

## CHAPTER 7

### 7-0 DISCUSSION

#### 7.1 ANTHROPOMETRIC CHARACTERISTICS

There was significant reduction BW, BMI, SBP and DBP in the yoga intervention group while the control group showed significantly decrease in SBP and DBP but significantly increase in BW and BMI. While comparing the results, the yoga group indicated more effective positive performance than the control group which showed negatively significant in BW and BMI.

The present findings on BW and BMI are in agreement with the findings of other researcher wherein the patients with T2DM showing improvement in glycaemic control with anti-diabetic medicines without diet control or exercise resulted in weight gain (Raveendran et al., 2018). The medications were associated with several adverse side effects including body weight gain, weakness, fatigue, diarrhoea. It was also reported that insulin treatment increases the risk of atherogenesis (Zia, Hasnain, & Hasan, 2001).

The findings of the present study are in conformity with the findings of (Mondal, Kundu, & Saha, 2018; Sahay, 2007) in which they reveal that yoga intervention has significantly brought down the level of HbA1c in T2DM patients over the control. They further stressed on the beneficial effect on the co- morbid conditions like hypertension and dyslipidemia.

A review study suggested that the growing number of studies on yoga may improve indices of risk in adults with T2DM, including glucose tolerance and insulin sensitivity, lipid profiles, anthropometric characteristic and blood pressure(Innes & Vincent, 2007). The treatment of T2DM with a holistic approach observed that the yogic practices per se would create a conducive internal atmosphere from the cellular to system level (Kutty & Raju, 2010). This would help to manage the stress effectively in addition to its positive regulatory role on the systems. A study on yoga intervention on oxidative stress in patients with T2DM with or without complications observed that there was significant reduction in oxidative stress (Hegde et al., 2011).

A yoga-based lifestyle modification programme for the patients with T2DM conducted by showed a significant reduction in oral anti-glycaemic medication requirement, blood glucose

level, HbA1c, total cholesterol, triglycerides, and VLDL but increase in HDL (Nagarathna et al., 2012). The yoga intervention on lipid profiles of diabetic patients with dyslipidemia was observed the positive response of improving lipid indices (Shantakumari et al., 2013).

A randomised controlled study on yoga intervention for T2DM revealed that there was significant reduction in systolic and diastolic blood pressure, total cholesterol, anxiety, depression, negative affect and perceived stress in both the yoga group and walking control over the course of study (McDermott et al., 2014). It was also observed that yoga offers a promising lifestyle change for decreasing weight related T2DM risk factors and potentially increasing psychological well being. The findings of the scientific studies on various aspects of management and treatment of patients with T2DM are in agreement with the findings of the present studies.

It was described that *Surya namaskar* (Sun salutation) and *asanas* (physical postures) which are included in the yoga intervention schedule were treated as moderate aerobic type of exercises and might have positively influence the lipid profile (Sinha et al., 2004). Many sports scientists also shared the view of improving lipid profile with regular moderate yoga exercise (Kelley & Kelley, 2007), which positively support the findings of the present study.

A yoga-based lifestyle modification programme for the patients with T2DM showed a significant reduction in oral hypoglycaemic medication requirement, blood glucose level, HbA1c, total cholesterol, triglycerides, and VLDL but increase in HDL (Nagarathna et al., 2012). The effect of yoga intervention on lipid profiles of diabetic patients with dyslipidemia observed a positive response (Shantakumari et al., 2013). The similar results were obtained in the present studies and significant improvements in the in all the parameters were shown improvement over the control group.

Lifestyle modification has been suggested to be the keystone for successful management of metabolic syndrome (Fappa et al., 2008; Pitsavos, Panagiotakos, Weinem, & Stefanadis, 2006). Yoga appears to have an anti-hypertensive effect as well as a positive impact on self-rated quality of life. Improvement of metabolic syndrome factors in middle-aged and older adults had been demonstrated to be associated with yoga intervention (Siu, Yu, Benzie, & Woo, 2015).

It was reported that yoga exercise could decrease stress, reduce depression and anxiety, and increased perceived self- efficacy in healthy individuals. The findings indicated that reduction of stress is one of the potential underlying mechanisms explaining the benefits of yoga practice (Chandra et al., 2014).

