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Association Of Pulmonary Function With Functional Capacity And Quality Of Life In Patients With Type 2diabetes Mellitus (T2DM)

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ABSTRACT

The complicated metabolic disease known as type 2 diabetes mellitus (T2DM) has systemic repercussions that go beyond the usual difficulties of the kidneys, heart, and eyes. New research shows that type 2 diabetes negatively affects cognitive function, functional exercise capacity, pulmonary function, and general quality of life. The results of case-control studies, intervention trials, population-based analyses, and systematic reviews that looked at T2DM patients' pulmonary parameters (FVC, FEV1, PEFR), performance on the Six-Minute Walk Test (6MWT), hand grip strength, cognitive tests, sleep quality, and quality of life indices are summarized in this narrative review. Studies have shown that T2DM is linked to decreased exercise tolerance and lung function, which is exacerbated by hyperglycemia, insulin resistance, obesity, inflammation, and the length of the disease. Sleep issues and cognitive impairments make functional decline even worse. While tele-assessment provides a dependable means of remote monitoring, evidence also shows that multicomponent exercise regimens and lifestyle treatments enhance lung function, functional capacity, and quality of life. In order to maximize functional independence and health outcomes for individuals with type 2 diabetes, these findings highlight the significance of early evaluation, integrated care, and customized therapies.

KEYWORDS:- Type 2 Diabetes Mellitus, Pulmonary Function, Functional Capacity, Six-Minute Walk Test, Quality of Life.

INTRODUCTION

The International Diabetes Federation estimated that 425 million people worldwide had diabetes in 2017, with 73 million of those people living in India. The condition is a metabolic disorder that is becoming more and more common and has ramifications on multiple body systems, primarily correlated with effects on micro and macro-vascular circulation. The complications have been linked to increased morbidity and mortality because of their effects on various organs. Most previous studies have focused on renal, ocular, and cardiac effects, but the focus has now shifted to the involvement of other systems. Further research is necessary to determine the impact of this multi-systemic disease on pulmonary functions as well, as the global burden of diabetes is predicted to increase over the next several years. The abundant blood supply in the lungs and airways accounts for about 10% of the total body's circulatory system. It is also known that persistent hyperglycemia promotes non- enzymatic glycosylation of proteins such as collagen, elastin, etc., which leads to the thickening of the basement membrane and microangiopathy. Given that diabetes mellitus has been shown to negatively impact the microvasculature, it is likely that the disease will also have an impact on pulmonary functioning.[1]

Since DM has a complex etiology and a wide range of symptoms, any classification of the condition is arbitrary yet nevertheless helpful and frequently impacted by the physiological circumstances that existed at the time of the diagnosis and evaluation. The current classification is helpful in determining the necessary therapy and in clinically assessing the condition since it takes into account both the pathophysiology and the etiology of the illness. Type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), gestational diabetes mellitus (GDM), and diabetes induced or related to particular specific illnesses, pathologies, and/or syndromes are the four primary forms or categories of diabetes that fall under this classification. According to earlier terminology, T2DM, often referred to as adult-onset diabetes or non-insulin-dependent diabetes mellitus (NIDDM), accounts for roughly 90– 95% of all diabetic cases. Insulin resistance and β-cell dysfunction are the two primary insulin-related abnormalities that define this kind of diabetes. Disruption of different cellular pathways causes insulin resistance, which lowers the sensitivity or reactivity of cells in peripheral tissues, especially the muscle, liver, and adipose tissue, to insulin. Reduced insulin sensitivity in the early stages of the disease causes β-cells to hyperfunction in order to maintain normoglycemia by increasing insulin production as a compensatory mechanism. Thus, hyperglycemia is prevented by hyperinsulinemia, or elevated amounts of circulating insulin. However, over time, the β-cells' increased production of insulin cannot adequately offset the decline.[2]

Pulmonary function is increasingly being recognized as an area of concern in patients with T2DM. Studies suggest that diabetes-induced systemic inflammation, oxidative stress, and glycation of

pulmonary collagen contribute to pulmonary function decline, leading to restrictive lung patterns and reduced ventilatory efficiency.1 Furthermore, impaired pulmonary function has been associated with decreased functional capacity, limiting physical activity and overall quality of life in patients with T2DM.[3]

