Intensive integrated yoga therapy on lipid profile, body composition, and insulin resistance among Type 2 diabetes mellitus

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Abstract

Background: Insulin resistance (IR) is a leading cause of the onset of Type 2 diabetes mellitus (T2DM) among overweight and obese individuals irrespective of their age. This study aimed at assessing the impact of 2 weeks of intensive integrated yoga therapy (IIYT) among overweight individuals diagnosed with T2DM identified with higher IR.

Methodology: The current single-group longitudinal pre–post study enrolled adults (n = 30) from a residential health-care center, Bengaluru (India), who were subjected to IIYT, comprising practices at physical, emotional, and intellectual levels incorporating *āsana* (postures), *prāṇāyāma* (breathing exercise), *kriyā* (internal cleansing technique), meditation, notional correction, counseling, yogic diet, and devotional sessions. Pre- and postoutcome measures were homeostatic model assessment for IR (HOMA-IR), fasting serum insulin, lipid profile, body composition, and anthropometric measurements.

Results: A significant reduction in HOMA-IR (35.69%, p < 0.001), fasting insulin (28%, p < 0.001), fasting glucose (12.3%, p = 0.039), triglycerides (15.43%, p = 0.003), very low-density lipoprotein (15.5%, p = 0.003), body mass index (2.4%, p < 0.001), weight (2.3%, p < 0.001), hip circumference (1.01%, p < 0.001), waist circumference (1.4%, p < 0.001), and body fat percentage (1.8%, p = 0.039) and a significant increase in lean mass percentage (0.95%, p = 0.045) and water percentage (0.99%, p = 0.04) were observed among the subjects.

Conclusion: Regular practice of IIYT regulates lipid and anthropometric measures and increases lean body mass, thereby managing IR, among overweight Type 2 diabetes. However, future works might confirm the findings of the present study.

Key Words: Body composition, insulin resistance, integrated intensive yoga therapy, Type 2 diabetes

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INTRODUCTION

People with higher body weight are prone to insulin resistance (IR), resulting in the early onset of Type 2 diabetes mellitus (T2DM),[1] which encompasses a broad range of pathology proceeding to elevated mean arterial pressure, dyslipidemia,[2] abdominal obesity,[3] glucose intolerance,[4] and inflammations[5] resulting in higher risk for cerebrovascular disease.[6] Incidence for IR-induced T2DM is reportedly high among Asians,[7] and two of the postulated causes among many identified etiologies are excess body fat and abdominal obesity.[8]

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As known, the pathogenesis of T2DM is related to glucose intolerance. Among individuals with normal glucose tolerance, the release of serum insulin from pancreatic β-cells in acute and sustained phases[9] is dependent on the quantity of ingested glucose, retaining the normal glucose tolerance.[10] Although, the way by which cells convert glucose to energy is associated with the secreted insulin from β-cells.[11] The resultant dynamic interaction between pancreatic insulin secretion and cellular insulin sensitivity is essential for normal glucose tolerance.[12] The inability of insulin to impart numerous actions in the cell in spite of impaired secretion from β-cell IR is seen much before hyperglycemia and the onset of associated metabolic abnormalities.[13] Apart from genetic markers that establish IR, several IR-related metabolic abnormalities can be aggravated by chronic overweight[14] in addition to physiological stress.[15]

According to published reports, T2DM is largely preventable and manageable through lifestyle modification,[16] involving diet,[17] exercise,[18] stress management,[19] and smoking cessation.[20] Lifestyle interventions are known to play an effective role than medications,[21] so patients can access to nonpharmacological interventions[22] such as physical activities,[23] diet modification,[24] and complementary and alternative medicine (CAM).[25] Yoga as a CAM[26] is found with enormous benefits in addressing IR among people with diabetes.[27] Hence, this study used an integrated approach of yoga comprising physical postures, breathing techniques, and meditation as an intervention in addressing IR and related factors such as body composition, anthropometric measures, and lipid profile, thereby managing T2DM. Studies focusing on IR in T2DM after a module of intensive integrated yoga therapy (IIYT) are lacking. Therefore, the present study was designed with a hypothesis that IIYT can reduce IR within a short span of 2 weeks among patients with T2DM.