Metabolic syndrome is a serious public health concern due to its intimate link to the pathogenesis of T2DM, stroke, and cardiovascular diseases. In other words, central obesity and insulin resistance have been considered as the prominent contributors to metabolic syndromes (Supriya et al., 2017). Some findings stated that positive health consequences of regular yoga training was reduction in waist circumference and blood pressure among the postmenopausal women aged 54.5 + 2.8 year (Lee, Kim, & Kim, 2012; Siu et al., 2015). Obese women and breast cancer survivors have been shown to reduce weight and waist circumference after receiving six months of yoga practice (Littman et al., 2012). Another study demonstrated that blood pressure was significantly reduced by yoga intervention in patients with mild hypertension (Hagins, Rundle, Consedine, & Khalsa, 2014). Yoga practice had also shown to reduce oxidative stress of T2DM patients by the mechanism of by reactivating the parasympathetic nervous system by consciously manipulating the breath rhythm ( slow breathing and a long exhalation) during yoga practice (Hegde, Adhikari, Shetty, Manjrekar, & D'Souza, 2013). These novel results support the beneficial complementary role of yoga intervention in the management of metabolic syndromes arisen with the T2DM patients.

The findings of earlier researchers had shown to benefit individuals with a wide range of health conditions including hypertension and diabetes by regular yoga programs using various physical postures, breathing exercises, meditation and relaxation (Bijlani et al., 2005; McCaffrey, Ruknui, Hatthakit, & Kasetomboon, 2005).

Many yoga intervention studies also indicated that the subjects who practiced yoga showed a pattern of improvement in exercise self-efficacy, a strong and consistent predictor of adherence to multiple health-related behaviour changes such as diet, physical activity and smoking (Gwaltney, Metrik, Kahler, & Shiffman, 2009; Warziski, Sereika, Styn, Music, & Burke, 2008).

It was advocated that when compared with education group, the yoga group experienced improvements in weight, blood pressure, insulin, triglycerides and practice self-efficacy

indicated by small to large effect sizes. Their study showed that a yoga program would be a possible risk reduction option for adults at high risk for T2DM and also holds promise as an approach to reducing cardio-metabolic risk factors and increasing exercise self-efficacy for the group (Yang et al., 2011).

## 7.2 GLYCAEMIC CONTROL AND LIPID PROFILE

The Meta-analysis studies uncovered clinically improved effect of yoga intervention on Glycaemic control, lipid parameters, and other indices of patients with T2DM over the control group. The results indicated the effect size values of HbA1c was (RCT, 0.46 ; Non-RCT, 0.26), FBG= (RCT, 0.42 ; Non-RCT, 0.69), PPBG= (RCT,0.33;Non -RCT,0.43), =(RCT,0.39; Non-RCT, 0.60), VLDL= (RCT, 0.47; Non- RCT, 0.52), LDL= (RCT, 0.65; Non -RCT, 0.60), HDL=( RCT, 0.58; Non- RCT, 0.44), TC= (RCT, 0.54; Non- RCT, 0.73), SBP= (RCT,0.30; Non -RCT, 0.18), DBP= (RCT,0.90; Non- RCT,0.64), BMI= (RCT, 0.46; Non- RCT, 0.59) and BW=(RCT, 0.53; Non- RCT,0.20) (Thind et al., 2017). With regard to the findings of the present study, between groups the results show more improvement of yoga intervention group over the control indicating effect size (Cohen's d) value of 1.165, HbA1c, 0.754 for FBG, 0.753 for PPBG, 0.42 for TG. However, the effect size values of TC, HDL, LDL, VLDL, SBP, DBP, BW, BMI found as 0.36, 0.388, 0.492, 0.256, 0.224, 0.142, 0.040, and 0.205 respectively indicated improvement over the control which are on par with the values of previous studies. Some other meta-analysis and systematic review studies on glycaemic control and lipid profiles of pre-diabetes patients through yoga intervention also observed improvement over the control in terms of SMD( standard mean difference) recorded as FBG= -0.064mg/dl, LDL= -0.090mg/dl, TG= -0.148mg/dl, TC= - 0.058mg/dl and SBP = - 0.058mgHg which support the findings of the present study in which the yoga intervention group shows significant improvement over the control group (Ramamoorthi et al., 2019) . This meta-analysis supported clinically improved effects of yoga intervention on glycaemic control, lipid profiles and other metabolic parameters of T2DM management in diabetic patients. These results suggest that yoga intervention may be considered as a comprehensive and alternative approach in preventing T2DM. The findings of the present study are consistent with other meta-analyses assessing the effects of yoga on glycaemic control among T2DM patients (Cui et al., 2017; Kumar et al., 2016). Consistent to The present study was found similar positive impact for lipid profile, blood pressure besides significant changes in other markers of diabetes management such as BMI, and HbA1c (Vizcaino & Stover, 2016).

