessing body composition in clinical practice and medical research (Lebiedowska *et al.*, 2021). According to the ICMR Guidelines for Management of Type 2 Diabetes (ICMR, 2018), the aim for metabolic control was defined as having a BMI of more than 25 kg/m2.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics version 23.0. Descriptive statistics were calculated for continuous and categorical variables. Normality was

assessed using the Shapiro-Wilk test; non-parametric tests (Chi-square, Mann-Whitney U, Kruskal-Wallis H, Spearman correlation) were used due to non-normal distribution. Binary logistic regression analyzed factors affecting depression, anxiety, and stress risk, with significance set at 5%. Results were presented as odds ratios (OR) and 95% confidence intervals (CI). Venn diagrams and stacked histograms for the analysis were created using Microsoft Excel 2013.

Significance

This study is significant for bridging between the "Mind and Metabolism" i.e. the mental health and physiological conditions. By exploring the interactions between psychiatric disorders like depression, anxiety and stress and metabolic diseases like Type 2 Diabetes Mellitus, hypertension and thyroid dysfunction, it can enhance treatment strategies and impact the overall health landscape in South India. Key implications include supporting integrated care approaches, improving early detection and management, contributing to personalized medicine, and guiding public health policies for comprehensive screening and management.

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