METHODOLOGY

Subjects

All patients admitted to the diabetes wing of Arogyadhama, a residential integrative holistic health center based in Bengaluru (India), fitting into the inclusion criteria were recruited after screening by medical history, physical examination, and laboratory tests. Signed informed consent was sought before the assessments, and the study criteria included patients with T2DM of both genders in age range from 35 to 75 years, without any major complications such as unstable angina, proliferative retinopathy, and severe peripheral vascular disease. Those who practiced yoga regularly over the previous 3-month period were excluded.

Design

This was a single-group pre–post design, and all patients underwent 2 weeks of residential IIYT [Figure 1] by certified yoga therapists under the guidance of the chief yoga therapy consultant from a deemed-to-be-yoga university, Bengaluru. IIYT included special diet, physical postures (*āsanā),* breathing technique (*prāṇāyāma),* internal cleansing technique (*kriyā*), meditation, notional correction, and devotional sessions. Daily 2 physical posture sessions were conducted starting with yogic loosening practices (*sukṣma vyāyāmas*) and breathing exercises followed by easy postures gradually moving toward more dynamic ones. Maintenance in the final posture of *āsanās* was encouraged. The internal cleansing technique was practiced 2 days in a week on empty stomach in the morning. Lectures were conducted by a senior faculty at the yoga university, a dietician, and a clinician to explain the yogic concept of disease and health, modern biomedical understanding of diabetes, its pathophysiology, and modalities of management. All the patients had yogic counseling by psychologists trained in yoga, and the assessments were done on the 1st day before the intervention and on the 14th day. Daily vital parameters were monitored by the medical team of the health home.

Assessments

Homeostasis model assessment of insulin resistance

This is an indirect method used to quantify IR[28] derived by the formula (fasting insulin [mU/L] × fasting glucose [mg/dL]/405). Blood glucose and insulin were estimated on the venous blood in a certified laboratory.

Biochemical parameters (fasting blood glucose, postprandial blood glucose, lipid profile, and fasting insulin)

Three milliliters of fasting (12 h) and 1 ml of postprandial (2 h after breakfast) blood samples were collected from venous puncture, and sent to laboratory for biochemical analysis. Serum insulin was estimated by solid-phase radioimmunoassay with an intra- and inter-assay coefficient of variation of 2.2%–6.1% and specificity of 4 ng/ml. Total cholesterol (intra-assay coefficient of variation CV 0.8%, inter-assay CV 1.7%), triglycerides (intra-assay CV 1.5%, inter-assay CV 1.8%), and glucose (intra-assay CV 0.9%, inter-assay CV 1.8%) were measured using the enzymatic calorimetric method. HDL cholesterol (intra-assay CV 2.9%, inter-assay CV 3.6%) was measured using a homogenous calorimetric assay, whereas LDL cholesterol (intra-assay CV 0.9%, inter-assay CV 2.0%) was measured using a homogenous turbid metric assay.

Body composition

This measurement included body fat, lean body mass, and water percentage obtained by the body-fat analyzer (BF 905, Maltron, UK).[29] The recording was done using the standard method after the patient rested comfortably in a supine position with their legs and arms slightly apart. Four electrodes were applied on the right side of the body on the hand, wrist, foot, and ankle with a total duration of 5 min.

Anthropometric measurements

Body weight: This was measured with the patient wearing light clothes on a research grade (DI 20, Essae, India) electronic weighing scale (nearest error of 0.1 kg). Height: Standing height was measured using wall mounted stadiometer with a nearest of 0.1 cm. Waist circumference: The horizontal girth at the midpoint between costal margin and iliac crests was measured