### 7.3 HEALTH SATISFACTION

Previous studies have demonstrated that life style changes mainly dietary control, physical exercise and stress relaxation have a vital role in the management of patients with T2DM (Eriksson & Lindgärde, 1991; Li et al., 2008; Tuomilehto et al., 2001). Several researchers have also shown that uncontrolled diet and less physical exercise programme were major limitations in achieving the target of success in non-pharmacological treatment of T2DM. Therefore, the present study is an attempt to find out the impact of life style modification through dietary control and yogic life style for management of mongoloid patients with T2DM. The findings of the present studies on health satisfaction for Diabetes patient questionnaires show significant improvements with positive health after intervention when compared with the results of the non- yoga control group who were on conventional treatment. The present findings are in agreement with the findings of (Bhanu et al., 2016; C. K. Miller et al., 2012; Raveendran et al., 2018; Ross & Thomas, 2010; Youngwanichsetha, Phumdoung, & Ingkathawornwong, 2014). T2DM is a chronic metabolic disease that adversely affects the patient's quality of life. Diabetic patients have higher level of psychological stress and depression resulting in bidirectional effect in the glycaemic control (Bystritsky, Danial, & Kronemyer, 2014; Innes, Bourguignon, & Taylor, n.d.). It was advocated that chronic psychological stress can result in insulin resistance, hypertension, and an increased risk of cardiovascular defects. However, significant improvement in stress scores by psychological counselling and self evaluation scoring system such as satisfaction score, impact score and worry score is obtained among the volunteers of yoga intervention of the present study. There had been evidence based report that yoga effectively reduces stress, thereby helping in controlling T2DM which support the present finding (M Kosuri & Sridhar, 2009). There was similar findings of significant improvement in treating depression through KriyaYoga (Cleansing techniques) with the present study (Naga Venkatesha Murthy et al., 1998). Regular and attentive participation in 4 month session of yoga practice including *yogasana*, *pranayama*, *kriya*, dietary class, cyclic meditation, counselling, *bhajan*, spiritual discussion and relaxation among the yoga intervention group result in significant improvements in the scores of various psychological assessments, including satisfaction impact and worry. Yoga session results in improvements in physical flexibility, behavioural changes, and dietary control, in addition to its effects on relaxation and stress management. The participants of yoga group have shown significant improvement of health satisfaction. The improvements observed in the present study are in conformity with the previous findings

(Aswathy, Kalra, & Unnikrishnan, 2013; Bhanu et al., 2016; Mohammed, Banu, & Kumar Jaiswal, 2016; Raveendran et al., 2018). It is believed that repeated abdominal stretch during yoga postures result in the regeneration of pancreatic cells (Raj Thangasami & Lal Chandani, 2015). Besides, yoga, India's traditional *vedic* science has shown improvement of oxidative stress as well as glycaemic status of hormonal homeostasis and glycaemic control in patients with T2DM (Jain, Uppal, Bhatnagar, & Talukdar, 1993; Ross & Thomas, 2010; Yadav, Ray, Vempati, & Bijlani, 2005). Summing up the benefits accrued to the yoga intervention group, many workers on yoga, the spiritual lore of Indian scriptures, are of the opinion that the various yoga postures during the session help to induce the sensitivity of B-cells to glucose, which enhances insulin secretion, increase the blood supply to the muscles resulting rise in glucose uptake (Bhanu et al., 2016; Bijlani et al., 2005; Kyizom, Singh, Singh, Tandon, & Kumar, 2010; Raveendran et al., 2018; Sahay, 2007). Insulin resistance and beta cell dysfunction which contribute to hyperglycaemia in diabetes are caused by systemic inflammation in the body. Some studies indicated that yoga life style reduces systemic inflammation in the body thereby increasing the regenerative capacity of pancreatic cells (Bower et al., 2014; Rajbhoj, Shete, Verma, & Bhogal, 2015).

