

Commentary

Yoga- a potential solution for diabetes & metabolic syndrome

India accounts for almost 70 million people with diabetes and the number is expected to increase to 90 million by the year 2030¹. Over the last few decades, the mean age of onset of diabetes has been on the decline, the disorder thereby affects a relatively younger segment of the population². Genetic predisposition and environmental factors like physical inactivity, excessive calorie intake and obesity, low birth weight and genetic factors play an important role in the evolution of diabetes^{3,4}. Visceral adiposity produces several inflammatory cytokines like tumour necrosis factor- α (TNF- α), interleukin-6 (IL-6), resistin and vistafin which are associated with insulin resistance and the metabolic syndrome⁵.

Vitamin D deficiency has been found to be more common among those with prediabetes, diabetes and obesity. The lowered serum circulating vitamin D levels are inversely associated with severity of insulin resistance⁶. Vitamin D supplementation has shown to prevent the development of new onset diabetes thereby improving the insulin sensitivity and glycaemic control⁷.

Large clinical studies like the United Kingdom Prospective Diabetes Study (UKPDS)⁸, Diabetes Control and Complications Trial Research Group (DCCT)⁹ and the Kumamoto study¹⁰ have demonstrated that intensive glycaemic control can significantly reduce microvascular complications, however, may fail to have an impact on reduction of macrovascular complications. The rapid increase in incidence of diabetes and the challenges faced by healthcare givers to provide high quality care to all persons with diabetes related complications and growing economic and personal cost of the treatment of disease are indeed compelling for the need of primary prevention in type 2 diabetes¹¹.

A strategy of primary prevention may be focused on high risk individuals who are prone for the development of diabetes. Lifestyle modifications (LSM) include enhanced physical activity, dietary modification, weight loss and behavioural modifications. Several studies such as the Finnish diabetes prevention study (DPS)¹², the Diabetes prevention program (DPP) in the United States of America¹³, the Indian Diabetes Prevention Programme (IDPP)^{11,14} and the Chinese Da Qing study have demonstrated the efficacy and benefits of life style interventions¹⁵. Pharmacological interventions with drugs like metformin, rosiglitazone, acarbose and orlistat have been studied in high risk individuals and were also proven to be effective¹⁶⁻¹⁸.

Lifestyle modification (LSM) is from a pragmatic perspective, considered to be the primary line of intervention prior to any pharmacological therapy for preventing the development of diabetes in high risk individuals¹⁹. Moreover, cohort studies like the 7-year project that was involved in the Finnish DPS and the 20 year follow up that was accomplished in the Da Qing Study, had established that the beneficial effects of lifestyle intervention were sustainable^{20,21}.

The modern form of yoga is primarily focused on simple physical exercises (*asanās*), breathing exercise (*prāṇayāma*), followed by relaxation techniques (*shāvasāna*) or meditation. Yoga has been considered as a simple and potentially economical therapy that may be used alongside medical treatment of diabetes. The benefits of yoga have been studied based on various aspects of diabetes such as glycaemic control, quality of life and on several complications of diabetes. In a systemic review Innes *et al*²² have analyzed 70 previous studies on the effect of yoga and suggested that yoga may reduce the insulin resistance related risks in relation to cardiovascular disease. Another study has prospectively evaluated the benefit of yoga

on glycaemic control and the quality of life of subjects with type 2 diabetes for a period of three months²³. All participants in the study had previously been on lifestyle modification (diet and exercise) and on oral medications. There was a significant improvement in the quality of life in the yogic group and only a marginal impact on glycaemic control²³. A study by Amita *et al*²⁴ assessed the effect of yoga *nidra* for three months among middle aged patients with diabetes on oral medications. The study group was randomized into those on yoga group and a control group on simple lifestyle measures. There was an improvement in symptom score, reduction of fasting blood glucose (22.75 mg/dl) and postprandial blood glucose by 18 mg/dl, both of which were significant when compared with the control group²⁴. The effect of yoga has also been studied in patients with gestational diabetes mellitus (GDM). The patients with GDM were randomized into those on yoga and mindful eating, and a control group for eight weeks. The difference in the mean fasting blood glucose, postprandial blood glucose and mean HbA1c levels between the two groups was significant, however, the clinical differences were rather small²⁵. Singh *et al*²⁶ studied the 40 day effect of yoga on glycaemic control and autonomic function in patients with diabetes. There was a marked improvement in the glycaemic profile inclusive of fasting blood glucose, postprandial blood glucose and HbA1c levels when compared with the baseline status. A positive impact was also noticed on various autonomic indices such as the pulse, blood pressure and corrected QT interval²⁶. Manjunatha *et al*²⁷ studied the beneficial effect of yogic postures on blood glucose control. In another study an improvement of glycaemic control and pulmonary function in type 2 diabetes patients was seen with yoga *asanas*²⁸. Singh *et al*²⁹ in a preliminary study, validated the efficacy of yoga in glycaemic control and on reducing the markers of oxidative stress: serum malondialdehyde (MDA). Malhotra *et al*³⁰ conducted a randomized controlled study and demonstrated the beneficial effect on glycaemic control and nerve conduction after 40 days of yoga. A short study of 10 days showed the effect of yoga in improving lipid profile and glycaemic parameters³¹. Yoga practice has also been shown to reduce anxiety and may improve overall wellbeing along with reduction in BMI³².