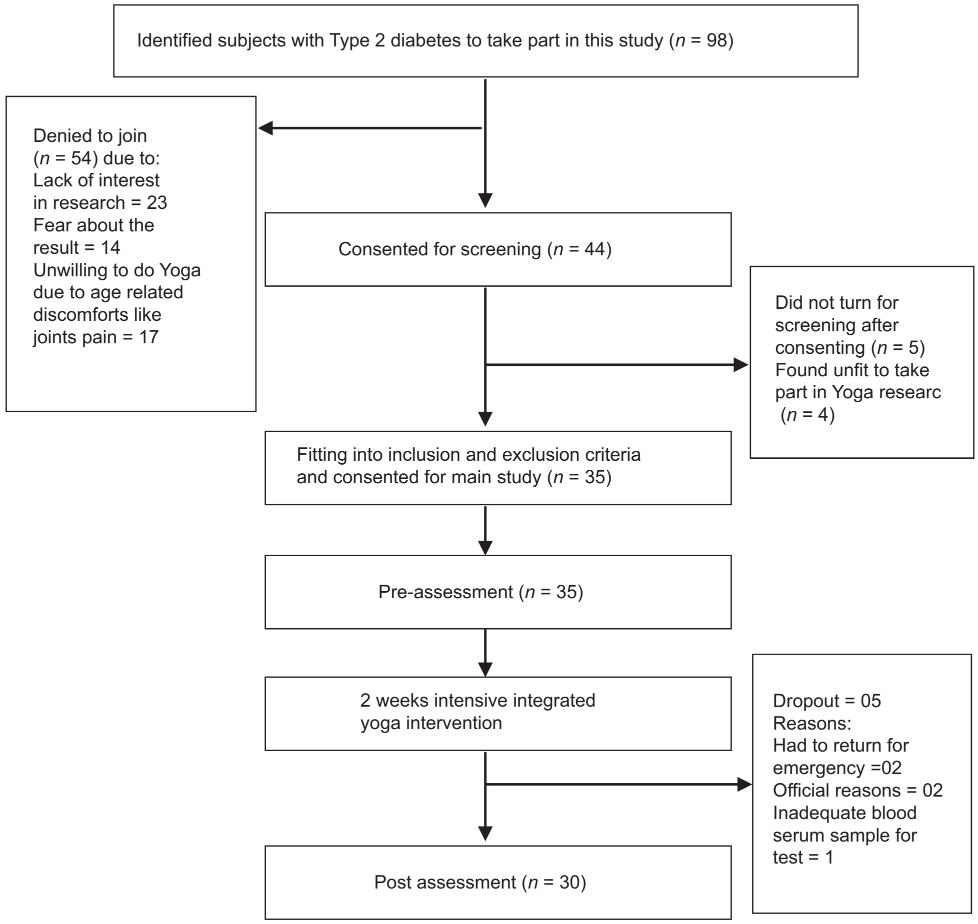

Figure 1: Study flowchart

with nonstretchable centimeter tape. Hip circumference: greatest horizontal circumference at the level of greater trochanters was measured using the same measuring tape.

Intervention

An integrated yoga therapy module [Table 1] was developed by a team consisting of a diabetologist, pathologist, physician, yoga therapist, and a philosopher with in-depth knowledge and experience of yoga. An integrated yoga program combines practices intended to act at physical, emotional, intellectual, and spiritual levels and includes diet, *āsanās*, *prāṇāyāma*, *kriyā*, meditation, notional correction, and devotional sessions.[30] This yoga module was derived from principles of ancient texts (Patanjali Yoga Sutras and Taittiriya Upanishad) and of traditional medicine involving a holistic healing approach.[31]

Ethics

This study was presented in the Research Departmental meeting and got approved by the Institutional Ethical Committee (RES/IEC-SVYASA/74/2019). Signed informed consent detailing about the nature and need of the study was obtained from all the participants before data collection. Ethical part was followed like drawing the blood and coding of data. Participants were given the freedom to quit the study at any point indicating the reason.

Data analysis

Data were analyzed by a statistician using the Statistical Package for the Social Sciences (SPSS, IBM SPSS Statistics, Chicago, IL, USA) version 23.0. Kolmogorov–Smirnov's test was used to check the normality of baseline data. Two related samples Wilcoxon's signed-rank *t*-test was used to check for pre–post changes as the data were not normally distributed.

RESULTS

Among the identified subjects with T2DM (N=98), close to one-half of them (n=44, 44.9%) consented to take part in this study. Among them, the majority (n=36) of them, who fitted into the inclusion-exclusion criteria got enrolled. The recruited subjects were with T2DM for a duration of 10.93 ± 7.90 years (ranging from 1 to 28 years). And, majority of them (n=30, 56.57 ± 9.19 years ranging from 36 to 71 years) [Table 2] completed the study. Furthermore, a few of them dropped themselves out (n=5) of the study, citing reasons like family emergencies (n=2) and office-related problems (n=2). Whereas, due to insufficient blood serum, one of the subject's sample was eliminated from tests and analysis [Figure 1].