Thus, the present study infers that yogic life style could accrue several physical and mental health benefits achieving current health satisfaction of type 2 diabetes patients through holistic cleansing. Further, it is also evident that the yoga life style intervention shows highly significant improvement in all clinical as well as psychological indices while comparing with the improvement indicated in the non- yoga control group who are under conventional treatment on anti- hyperglycaemic agents.

#### **7.4 QUALITY OF LIFE**

The present study was an attempt to determine the impact of life style modification and yogic life style on quality of life in mongoloid patients with T2DM based on the findings of quality of life instrument for Diabetes patient questionnaires. The result showed significant improvements of quality of life after intervention when compared with the results of the non-yoga control group who were on conventional treatment. (Wolff, Sundquist, Larsson Lönn, & Midlöv, 2013) demonstrated that yoga at home group showed a greater improvement in quality of life than the control group which supports the findings of the study. The findings of the present study are in agreement with the findings of (Bhanu et al., 2016; C. K. Miller et al.,

2012; Raveendran et al., 2018; Ross & Thomas, 2010; Youngwanichsetha et al., 2014). T2DM is a chronic metabolic disease that adversely affects the patient's quality of life. Diabetic patients have higher level of psychological stress and depression resulting in bidirectional effect in the glycaemic control (Bystritsky et al., 2014; Innes et al., n.d.; Madhu Kosuri & Sridhar, 2009). It was advocated that chronic psychological stress can result in insulin resistance, hypertension, and an increased risk of cardiovascular defects. However, significant improvement in stress scores by psychological counselling and self evaluation scoring system such as satisfaction score, impact score and worry score was obtained among the volunteers of yoga intervention of the present study. (M Kosuri & Sridhar, 2009) It was described that yoga effectively reduces stress, thereby helping in controlling T2DM (Naga Venkatesha Murthy et al., 1998). Regular and attentive participation in 16 week session of yoga practice including *yogasana*, *pranayama*, *kriya*, dietary class, cyclic meditation, counselling, *bhajan*, spiritual discussion and relaxation among the yoga intervention group result in significant improvements in the scores of various psychological assessments, including quality of living. Yoga session results in improvements in physical flexibility, behavioural changes, and dietary control, in addition to its effects on relaxation and stress management. The participants of yoga group have shown significant improvement of quality life. The improvements observed in the present study are in conformity with the findings of (Aswathy et al., 2013; Bhanu et al., 2016; Mohammed et al., 2016; Raveendran et al., 2018). It is believed that repeated abdominal stretch during yoga postures result in the regeneration of pancreatic cells (Raj Thangasami & Lal Chandani, 2015). Besides, yoga, India's traditional vedic science has shown improvement of oxidative stress as well as glycaemic status of hormonal homeostasis and glycaemic control in patients with T2DM (Jain et al., 1993; Ross & Thomas, 2010; Yadav et al., 2005). Summing up the benefits accrued to the yoga intervention group, the various yoga postures during the session help to induce the sensitivity of B-cells to glucose, which enhances insulin secretion, increase the blood supply to the muscles resulting rise in glucose uptake (Bhanu et al., 2016; Bijlani et al., 2005; Kyizom et al., 2010; Raveendran et al., 2018; Sahay, 2007). Insulin resistance and beta cell dysfunction which contribute to hyperglycaemia in diabetes are caused by systemic inflammation in the body. The studies of (Bower et al., 2014; Rajbhoj et al., 2015) indicated that yoga life style reduced systemic inflammation in the body thereby increasing the regenerative capacity of pancreatic cells.

It was widely advocated that in diabetes management, psychological factors have an important impact on self care, acceptance of therapeutic regimens and treatment success and metabolic measures like glycaemic control are poorly correlated with quality of life and need separate assessment (Bardsley et al., 1993; Weinberger et al., 1994). Some researchers observed that ethnicity, culture, education, income etc. had influenced the perception of quality of life of patients (Glasgow & Osteen, 1992).