In this issue Netam *et al*³³ have demonstrated beneficial effects of short-term yoga-based lifestyle intervention programme on diabetes risk factors in obese individuals. The study included supervised yoga

intervention for 10 days and a follow up at 30 days. At day 10 a significant reduction was observed in body weight, BMI, waist-hip ratio, blood glucose level and median fasting insulin and interleukin-6 (IL-6). This study also highlighted the challenges in sustainability of this intervention during the follow up period. McDermott *et al*³⁴ did a pilot study to look at the effect of yoga in individuals at a high risk for diabetes. Each yoga session lasted for 75 min. The study group showed a significant weight loss, reduction in waist circumference and an improvement in psychological well being.

Kanayan *et al*³⁵ in the PRYSMS study, randomized patients into a yoga group and stretching group for 48 wk. At six months of follow up, the yoga group had a reduction in the levels of fasting blood glucose, HbA1c, low density lipoprotein cholesterol and increase in HDL-C. However, at the end of 12 months, there was no sustained change except for a drop in fasting blood sugar. In a community based study, Hegde *et al*³⁶ evaluated the effect of yoga on oxidative stress in prediabetes patients. At the end of three months, yoga was associated with reduction in malondialdehyde, a marker of oxidative stress. A similar study showed that short-term yoga for 10 days reduced the IL-6 level and increased the adiponectin level³⁷. Yoga was shown to be effective in reducing the waist circumference, blood pressure and improving the lipid and glycaemic profiles in metabolic syndrome³⁸. A study from Korea was conducted on boys with obesity for a period of eight weeks. It was found that yoga could significantly reduce the body weight, BMI, fat mass (FM) and body fat percentage and improve fat free mass and the basal metabolic rate³⁹.

In summary, short-term studies on yoga have been found to be moderately effective in reducing various risk factors of prediabetes, obesity and the metabolic syndrome. Studies have shown a beneficial impact on achieving glycaemic control in type 2 diabetes and gestational diabetes mellitus. However, there was heterogeneity in the methodology and the sample sizes across the various studies. In majority of these studies, the sample size was small and the duration of the studies was short. There was also a variability in the pattern of yoga, type of yoga and timing of individual sessions among all studies.

There is a need for proper randomized controlled interventions with adequate sample size and power with an appropriate duration. The effect of yoga also

has to be studied across various ethnic populations and risk categories to identify which pattern of yoga is more beneficial and which disorders benefit best from yogic interventions. It is also essential to have a trained expert yoga instructor, to design and individualize the yoga to maximize the benefit when yoga is advised for therapeutic purposes.

