

Chapter 3
Scientific Literature Review
ROLE OF YOGA IN T2DM

3. Introduction

Type 2 Diabetes Mellitus (T2DM) is a metabolic disorder characterized by chronic hyperglycemia. It is one among the most prevalent metabolic disorders and a leading cause of death and disability all over the globe (Aggarwal & Jain, 2018). T2DM is the number one leading cause of chronic kidney disease, heart disease and blindness (Canivell and Gomis, 2014). It increases the risk of myocardial infarction and stroke by 4 folds (Diabetes Fact Sheet, 2002). T2DM is considered to be an important cause of cardiovascular disease, chronic kidney disease, stroke and blindness (Canivell & Gomis, 2014).

The global prevalence of T2DM varies from 5% to 20%. Sedentary lifestyle, psychological stress, obesity, depression, unhealthy and addictions such as smoking and alcohol are considered to be the most common risk factors for T2DM (Turner et al., 1998a; Eriksson & Lindgärde, 1991).

Progressive beta cell dysfunction is the hallmark of T2DM. By the time T2DM is diagnosed almost 50% of beta cell mass is lost this progresses further with the course of the disease (Bhansali *et al.*, 2009). Conventional management of T2DM targets on insulin resistance and insulin production, leaving the basic defects as it is (Anjana *et al.*, 2011). The large number of patients with T2DM on anti-diabetic medication eventually shifts to insulin therapy. However, despite of the rigorous insulin therapy 24hrs glucose control keep fluctuating leading to T2DM complications. Hence, in order to correct the T2DM pathology beta cell mass enhancement is crucial. Stem cell therapy is an emerging field in the management of various kinds of disorders including T2DM. A study 10 patients with T2DM received a stem cell transplant showed significant decrease in insulin requirement and a significant reduction in blood glucose level following stem cell therapy (Bhansali *et al.*, 2009). Stem cell transplant increase the beta cell mass and eventually insulin production. However, the research in the stem cell therapy has a long way to go.

Yoga is a form of mind body practice (Tyagi & Cohen, 2016). It is also a lifestyle which involves the practice of moderation in diet, behavior and sleep pattern along with the practice of physical postures, a set of breathing techniques, relaxation techniques and meditation (Nagarathna et al., 2012). Numerous scientific investigations have found significant role of *Yoga* in the prevention and the management of several chronic health conditions including T2DM (A.Singh, Tekur, Metri, *et al.*, 2018). *Yoga* helps in T2DM with various aspects which

are discussed below. Objective of this review is to review the different aspect of *Yoga* health benefits in T2DM.

3.1 *Yoga* and Blood glucose control

Blood glucose control is the primary objective of the T2DM management. Optimal blood glucose control is associated with decreased risk of diabetic complications and better quality of life in T2DM (Nathan, Singer, Godine, Harrington, & Perlmutter, 1986). Several RCTs have shown that *Yoga* improves the blood glucose control among T2DM patients (A. Singh, Tekur, Metri, *et al.*, 2018; Nagarathna *et al.*, 2012).

Yoga reduces the fasting blood glucose; post-prandial blood glucose and it also reduce HbA1C (Nagarathna *et al.*, 2012) (Rajani, Indla, Archana, & Rajesh, 2015). In a metacentric study, three months of intense *Yoga* intervention reduced fasting and postprandial blood glucose by 32.6% and 34.7%% respectively in participants with T2DM (Singh *et al* 2017). Studies have also shown a decrease in anti-diabetic medication requirement following *Yoga* practice (S. Singh, Kyizom, Singh, Tandon, and Madhu, 2008).

Yoga practice also shown to improve insulin resistance in T2DM (Nidhi, Padmalatha, Nagarathna, and Ram, 2012) (P. *et al.*, 2012). A meta-analysis has concluded that *Yoga* can be a potential intervention to reduce blood glucose in T2DM (Cui *et al.*, 2017).

3.2. *Yoga* and cardiovascular disease (CVD) in T2DM

Uncontrolled blood glucose level eventually leads to damage the endothelial layer of micro and macro blood vessels leading to atherosclerosis. T2DM is an independent risk factor for coronary artery disease and stroke. Prevalence CAD and its severity are higher among T2DM participants compared to the controls. Participants with T2DM have 2 times higher risk of cardiac disease compared to non-diabetic population (Turner *et al.*, 1998). CAD has been a most important cause of mortality in T2DM. It is well documented that, *Yoga* is helpful in improving various cardiac risk factors among participants with high risk of CAD (Manchanda *et al.*, 2000). *Yoga* improves dyslipidemia, blood pressure, BMI and waist circumference which are considered to be an independent risk factor for CAD (Jain, Agrawal, Gahlot, Khatri, & Mathur, 2009).

Hypertension is a frequently observed co-morbid condition in T2DM (Sowers & Epstein, 1995) which is associated with increased risk of CVD in T2DM. 40% of T2DM patients

found to have hypertension (Saad, Gabr, El-Azouni, & Barakat, 2014) (Manzella & Paolisso, 2005). Presence of hypertension as a co-morbid condition increases the risk of CAD by 4 folds. Each 10-mmHg increase in the blood pressure increases the CAD risk by 1.5-fold. Control of blood pressure >140/90 mmHg among T2DM is associated with decreased risk of CVD and End Stage renal disease in T2DM (Tuomilehto *et al.*, 1999).