A study for 3- month yoga intervention program for adults at high risk for Type 2 diabetes, indicated that yoga is an ingenious technique to attain equilibrium and well-being of mental, physical, emotional and spiritual aspects thereby improving quality of life of the individual (Yang et al., 2011). According to (Burckhardt & Anderson, 2003) quality of life is the 'ultimate goal of all health interventions' and he further stated quality of life as the complete influence of the disease condition not only on the physical or social domains but also on mental well being. It was also reported that diabetics showed significant improvement in quality of life but non- significant glycaemic improvement with yogic breathing (Gupta et al., 2006), which is contradictory to the present study.

## **7.5 EFFECT OF INCLUSION STUDY**

There was a significantly inter-linked relation of the results of the different parameters studied and found improvement in physical and mental well-being of both the participants of the yoga intervention group and control group of patients with T2DM. However, the experimental group with yoga life style showed more positively significant improvement in group comparisons of the different parameters thereby achieving the goal of self satisfaction holistically (physically, mentally, emotionally and spiritually) beyond the drug action. Evidence based research findings had shown that life style modification and treatment along with anti-glycaemic agents improve T2DM inflammation markers associating with significant changes in B cell function in patients with T2DM (Cavelti-Weder et al., 2012; Haffner et al., 2005; Larsen et al., 2009). It is also advocated that the success of treatment algorithms of T2DM was strongly associated with concomitant synergistic lifestyle changes along with pharmacotherapy (Arumugam et al., 2020). The findings of the previous workers conform with result of the present study in respect of composite treatment at *Pancha Kosa* level i.e. treatment at five layers of human existence associating with physical body and

subtle layers (vital force or breath, mind, intellect , and blissful state or action without fruit) converse towards the ultimate treatment goal of self-satisfaction.

## 7.5 POSSIBLE CONCEPTUALIZED MECHANISMS

The present study suggests a positive role of a 16-week integrated yoga intervention session in management of patients with T2DM. Yoga based lifestyle intervention is a holistic approach of intervention with various components including cleansing processes (*kriya*), postures (*asana*), controlled breathing (*pranayama*), meditation, relaxation, chanting *mantras*, yogic diet, code of conduct, philosophy, and spirituality. The philosophy of traditional Indian yogic texts always aims at harnessing the full gamut of physical, mental, social and spiritual well- being of human being. In addition, the yoga protocol embodied integration of all practices and techniques to treat the 5 layers of human existence comprehensively leading to balancing and harmonizing the body, mind and emotions (Liu et al., 2014). At *Anamaya kosha*( Physical level), a true yogi needs on moderation way of life by moderation in food intake, sleep, even moderation in physical activity. With respect to T2DM, reduced physical activity is a long known risk factor of T2DM. Increase in duration/intensity of physical activity might also increase sympathetic arousal worsening glycaemic control. Post prandial blood glucose level after heavy food results in acute hyperglycaemia activating oxidative stress (Monnier, Colette, & Owens, 2008). This shows the importance of moderation in T2DM (Johnsson, Haglund, Ahlsson, & Gustafsson, 2015). Treatment at *Annamaya kosha* level through *yogasana*, *kriya* with relaxation and yogic diet modification bring body and mind balance. The extreme emotion is root cause of “Psychosomatic diseases” and also a contributing risk factor of T2DM. Increased anxiety, stress and depression double the risk of T2DM. Hence, balancing mind by staying equipoise during emotional disturbances and treating *sukha* (happy) and *dukha* (sadness) as one and the same are the attributes of yogis at the *Manomaya kosha* level(Eaton, Armenian, Gallo, Pratt, & Ford, 1996) . Increased sympathetic tone and reduced vagal activity has been reported in T2DM (Benichou et al., 2018) . Meditation is a Yogic process of providing deep rest to the system by allowing the mind to calm down to its basal states. Treating at *Vijnamaya kosha* level through counselling, yogic education, happiness analysis is beneficial in balancing the autonomic imbalances and hormonal imbalances. (S. Singh, Malhotra, Singh, Madhu, & Tandon, 2004; Vaishali, Kumar, Adhikari, & UnniKrishnan, 2012). At *Pranamaya kosha* level, *ida* and *pingala nadis* through *pranayama* is believed to allow the smooth flow of