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References

1. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care* 2004; 27 : 1047-53.
2. Alberti G, Zimmet P, Shaw J, Bloomgarden Z, Kaufman F, Silink M; Consensus Workshop Group. Type 2 diabetes in the young: the evolving epidemic: the international diabetes federation consensus workshop. *Diabetes Care* 2004; 27 : 1798-811.
3. Thomas N, Grunnet LG, Poulsen P, Christopher S, Spurgeon R, Inbakumari M, et al. Born with low birth weight in rural Southern India: what are the metabolic consequences 20 years later? *Eur J Endocrinol* 2012; 166 : 647-55.
4. Chapla A, Mruthyunjaya MD, Asha HS, Varghese D, Varshney M, Vasani SK, et al. Maturity onset diabetes of the young in India - a distinctive mutation pattern identified through targeted next-generation sequencing. *Clin Endocrinol (Oxf)* 2015; 82 : 533-42.
5. Guilherme A, Virbasius JV, Puri V, Czech MP. Adipocyte dysfunctions linking obesity to insulin resistance and type 2 diabetes. *Nat Rev Mol Cell Biol* 2008; 9 : 367-77.
6. Dutta D, Maisnam I, Shrivastava A, Sinha A, Ghosh S, Mukhopadhyay P, et al. Serum vitamin-D predicts insulin resistance in individuals with prediabetes. *Indian J Med Res* 2013; 138 : 853-60.
7. Tabesh M, Azadbakht L, Faghihimani E, Tabesh M, Esmailzadeh A. Effects of calcium-vitamin D co-supplementation on metabolic profiles in vitamin D insufficient people with type 2 diabetes: a randomised controlled clinical trial. *Diabetologia* 2014; 57 : 2038-47.
8. The UK Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). *Lancet* 1998; 352 : 837-53.
9. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 1993; 329 : 977-86.
10. Ohkubo Y, Kishikawa H, Araki E, Miyata T, Isami S, Motoyoshi S, et al. Intensive insulin therapy prevents the progression of diabetic microvascular complications in Japanese patients with non-insulin-dependent diabetes mellitus: a randomized prospective 6-year study. *Diabetes Res Clin Pract* 1995; 28 : 103-17.
11. Ramachandran A, Snehalatha C, Yamuna A, Mary S, Ping Z. Cost-effectiveness of the interventions in the primary prevention of diabetes among Asian Indians: within-trial results of the Indian Diabetes Prevention Programme (IDPP). *Diabetes Care* 2007; 30 : 2548-52.
12. Lindström J, Ilanne-Parikka P, Peltonen M, Aunola S, Eriksson JG, Hemiö K, et al. Finnish Diabetes Prevention Study Group. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. *Lancet* 2006; 368 : 1673-9.
13. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. Diabetes Prevention Program Research Group. *N Engl J Med* 2002; 346 : 393-403.
14. Ramachandran A, Snehalatha C, Mary S, Mukesh B, Bhaskar AD, Vijay V. Indian Diabetes Prevention Programme (IDPP). The Indian Diabetes Prevention Programme shows that lifestyle modification and metformin prevent type 2 diabetes in Asian Indian subjects with impaired glucose tolerance (IDPP-1). *Diabetologia* 2006; 49 : 289-97.
15. Li G, Hu Y, Yang W, Jiang Y, Wang J, Xiao J, et al. Effects of insulin resistance and insulin secretion on the efficacy of interventions to retard development of type 2 diabetes mellitus: the DA Qing IGT and Diabetes Study. *Diabetes Res Clin Pract* 2002; 58 : 193-200.
16. Gerstein HC, Yusuf S, Bosch J, Pogue J, Sheridan P, Dinccag N, et al. DREAM (Diabetes Reduction Assessment with Ramipril and Rosiglitazone Medication) Trial Investigators. Effect of Rosiglitazone on the frequency of diabetes in patients with impaired glucose tolerance or impaired fasting glucose: A randomized controlled trial. *Lancet* 2006; 368 : 1096-105.
17. Chiasson JL, Josse RG, Gomis R, Hanefeld M, Karasik A, Laakso M. Acarbose for prevention of type 2 diabetes mellitus: The STOPNIDDM randomised trial. *Lancet* 2002; 359 : 2072-7.
18. Torgerson JS, Hauptman J, Boldrin MN, Sjörström L. XENical in the prevention of diabetes in obese subjects (XENDOS) study: A randomized study of orlistat as an adjunct to lifestyle changes for the prevention of type 2 diabetes in obese patients. *Diabetes Care* 2004; 27 : 155-61.
19. Tuomilehto J, Lindström J, Eriksson JG, Valle TT, Hämäläinen H, Ilanne-Parikka P, et al; Finnish Diabetes Prevention Study Group. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. *N Engl J Med* 2001; 344 : 1343-50.
20. Lindström J, Ilanne-Parikka P, Peltonen M, Aunola S, Eriksson JG, Hemiö K, et al. Sustained reduction in the incidence of type 2 diabetes by lifestyle intervention: follow-up of the Finnish Diabetes Prevention Study. *Lancet* 2006; 368 : 1673-9.
21. Li G, Zhang P, Wang J, Gregg EW, Yang W, Gong Q, et al. The long-term effect of lifestyle interventions to prevent diabetes in the China Da Qing Diabetes Prevention Study: a 20-year follow-up study. *Lancet* 2008; 371 : 1783-9.