Post-IIYT intervention and HOMA-IR showed a 35.7% reduction ($p < 0.001$) from mean ± standard deviation of

Table 1: Yoga module

Name of practices	Number of repetitions	Duration (min)
Starting prayer		1
Breathing practices		
Hands stretch breathing	180°-5 rounds 135°-5 rounds 90°-5 rounds	3
Hands in and out breathing	5 rounds	2
Tiger breathing	5 rounds	2
Loosening practices		
Jogging (slow, forward, backward, and sideward)		3
Twisting		1
Bending (forward, backward, and sideward)		1
Instant relaxation technique		2
Asanas		
Surya namaskara	3-5 rounds	10
QRT		3
Standing practices		
Ardhakati cakrásana	Alternate	2
Ardha cakrásana	1 round	1
Pāda hastāsana	1 round	1
Trikonāsana	Alternate	2
Sitting practices		
Ardhamatsyendrāsana	Alternate	2
Vajrāsana	1 round	1
Pashimottanāsana	1 round	1
Vakrāsana	Alternate	2
Supine practices		
Halāsana	1 round	1
Pavanamuktāsana	1 round	1
Naukāsana	1 round	1
Prone practices		
Dharnurāsan	1 round	1
Bhūjaṁgāsana	1 round	1
DRT		15
Closing prayer		1

QRT, Quick relaxation technique; DRT, Deep relaxation technique

3.10 ± 1.57–1.89 ± 1.10 with an effect size of 0.71. The fasting insulin showed a 28% reduction ($p < 0.001$) with an effect size of 0.76. The fasting blood glucose (FBS) showed a 12.3% decrease ($p = 0.039$) with effect size of 0.3, whereas postprandial blood glucose showed a 12.3% decrease ($p = 0.061$) with an effect size of 0.32. Moreover, there was a significant reduction in triglycerides ($p = 0.003$) and very low-density lipoprotein (VLDL) ($p = 0.003$) [Table 3].

Parameters like body mass index (BMI) were found with a reduction of 2.36% ($p < 0.001$, effect size: 1.28), body weight by 2.3% ($p < 0.001$, effect size: 1.19), waist circumference by 1.36% ($p < 0.001$, effect size: 1.07), hip circumference by 1.01% ($p < 0.001$, effect size: 0.89), and body fat percentage by 1.81% ($p = 0.039$, effect size: 0.39), while parameters like lean mass percentage increased by 3.76% ($p = 0.045$, effect size: 0.37) and water percentage increased by 1% [$p = 0.045$, effect size: 0.38, Table 4].

DISCUSSION

This study resulted in manifesting positive impact of intensive integrated yoga practice for 2 weeks was effective in managing HOMA-IR, fasting insulin, FBS, triglycerides, VLDL, weight, BMI, hip/waist circumference, and body fat percentage with increased lean body mass among the patients, rejecting the null hypothesis. The study found a reduction by 2.3% in weight and 2.4% in BMI within 2 weeks of IIYT, which is in line with a previous report. For example, Telles *et al.*[32] reported a decrease by 1.6% in obese nondiabetic subjects in a residential interventional approach conducted for 6 days. Furthermore, Gram's study showed varying degrees of reduction in weight of approximately 10% among people with Type 2 diabetes with lifestyle intervention.[33]

However, an increase in weight by 1.2% noted by Malhotra *et al.*[42] was an unusual observation. Vaishali *et al.*[31] reported that yoga-based programs were associated with a 3.5%–8.2% reduction in body weight.[34] These differences may be attributed to several factors such as differences in design, lack of strict monitoring over the diet as most of them were outpatient studies, and/or the type of yoga module used.

It is known that body composition, which includes percentage of fat, lean mass, and total body water, is a simple measure that has a high correlation with blood glucose, HbA1c, and cholesterol.[35] Furthermore, visceral and central abdominal fat is strongly associated with impaired glucose tolerance,