Functional capacity, often measured by tests such as the Six-Minute Walk Test (6MWT), reflects an individual's ability to perform daily activities and is crucial for maintaining independence and overall health. Several studies have reported a significant association between reduced pulmonary function and diminished functional capacity in patients with T2DM.[4]

This decline in functional capacity has been linked to increased cardiovascular risk, poor glycemic control, and reduced exercise tolerance, further exacerbating diabetes-related complications.[5]

Despite growing evidence of the interplay between pulmonary function and functional capacity in T2DM, limited research has comprehensively examined their combined impact on quality of life. Understanding these relationships is essential for developing targeted interventions to improve respiratory health, enhance functional capacity, and optimize clinical outcomes for patients with T2DM. Therefore, this study aims to explore the association between pulmonary function and functional capacity in patients with T2DM, providing insights that may contribute to improved management strategies and patient care.

METHODS

Author and year	Design and Characterstics of participants (sample size)	Objective	Material and Method	Outcome measures	Result
Awotidebe et al.[6], 2014	Total participants: 70 With T2DM, Case–control study	To compare the functional exercise capacity of patients with Type 2 Diabetes Mellitus (T2DM) and healthy controls	Cardiovascular indices, anthropometry, demographics, fasting blood glucose (glucometer), hand grip strength (dynamometer), and Six-Minute Walk Test.	FBG, HGS, 6MWT distance	T2DM patients had reduced functional capacity; negatively correlated with ↑BMI & ↑FBG
Chasens et al.[7], 2014	116 adults with Type 2 Diabetes, Secondary analysis of baseline data from a clinical trial.	To examine the association between sleep quality, health-	Pittsburgh Sleep Quality Index (PSQI), Short-Form Health Survey (SF-36), and Functional	Sleep quality (PSQI) HRQoL (SF-36)	Poor sleep quality was significantly associated with reduced physical,

		related quality of life (HRQoL), and functional outcomes in adults with T2DM	Outcomes of Sleep Questionnaire (FOSQ) were used to assess sleep quality, HRQoL, and functional outcomes in 116 adults with T2DM.	Functional outcomes (FOSQ)	mental, and functional health, highlighting the role of sleep management in diabetes care.
Barril et al.[8], 2016	8 older adults (≥60 years) with Type 2 Diabetes , Intervention study (pre–post design)	To evaluate the effects of multicomponent exercise training on pulmonary function, functional capacity, and quality of life in older adults with T2DM.	Intervention: 12-week multicomponent training program (3 sessions/week, 80 minutes each) Assessments: Pre- and post-training evaluations of pulmonary function, functional capacity, and quality of life	Pulmonary function, Functional capacity, Quality of life.	Significant improvements in pulmonary function, functional capacity, and quality of life were observed after training.
Rani et al.[9], 2018	40 total , Case–control study	To evaluate pulmonary function parameters in patients with Type 2 Diabetes Mellitus and their correlation with duration of diabetes.	Spirometry performed to assess lung function Statistical tests: Student's t-test and Pearson's correlation coefficient	Forced Vital Capacity (FVC) Forced Expiratory Volume in 1 second (FEV1) FEV1/FVC ratio Peak Expiratory Flow Rate (PEFR)	T2DM patients had reduced pulmonary function parameters (FVC, FEV1, PEFR) compared to controls
Kuziemski et al.[10], 2019	131 total 64 patients with Type 1 or Type 2 Diabetes Mellitus 67 healthy controls All non-smokers without pulmonary disorders, Comparative study (case–control	To compare functional exercise capacity and pulmonary function between patients with diabetes and healthy controls.	Full pulmonary function tests Six-Minute Walk Test (6MWT) Assessment of metabolic and inflammatory biomarkers	Pulmonary function parameters 6MWT distance Metabolic and inflammatory biomarkers	Patients with diabetes had reduced pulmonary function and exercise capacity compared to healthy controls.