*prana*, the vital force through *sushumna nadi* which lead to self- realisation. The predominance of either of the *nadis* leads to *tamus* personality( type-D) and *rajas* personality(type-A). Type-D and Type- A predominant personality traits are already known to influence the risk of T2DM (Kyizom et al., 2010; Nivethitha, Mooventhan, & Manjunath, 2016). Balancing these two *nadis* is essential to increase *sattva* leading to a perfectly blessed state known as *Anandamaya kosha*. This is the *kosa* (sheath) where one has fulfilled the desire and in the thought-free-state of *nirvikalpa samadhi* i.e. in deep sleep (Raina & Ph, 2016) The present studies embodied the *Panch Kosha* model of treatment integrating all the yogic practices in the ideal yoga module thereby improving at each level.

There were ample evidences that yoga practice tackles the pathophysiologic mechanisms of diabetes and helps in controlling diabetes and its complications (Raveendran et al., 2018). Various studies indicated that practicing yoga postures help to activate B-cell function thereby improving insulin secretion, increasing blood supply to the muscles and muscle relaxation that results in increasing glucose uptake and thus reducing blood sugar (Chandratreya, 2011). Improvement in the hormonal secretion also improves glycaemic control in diabetic patients. Yoga practice is cost effective and easy to maintain, requiring not much equipment or professional personnel. Another possible mechanism suggested by (Delmonte, 1985) for improving lipid profile after yoga could be due to increased hepatic lipase and lipoprotein lipase at cellular level, which affects the metabolism of lipoprotein and thus increase uptake of TG by adipose tissues. But there is evidence indicating excellent long term adherence and benefits ( Singh et al., 2008). Extensive research on yogic science has shown improvement on oxidative stress as well as glycaemic status of diabetes through neuroendocrinal mechanism (Bijlani et al., 2005; Jain et al., 1993) It has also been advocated that various yoga- asana may be directly rejuvenating cells of pancreas resulting increase in utilization and metabolism of glucose in the peripheral tissues, liver and adipose tissues through enzymatic process (Kyizom et al., 2010; Sahay, 2007) It was consistently observed that meditation, one of the different yoga components, was found to have a significant effect on lowering weight and reducing triglycerides levels and relaxation techniques were associated with reduction in BMI which could be the reason for improved body composition measures (Alberts, Thewissen, & Raes, 2012; Daubenmier et al., 2011; Katterman, Kleinman, Hood, Nackers, & Corsica, 2014). In the similar way, studies had shown that relaxation techniques used in the yoga practice might help with stress reduction. Earlier evidences

suggest that stress is activated by hypothalamus-pituitary- adrenal axis resulting excess of circulating cortisol leads to abdominal adiposity (Björntorp & Rosmond, 2000; Pasquali, Vicennati, Cacciari, & Pagotto, 2006). Furthermore, numerous studies have shown that stress is associated with increased consumption of energy- loaded foods high in sugar and fat, and emotional eating (Oliver, Wardle, & Gibson, 2000; Tryon, DeCant, & Laugero, 2013). It was reported that yogic intervention changes in biochemical and hormonal profile, elimination of stress and instilling a sense of discipline (Sahay, 2007). By reducing stress through yoga relaxation practice may positively influence BMI and resultant effect in maintaining Homeostasis of sympathetic and parasympathetic nervous system (Block, He, Zaslavsky, Ding, & Ayanian, 2009; Smith, Hancock, Blake-Mortimer, & Eckert, 2007).

The condition of T2DM could be intervened by yoga practice involving two mechanisms-down regulation of both the hypothalamic pituitary adrenal axis and the sympathetic nervous system (Nivethitha et al., 2016; Pasquali et al., 2006). To sum up, based on the evidences, yoga significantly reduces FBG levels and alters significant clinical outcomes in mongoloid patients with T2DM. Thus, the findings of the present study support the idea that yoga-based training is a possible alternative practice for T2DM management. In conclusion, yoga life style may be considered as a boon for management of psychosomatic disease/ stress related disease like diabetes since it acts holistically beyond the drug action.