Table 2: Demographic data

Details (n=30)	n (%)
Females	11 (37)
Males	19 (63)
Age (years)	
Mean	56.57±9.19
Range	36-71
Education	
Postgraduate	4 (13.3)
Graduate	19 (63.4)
<12th	7 (23.3)
Occupation	
Retired	7 (23.3)
Business/employee in private company	16 (53.4)
Housewife	7 (23.3)
Duration of illness (years), mean (range)	10.93±7.90 (1-28)
Below 1	0
1-5	8 (27)
5-10	8 (27)
Above 10	14 (46)
BMI (kg/m^2)	
Below (18.5)	0
Normal (18.5-24.9)	9 (30)
Overweight (25.0-29.9)	14 (47)
Obese (>30)	7 (23)
Associated conditions	
Hypertension	20 (66.6)
Hyperlipidemia	10 (33.4)
Medication	
Oral hypoglycemic drugs	20 (66.6)
Insulin (subcutaneous injection)	10 (33.4)
Family history of T2DM	17 (57)

BMI, Body mass index; T2DM, Type 2 diabetes mellitus

IR, and T2DM. This study showed a 1.36% decrease in waist circumference, which was lesser than that (3.89%) observed by Telles *et al.*,[32] among obese subjects in an inpatient yoga program daily in north India similar to our setup. It is interesting to note that the study reported a higher reduction in WC than our study, as the body fat percentage had increased by 1.66% while we observed a reduction in body fat by 1.8%. Our result is similar to Gastaldelli *et al.*'s study[36] that observed a reduction in body fat by 1%. An increase in lean body mass with a decrease in fat percentage and BMI[37] is the favorable change that indicates improved muscle mass and muscle/fat ratio,[38] and our study recorded a similar pattern. Earlier studies on yoga have documented a reduction in lean body mass: 10.9% by Malhotra *et al.*,[42] and 4.4% by Telles *et al.*,[32] in nondiabetic obese volunteers,[32] and the differences might have been attributed to the module of yoga practices and the diet provided during the experiment.

Our study found a significant reduction in HOMA IR by 35.7%, fasting insulin by 28%, and glucose by 12.3%. These values are much higher than that observed after metformin intake. which showed a reduction in IR by 26.8% when it was combined with a 6-month multidisciplinary lifestyle intervention among obese adolescents[39] or in physically inactive healthy subjects after moderate doses (500 mg/3 times/day) for 1 week that showed a reduction in IR by 25%.[40] Thus, it appears that IIYT is better than metformin alone or in combination with conventional multidisciplinary lifestyle modification. Our study is supported by earlier observations on IR using insulin clamp study,[41] which was a gold standard to measure IR, in healthy volunteers with long-term yoga practice (≥1 year) with significantly better insulin sensitivity than control group.

Malhotra *et al.*[42] reported the effect of *yogāsanās* with emphasis on maintenance in *āsanā*s found a rise in plasma insulin levels unlike our and other studies and suggested that yogic postures *(āsanās)* may release stored insulin or free the bound insulin from the pancreas when abdomen pressure is applied and the study reported a significant reduction in fasting glucose by 12.3%, which coincides with our study and also a previous study by Amita *et al.*[43] These evidences proclaim the effects of yoga in reducing blood glucose levels ranging from 10% to 35% depending on the type and duration of the practices which is remarkable. This may pave the way to prepare structured recommendations for the use of different types of yoga in different stages of T2DM.

Mechanism

Exhibiting a significant decrease in IR, this study implies that IIYT has the potential to increase cell wall sensitivity to insulin and hence redress the basic T2DM pathology.[44] A previous study on yoga has shown a decrease in inflammatory responses to stressful encounters that influence the burden that stressors place on an individual.[45] Yoga has shown improvement in adiponectin level and metabolic syndrome risk in obese postmenopausal women.[46] Further, weight reduction by lifestyle intervention was associated with improvements in blood inflammatory markers in obese children and adolescents.[47] These facts point to the holistic approach of yoga as effective enough in correcting the problems at several levels to restore metabolic and glycemic homeostasis.[48]

IIYT is a lifestyle management program that includes various activities such as included yogic diet, *āsanās*, *prāṇāyāma*, relaxation techniques, *kriyā*, meditation, yogic counseling, devotional sessions for emotion culturing, and lectures. This module has proven effective to reduce stress in a previous study.[49] Similar observation is made in this study which could be due to improved pancreatic beta-cell function, skeletal muscle cell receptor's sensitivity to glucose signal through reduced IR. Furthermore, the reversibility model of yoga proposes that resting is needed to the body and mind to enhance mindfulness[50] that could lead to restoration of homeostasis by balancing the HPA axis and psychoneuroimmunological[51] and oxidative stress[52] pathways. This study provided evidence to the efficacy of intensive yoga in managing the two basic abnormalities among T2DM, which are IR and body composition within a short period of 2 weeks. Future RCTs on larger sample may be conducted including other variables such as cytokines and free radical assessments to understand the mechanism of such intensive yoga programs should be conducted to strengthen the findings. However, in addition to low sample size and short intervention period, one of the major limitations of this study is not having a control group and a weak design. Therefore, the authors of this study would suggest future studies to have stringer study designs like randomized control trials.

