REVIEW
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A mini review of effects of yoga intervention on type 2 diabetes mellitus: prevention, management, and implementation

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Competing interests
The authors declare no conflicts of interest.

Abbreviations
NIH, national institute of health; CAM, complementary and alternative medicine; DM, diabetes mellitus; HbA1c, glycated hemoglobin; FBG, fasting blood glucose; PPBG, post-prandial blood glucose; TC, total cholesterol; HDL, high-density lipoprotein; LDL, low-density lipoprotein; VLDL, very Low-density lipoprotein; IL-6, interleukin-6; TNF-alpha, tumor necrosis factor-alpha; TBARS, thiobarbituric acid reactive substances; MDA, malondialdehyde; DBP, diastolic blood pressure; BMI, basal metabolic index; WC, waist circumference; RCT, randomized controlled trial.

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Abstract
Across the world, there has been a rise in patients with diabetes, and the majority of them have type 2 diabetes. Management of patients with type 2 diabetes mellitus and its severe complications are causing a massive burden on resource-poor countries. There is a need to find a solution, and yoga seems to be a cost-effective method to deal with this problem. In this review, we aim to find out various evidence related to the effect of yoga on patients with type 2 DM, its role in prevention and implementation.

Keywords: type 2 diabetes; yoga; prevention; management; implementation

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Background

Diabetes cases soared globally from 108 million in 1980 to 422 million in 2014, with the incidence increasing faster in low-and middle-income economies [1]. Diabetes accounted for an estimated 1.5 million death toll in 2019, and diabetes-associated premature mortality climbed by 5% between 2000 and 2016 [1]. Diabetes is a metabolic condition that occurs either when the pancreas fails to make enough insulin or fails to use the insulin that is generated efficiently. The vast majority of diabetics have type 2 diabetes [2] which is caused by the body's improper insulin use. Yoga is a 5,000-year-old discipline whose traditional goal is to free oneself from suffering in this life [2]. The National Institute of Health (NIH) recognizes yoga under Complementary and Alternative Medicine (CAM) [3]. Due to the surge in patients with diabetes, there is a need to prevent and effectively manage the situation using an interdisciplinary approach. The approach should be to include the evidence-based traditional methods with the mainstream management modalities. Many countries worldwide, primarily resource-poor countries, are trying to utilize yoga as a cost-effective method for improving the quality of life. There are various methods of yoga for different diseases. The scope of yoga extends from prevention to management of patients with diabetes. Multiple studies have been conducted worldwide to analyze and understand the effects of yoga in the management of diabetics. The goal of this review is to better identify the influence of yoga intervention on individuals with diabetes mellitus type 2 (type 2 DM).

Effects of yoga on biochemical, inflammatory, and oxidative stress indicators associated with type 2 DM

Diabetes mellitus type 2 is characterized by defective insulin secretion, insulin resistance, enhanced hepatic glucose production, aberrant lipid metabolism, and minimal systemic inflammation. Furthermore, the majority of individuals with type 2 diabetes are overweight. To understand the interplay between yoga and type 2 DM, we need to understand the evidence available so far. The various parameters which are involved are shown in Table 1. The majority of evidence published thus far points to the favorable effects of yoga on individuals with type 2 diabetes [4-18, 19]. These effects can be on fasting blood glucose (FBG) and post-prandial blood glucose (PPBG), glycated hemoglobin (HbA1c), total cholesterol (TC), triglycerides, and on various lipoproteins such as low-density lipoprotein (LDL), high-density lipoprotein (HDL) and very-low-density lipoproteins (VLDL). Thiobarbituric acid reactive substances (TBARS), a byproduct of lipid peroxidation and other oxidative markers such as interleukin-6 (IL-6), tumor necrosis factor (TNF-alpha), and malondialdehyde (MDA) can be influenced by yoga. Also, yoga can have an effect on the basal metabolic index (BMI). Not only this, but yoga can also have psychological effects related to stress, anxiety, and depression. The majority of the studies support that yoga can significantly help in reduction in FBG, PPBG, HbA1c, TC, Triglyceride, LDL, TBARS, IL-6, TNF-alpha, MDA [4-17]. The yoga intervention can also help reduce psychological stress, anxiety traits, and depression [8, 9, 18]. These pieces of evidence thus pave the way for the use of yoga in conjunction with allopathic treatment to develop a comprehensive approach to management.