Yoga reduces blood pressure in hypertensive individuals. Several RCTs has documented the decrease in the systolic, diastolic and mean arterial blood pressure following *Yoga* in hypertension (S. Singh, Malhotra, Singh, Madhu, & Tandon, 2004) Studies have also reported the decrease in anti-hypertension medication requirement following *Yoga* practices (Jain *et al.*, 2009). Their RCT studies documented the improvement in blood pressure after *Yoga* intervention among T2DM patient suggestive of *Yoga* as potential intervention to reduce cardiac risk factor in T2DM (Jain *et al.*, 2009).

3.3. *Yoga* for Dyslipidemia

Dyslipidemia has been an independent risk for CVD. Dyslipidemia is associated with higher incidences of stroke and myocardial infarction among T2DM participants. *Yoga* practice reduces low density lipoprotein, cholesterol and triglycerides; it also improves high density lipoprotein among patients with dyslipidemia (Vyas & Dikshit, 2002). The practice of *Yoga* helps in improving dyslipidemia among T2DM by reducing triglycerides, LDL and VLDL and increasing HDL in T2DM participants, as seen in an RCT (D. *et al.*, 2002).

3.4. *Yoga* and atherosclerosis

Endothelial dysfunction in T2DM leads to atherosclerosis. T2DM increases the risk of CAD by 4 folds. *Yoga* improves various cardiac risk factors such as dyslipidemia, blood pressure. There are studies which have shown regression in atherosclerosis following *Yoga* practice in patients with coronary artery disease (Manchanda *et al.*, 2000). Improvement in carotid artery lumen diameter following *Yoga* intervention among patients with carotid artery stenosis has been documented, (Nagarathna *et al.*, 2012) which suggests the potential benefits of *Yoga* in reducing risk of stroke (Manchanda *et al.*, 2000).

3.5. *Yoga* Improves nerve conduction

Diabetic neuropathy is a most commonly reported in T2DM complication that eventually results in diabetic foot, gangrene and amputation. It is considered to be the leading cause for

amputation. Studies following *Yoga* practice have shown improvement in nerve conduction (Malhotra *et al.*, 2002) which is suggestive of the potential role of *Yoga* in the management and prevention of diabetic neuropathy.

3.6. *Yoga* improves cognitive functions

Micro-vascular complications of T2DM lead to cognitive decline and eventually puts the participants at high risk of dementia and Alzheimer's disease (Roberts *et al.*, 2008). Many longitudinal studies have reported the increased risk of cognitive decline among T2DM than the normal population (Cukierman, Gerstein, & Williamson, 2005). *Yoga* is known to enhance cognition capacity (Froeliger, Garland, Modlin, & McClernon, 2012). Studies on *Yoga* practice have shown improvement in various cognitive domains such as attention, processing speed, memory, selective attention, concentration, etc. (Ross & Thomas, 2010). A study found improvement in memory and attention following three months of *Yoga* practice in participants with T2DM (Rajani *et al.*, 2015).

3.7. *Yoga* and Mental Health in T2DM

Chronic stress and depression are the two important contributing factors for T2DM and they also accelerate the progression of T2DM and its complications. They are also associated with need for increased requirement of hypoglycemic and other medications and CVD risk in T2DM participants. There is evidence that *Yoga* practice reduces stress and depression and enhances mood (Khalsa, Hickey-Schultz, Cohen, Steiner, & Cope, 2012). *Yoga* practice in T2DM reduces perceived stress and depression and helps in improving blood glucose control (Agte & Tarwadi, 2004).

Chronic Stress and depression are considered to be an important risk factor for T2DM. *Yoga* is found to be an effective intervention in reducing stress and its effects (West, Otte, Geher, Johnson, & Mohr, 2004). *Yoga* reduces depression and improves mood, helping to adopt good stress coping strategies (Kozasa *et al.*, 2008)

3.8. *Yoga* for Autonomic dysfunction

T2DM is characterized by autonomic dysfunction with increased sympathetic activity and reduced parasympathetic tone (Manzella & Paolisso, 2005). Increased sympathetic activity in T2DM is associated with increased risk of CVD and incident MI (Pop-Busui *et al.*, 2010).

Yoga practice helps in reducing sympathetic activity and improves parasympathetic tone in T2DM patients as shown by reduced low frequency and increased high frequency power on spectral analysis of heart rate variability spectrum (Tyagi & Cohen, 2016).

3.9. Studies on Mechanism of *Yoga* in T2DM

The exact mechanism of how *Yoga* helps in improving various health parameters in T2DM is not fully understood, However, these changes can be attributed to decreased activation of HPA (hypothalamus-pituitary adrenal axis) as evidenced by decreased sympathetic arousal and increased cardiac autonomic stability (Manchanda *et al.*, 2000). Various *yogic* postures and *sūkṣma vyāyāma* increase the glucose uptake and reduce insulin resistance (Saad *et al.*, 2014; Innes & Vincent, 2007).

Conclusion: Thus, this review concludes that *Yoga* is a cost effective, feasible and effective intervention which may help in blood glucose control, reducing cardiac risk factors and it may also help in prevention of cognitive decline and diabetic neuropathy.