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Albernaz et al.[11], 2021	218elderly patients from geriatric and endocrinology outpatient clinics, Case–control study	To evaluate cognitive capacity and functional development in elderly patients with Type 2 Diabetes Mellitus (T2DM).	Cognitive and functional assessments using validated tools Interviews conducted at outpatient clinics	Cognitive performance (memory, executive function) Functional ability in daily living activities	Cognitive impairment was strongly associated with HbA1c levels and educational background
Zhang et al.[12], 2022	8,584 patients, Population-based observational study	To investigate the non-linear association between diabetes mellitus and pulmonary function and the role of glycemic control, obesity, inflammation, and insulin resistance.	Pulmonary function tests (FVC, FEV1) Measurement of HbA1c, CRP, insulin resistance, and anthropometric data Statistical analyses to explore non-linear correlations	Pulmonary function: Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1) HbA1c and metabolic/ inflammatory markers	Diabetes was associated with reduced FVC and FEV1
Laverty et al.[13], 2023	Data from 23 studies on patients with Type 2 Diabetes (sample sizes varied across included studies), Systematic review	To examine the relationship between sleep and quality of life (QoL) in patients with Type 2 Diabetes and assess the prevalence of sleep disturbances.	Systematic search of four databases Narrative synthesis of 23 relevant studies	Sleep disturbances and sleep quality Quality of Life (QoL) indicators	17.8%–79% of T2D patients experienced sleep disturbances Sleep quality was directly related to QoL,with indirect effects via psychological distress and biological symptoms.

DISCUSSION

The effects of type 2 diabetes mellitus (T2DM) on mental, physical, lung, and social health are complex. The functional exercise capacity of T2DM patients is consistently lower than that of healthy controls across a number of investigations. Reduced performance on the Six-Minute Walk Test (6MWT) and hand grip strength (HGS) were linked to increased body mass index and raised fasting blood glucose, according to Awotidebe et al. (2014). In a larger sample, Kuziemski et al. (2019) confirmed similar results, demonstrating the 6MWT's validity as a gauge of pulmonary function and functional capacity in diabetic patients.

T2DM significantly impairs pulmonary function. Rani et al. (2018) found a negative relationship between lung function and the length of the disease, as well as decreases in FVC, FEV1, and PEFR. Zhang et al. (2022) also emphasized a non-linear relationship between pulmonary measures and glycemic control (hba1c), which is impacted by insulin resistance, low-grade inflammation, and obesity. These studies highlight the roles that inflammation and metabolism play in diabetic respiratory impairment.

Functional and cognitive results are also impacted. According to Albernaz et al. (2021), cognitive decline is closely associated with increased hba1c, and senior T2DM patients have memory difficulties and reduced daily activities. According to Chasens et al. (2014) and Laverty et al. (2023), who found both direct and indirect links between poor sleep quality, decreased quality of life, and psychological distress, sleep disturbances further worsen functional decline. These results highlight how crucial sleep evaluation is to all-encompassing diabetic care.

According to intervention research, these deficiencies may be lessened by organized programs. Barril et al. (2016) found that older persons with type 2 diabetes who participated in a 12-week multicomponent exercise program experienced improvements in their pulmonary function, functional capacity, and quality of life. Furthermore, Pepera et al. (2023) showed that the 6MWT is a valid and trustworthy technique for tele-assessment of functional capacity, offering useful tools for remote monitoring.

When taken as a whole, these studies show that metabolic, inflammatory, and lifestyle variables impact the detrimental effects of type 2 diabetes on several aspects of health. Functional, pulmonary, cognitive, and sleep evaluations are essential for identifying deficiencies early. Exercise, glycemic control, and sleep management are examples of structured therapies that help maintain autonomy and improve quality of life.

There are still restrictions in spite of these realizations. Causal inference is limited by the majority of studies' cross-sectional or short-term design. To fully address functional and psychosocial decline in T2DM patients, future research should use longitudinal designs, incorporate multidomain assessments, and investigate tailored therapies.

CONCLUSION

Recent research shows that Type 2 Diabetes Mellitus (T2DM) has significant and multifaceted health effects, including decreased functional exercise capacity, pulmonary function, and cognitive function, as well as poor sleep and general quality of life. The systemic burden of diabetes is highlighted by the tight relationships between these functional and physiological deficiencies and poor glycemic control, obesity, inflammation, and the length of diabetes. Crucially, tele-assessment techniques offer dependable, useful choices for remote monitoring of functional capacity, and structured interventions—such as multicomponent exercise regimens and lifestyle management—have shown quantifiable improvements in physical, cognitive, and psychosocial outcomes. In order to maintain autonomy, maximize functional independence, and improve quality of life for patients with type 2 diabetes, the combined results highlight the importance of early detection, thorough evaluation, and customized management approaches. To elucidate causal links and improve evidence-based strategies for reducing the extensive effects of diabetes on human health, more longitudinal and interventional research is required.

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