Effects of yoga on disease prevention

The effects of yoga are not only limited to the management of type 2 DM patients. There are pieces of evidence that point towards a more prominent role of yoga in disease prevention. Prediabetics and Diabetics with severe perceived stress have substantially higher HbA1c and FBG levels [20]. In pre-diabetic patients, short-term yoga intervention reduced blood glucose, HbA1c, lipid profile such as cholesterol, triglyceride, and LDL levels but greater than before HDL and VLDL were reported [21]. After practicing a diabetic yoga program (DYP), HbA1c and glucose levels were considerably decreased in pre-diabetic women, but cholesterol levels rose in menopausal women [22]. There are promising pieces of evidence that yoga can help reduce stress shown in Table 1. This further supports the use of yoga in the prevention of type 2 DM.

Table 1 Evidence regarding effects of yoga on type 2 DM patients

Study	Type of study	Significant findings
Viswanathan et al. 2021 [4]	RCT	Basal Metabolic Index, blood glucose, HbA1c, lipids, IL6, TNF-alpha, and TBARS decreased significantly.
Dutta et al. 2021 [5]	Meta-analysis	FBG, PPBG, TC, triglycerides, and LDL-C were considerably reduced, whereas HDL-C levels were significantly increased.
Nair et al. 2021 [6]	RCT	Significant reduction in DNA damage indicators like Tail Moment, Olive Tail Moment, oxidative DNA damage marker 8-OHdG, Fasting Blood Sugar; OGG1 protein expression indicating DNA repair improved significantly.
Venugopal et al. 2021 [7]	Systematic review and meta-analysis	Significant reduction in MDA, fasting plasma glucose, and HbA1C.
Singh et al. 2020 [8]	RCT	Significant reduction in HbA1c, anxiety trait, and depression.
Sarika et al. 2020 [9]	RCT	Significant reduction in HbA1c and psychological stress.
Gupta et al. 2020 [10]	RCT	Significant HbA1c decrease, and greater decrease in HbA1c level in people who attended 75% sessions.
Bock et al. 2019 [11]	RCT	Significant reduction in HbA1c.
Shiju et al. 2019 [18]	Clinical trial	The quality of life enhanced significantly along with improvement in depression, anxiety, and insomnia.

Yu et al. 2018 [12]	Clinical trial	Significant reduction in Waist Circumference (WC).
Jayawardena et al. 2018 [13]	Systematic review and meta-analysis	FBG, PPBG, HbA1c, and BMI all decreased significantly.
Mondal et al. 2018 [14]	Clinical trial	FBG, PPBG, TC, triglycerides, LDL, and VLDL all decreased significantly, while HDL increased significantly.
Sreedevi et al. 2017 [22]	RCT	Diastolic blood pressure (DBP) and circumference of hip both decreased significantly.
Angadi et al. 2017 [15]	Longitudinal study	Significantly lower HbA1c (end of 3rd month).
Venugopal et al. 2017 [16]	Clinical trial	Significant decrease in FBG.
Cui et al. 2017 [17]	Meta-analysis	DBP and hip circumference both decreased significantly.

Need for evidence-based systematically structured yoga program

There are various yoga programs throughout the world, each having its own benefits and limitations. There is a need to develop a standardized yoga program for the prevention and management of diabetes. Developing and implementing yoga programs has its own challenges. In this world of evidence-based medicine, the proposed programs should be evaluated based on evidence, and then only should they be recommended. The systematically developed 24-week comprehensive Yoga-DP program and three-step yoga program are small progress in this domain [23-25]. A randomized controlled trial (RCT) revealed the various factors salient to successful implementation in resource-poor nations. The focus should be on identifying the hurdles at the provider, consumer, and community levels for effective yoga program implementation and continuity of care [26].

Conclusion

There has been a rise in patients with type 2 DM and increased mortality due to complications. This burdens the healthcare system, especially for low and middle-income countries. Evidence shows the significant reduction in FBG, PPBG, HbA1c, TC, Triglyceride, LDL, TBARS, IL-6, TNF-alpha, MDA, and decreased psychological stress, anxiety traits, and depression. With its various beneficial effects, yoga seems to be a cost-effective option for both prevention and management along with the allopathic modality. Despite promising evidence, there is a need to develop a robust multinational support system to conduct more extensive studies and create systematic, standardized yoga programs.

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