Although the exact mechanisms how the yoga therapy brings amelioration on diabetes risk profiles are not yet well understood, at least four mechanistic pathways are believed to exhibit observed changes in the metabolic functions of the patients with T2DM (de G R Hansen & Innes, 2013; Innes & Vincent, 2007) First, Yoga practice may enhance well-being and reducing reactivity and activation of the HPA axis and the sympathoadrenal system (Innes & Selfe, 2016). The studies on controlled trials on yoga had found similar findings suggesting the short term yoga practice could reduce perceived stress, improved mood, and lower catecholamine and cortisol levels, cardiovascular response to stress, blood pressure and other parameters of sympathetic activation in healthy and adults with diabetes (de G R Hansen & Innes, 2013; Gowtham, Vasanthi, Jayshree, Ambika, & Jacob, 2018; Khatri, Mathur, Gahlot, Jain, & Agrawal, 2007; Uebelacker et al., 2010). Secondly, many researchers observed that yoga practices may shift the autonomic nervous system balance from sympathetic to parasympathetic, by enhancing parasympathetic output, passively via vagal stimulation, resulting in positive changes in cardiovagal function, neuro-endocrine,

hemodynamic, and inflammatory profiles (Brown & Gerbarg, 2005; Innes, Vincent, & Taylor, 2007; R. B. Singh, Kartik, Otsuka, Pella, & Pella, 2002). Next, yoga may also promote favourable changes in autonomic balance, memory and mood, neurological structure and function, and related metabolic and inflammatory responses by selectively activating specific brain structures and neurochemical systems related to attention and positive affect (Kjaer et al., 2002; Newberg et al., 2010; Rubia, 2009; Wang et al., 2011). Finally, yoga training may improve both metabolic and psychological risk profiles, support increased physical activity, enhance neuroendocrine function, improve body composition, and promote weight loss resulting increased strength, overall fitness and physical function (Alexander, Innes, Selfe, & Brown, 2013).

In the narrative review studies, it was indicated that the various mechanisms by which yoga training and integrated approach on yoga therapy for treatment of T2DM are understood as either through single or combined impact of the intervention on regaining autonomic balance, vagal modulation, regulation of hormones and thereby attaining glycemic control (Kurian, Mohanthy, & Nanjumdaiah, 2022).

A more comfortable and happy feeling of well-being of the subjects on BP, BG and HbA1c levels of patients with T2DM, was reported after practicing different yoga postures and co-ordinated breathing in *pranayama* (Ranga, Agrawal, Rukadikar, & Rukadikar, 2021). Similar findings were observed by (Telles, Naveen, Balkrishna, & Kumar, 2010), which support the present finding.

*Asana*, one of the limbs of *Asanga yoga* focuses on the synchronization of breathing and movement. *Asanas* involve stretching, twisting, bending, balancing, and relaxation. Seated postures with twist improve pancreatic function. Forward bending *asanas* massage and pressurise the pancreas and stimulate the secretion of insulin. Twisting poses squeeze the intestines and massage them to prevent constipation. A research study (Malhotra, Singh, Tandon, & Sharma, 2005) showed that yoga poses had a positive effect on glucose utilization and fat distribution in subjects with T2DM. Pancreatic B-cell sensitivity may be increased by the alternating abdominal contractions and relaxations involved in yoga practice (Raj Thangasami & Lal Chandani, 2015). However, inverted poses such as *sarvangasana* and *sirshasana* may lead to retinal detachment or bleeding. As such, the T2DM patients are advised to not to practice such poses.

The slow breathing technique in *pranayama* may cause changes in body physiology by controlling the autonomic nervous system. It regulates the rate and pattern of breathing and regulates the heart beat rate (Nivethitha et al., 2016). The practice of meditation helps in attaining mental stability of diabetes patients. A 6- week meditation treatment showed improvement in health satisfaction, anxiety reduction, and blood pressure control (Chung, Brooks, Rai, Balk, & Rai, 2012).

Thus, the present study infers that yogic life style could accrue several physical and mental health benefits achieving current health satisfaction of type 2 diabetes patients through holistic cleansing. Further, it is also evident that the yoga life style intervention shows highly significant improvement in all clinical as well as psychological indices while comparing with the improvement indicated in the non-yoga control group who are under conventional treatment on anti- hyperglycaemic agents.