22. Innes KE, Bourguignon C, Taylor AG. Risk indices associated with the insulin resistance syndrome, cardiovascular disease, and possible protection with yoga: a systematic review. *J Am Board Fam Pract* 2005; 18 : 491-519.
23. Jyotsna VP, Joshi A, Ambekar S, Kumar N, Dhawan A, Sreenivas V. Comprehensive yogic breathing program improves quality of life in patients with diabetes. *Indian J Endocrinol Metab* 2012; 16 : 423-8.
24. Amita S, Prabhakar S, Manoj I, Harminder S, Pavan T. Effect of yoga-nidra on blood glucose level in diabetic patients. *Indian J Physiol Pharmacol* 2009; 53 : 97-101.
25. Youngwanichsetha S, Phumdoung S, Ingkathawornwong T. The effects of mindfulness eating and yoga exercise on blood sugar levels of pregnant women with gestational diabetes mellitus. *Appl Nurs Res* 2014; 27 : 227-30.
26. Singh S, Malhotra V, Singh KP, Madhu SV, Tandon OP. Role of yoga in modifying certain cardiovascular functions in type 2 diabetic patients. *J Assoc Physicians India* 2004; 52 : 203-6.
27. Manjunatha S, Vempati RP, Ghosh D, Bijlani RL. An investigation into the acute and long-term effects of selected yogic postures on fasting and postprandial glycemia and insulinemia in healthy young subjects. *Indian J Physiol Pharmacol* 2005; 49 : 319-24.
28. Malhotra V, Singh S, Singh KP, Gupta P, Sharma SB, Madhu SV, et al. Study of yoga asanas in assessment of pulmonary function in NIDDM patients. *Indian J Physiol Pharmacol* 2002; 46 : 313-20.
29. Singh S, Malhotra V, Singh KP, Sharma SB, Madhu SV, Tandon OP. A preliminary report on the role of yoga asanas on oxidative stress in non-insulin dependent diabetes mellitus. *Indian J Clin Biochem* 2001; 16 : 216-20.
30. Malhotra V, Singh S, Tandon OP, Madhu SV, Prasad A, Sharma SB. Effect of Yoga asanas on nerve conduction in type 2 diabetes. *Indian J Physiol Pharmacol* 2002; 46 : 298-306.
31. Bijlani RL, Vempati RP, Yadav RK, Ray RB, Gupta V, Sharma R, et al. A brief but comprehensive lifestyle education program based on yoga reduces risk factors for cardiovascular disease and diabetes mellitus. *J Altern Complement Med* 2005; 11 : 267-74.
32. Kosuri M, Sridhar GR. Yoga practice in diabetes improves physical and psychological outcomes. *Metab Syndr Relat Disord* 2009; 7 : 515-7.
33. Netam R, Yadav RK, Khadgawat R, Sarvottam K, Yadav R. Interleukin-6, vitamin D & diabetes risk factors modified by a short-term yoga-based lifestyle intervention in overweight/obese individuals. *Indian J Med Res* 2015; 141 : 775-82.
34. McDermott KA, Rao MR, Nagarathna R, Murphy EJ, Burke A, Nagendra RH, et al. A yoga intervention for type 2 diabetes risk reduction: a pilot randomized controlled trial. *BMC Complement Altern Med* 2014; 14 : 212.
35. Kanaya AM, Araneta MR, Pawlowsky SB, Barrett-Connor E, Grady D, Vittinghoff E, et al. Restorative yoga and metabolic risk factors: the Practicing Restorative Yoga vs. Stretching for the Metabolic Syndrome (PRYSMS) randomized trial. *J Diabetes Complications* 2014; 28 : 406-12.
36. Hegde SV, Adhikari P, Shetty S, Manjrekar P, D'Souza V. Effect of community-based yoga intervention on oxidative stress and glycemic parameters in prediabetes: a randomized controlled trial. *Complement Ther Med* 2013; 21 : 571-6.
37. Sarvottam K, Magan D, Yadav RK, Mehta N, Mahapatra SC. Adiponectin, interleukin-6, and cardiovascular disease risk factors are modified by a short-term yoga-based lifestyle intervention in overweight and obese men. *J Altern Complement Med* 2013; 19 : 397-402.
38. Khatri D, Mathur KC, Gahlot S, Jain S, Agrawal RP. Effects of yoga and meditation on clinical and biochemical parameters of metabolic syndrome. *Diabetes Res Clin Pract* 2007; 78 : e9-10.
39. Seo DY, Lee S, Figueroa A, Kim HK, Baek YH, Kwak YS, et al. Yoga training improves metabolic parameters in obese boys. *Korean J Physiol Pharmacol* 2012; 16 : 175-80.