Table 3: Changes in biochemical and clinical variables after yoga

Variable	Mean±SD	95% CI		ES	Percentage change	*p*
		LB	UB			
HOMA-IR						
Pre	3.10±1.57	2.51	3.69	0.71	35.69	<0.001
Post	1.86±1.10	1.59	2.40			
FI						
Pre	10.85±5.50	8.79	12.90	0.76	28.00	<0.001
Post	7.81±4.24	6.23	9.39			
FBS						
Pre	120.53±40.65	105.36	135.71	0.3	12.28	0.039
Post	105.73±31.88	93.83	117.64			
PPBS						
Pre	193.90±72.17	166.95	220.85	0.32	11.57	0.061
Post	171.47±47.45	153.47	189.18			
Tri						
Pre	150.17±37.77	136.06	164.27	0.6	15.43	0.003
Post	127±21.64	118.92	135.08			
TC						
Pre	175.83±30.88	164.30	187.36	0.23	4.13	0.072
Post	168.57±32.89	156.29	180.85			
HDL						
Pre	42.37±2.98	41.26	43.48	0.04	0.31	0.848
Post	42.23±2.66	41.23	43.24			
LDL						
Pre	103.43±27.91	93.01	113.86	0.09	2.42	0.393
Post	100.93±31.42	89.20	112.67			
VLDL						
Pre	30.03±7.55	27.21	32.85	0.61	15.54	0.003
Post	25.37±4.40	23.72	27.01			

Unit of measurement of parameters other than FI and HOMA-IR is mg/dL. HOMA-IR, Homeostatic model assessment for IR; IR, Insulin resistance; FI, Fasting insulin; FBS, Fasting blood glucose; PPBS, Postprandial blood glucose; SD, Standard deviation; CI, Confidence interval; LB, Lower bound; UB, Upper bound; ES, Effect size; Tri, Triglyceride; TC, Total cholesterol; HDL, High-density lipoprotein; LDL, Low-density lipoprotein; VLDL, Very low density lipoprotein

Table 4: Body composition

Variable	Mean±SD	95% CI		ES	Percentage change	*p*
		LB	UB			
Weight (kg)						
Pre	71.72±15.13	66.07	77.37	1.19	2.30	<0.001
Post	70.07±14.24	64.75	75.39			
BMI (kg/m^2)						
Pre	27.66±5.41	25.64	29.68	1.28	2.36	<0.001
Post	27.01±5.11	25.10	28.92			
HC (cm)						
Pre	103.13±13.46	98.098	108.15	0.89	1.01	<0.001
Post	102.09±13.37	97.094	107.08			
WC (cm)						
Pre	93.40±11.71	89.029	97.78	1.07	1.36	<0.001
Post	92.13±11.61	87.798	96.47			
BFP (%)						
Pre	36.01±7.30	33.28	38.74	0.39	1.81	0.039
Post	35.36±7.17	32.68	38.04			
LMP (%)						
Pre	63.98±7.29	61.26	66.71	0.37	0.95	0.045
Post	64.60±7.164	61.92	97.27			
WCP (%)						
Pre	46.84±5.34	44.83	48.83	0.38	0.996	0.045
Post	47.30±5.24	45.34	49.26			

BFP, Body fat percentage; LMP, Lean body mass in percentage; WCP, Water content percentage; HC, Hip circumference; WC, Waist circumference; BMI, Body mass index; LB, Lower bound; UB, Upper bound; SD, Standard deviation; CI, Confidence interval; ES, Effect size

CONCLUSION

This study on T2DM conducted among people with IR showed the potential role of IIYT on two basic abnormalities among T2DM, which are IR and body composition. Therefore, we postulate that IIYT can serve as a cost-effective complementary and alternative therapy for the management of T2DM and can help reduce the requirement of oral hypoglycemic agents or insulin by improving glucose tolerance.

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Conflicts of interest

There are no conflicts of interest.

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