RESEARCH LETTER

Research Letter—The Role of Yoga as a Lifestyle Modification in Treatment of Diabetes Mellitus: Results of a Pilot Study

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Exercise is a major therapeutic method for the treatment of diabetes mellitus (DM). Regular physical exercise has been reported to be effective for the prevention and delay of the onset of type 2 diabetes; it increases insulin sensitivity and ameliorates glucose metabolism.[1]

Yoga has become increasingly popular in Western cultures as a means to enhance fitness. A growing body of research has shown that yoga can improve metabolic rate, which can improve overall exercise capacity.[2] The long-term practice of yoga leads to lower metabolic rates,[3] lower levels of the stress hormone cortisol,[4] changes in the activity of the autonomous nervous system,[5] and increases in insulin secretion.[6] Yoga is beneficial in conditions associated with diabetes, namely hypertension and obesity. The exact mechanism as to how postures and controlled breathing interact with the somato-neuro-endocrine mechanism that affects metabolic functions remains to be worked out. Researchers have concluded that yoga may be considered to be a beneficial adjuvant for non-insulin-dependent diabetic patients.

In a feasibility study, the authors had wanted to explore the effect of a yoga-based intervention on glucose control to determine the sustainability of the use of yoga for patients with diabetes. Data from the pilot was needed to calculate sample sizes for a randomized, controlled trial (RCT).

Methods

Participants

The author's cohort study was performed at Bhagat Hospital in Janakpuri, Delhi, India, to quantify the effect of a yoga-based intervention. The study was approved by the hospital's ethics committee.

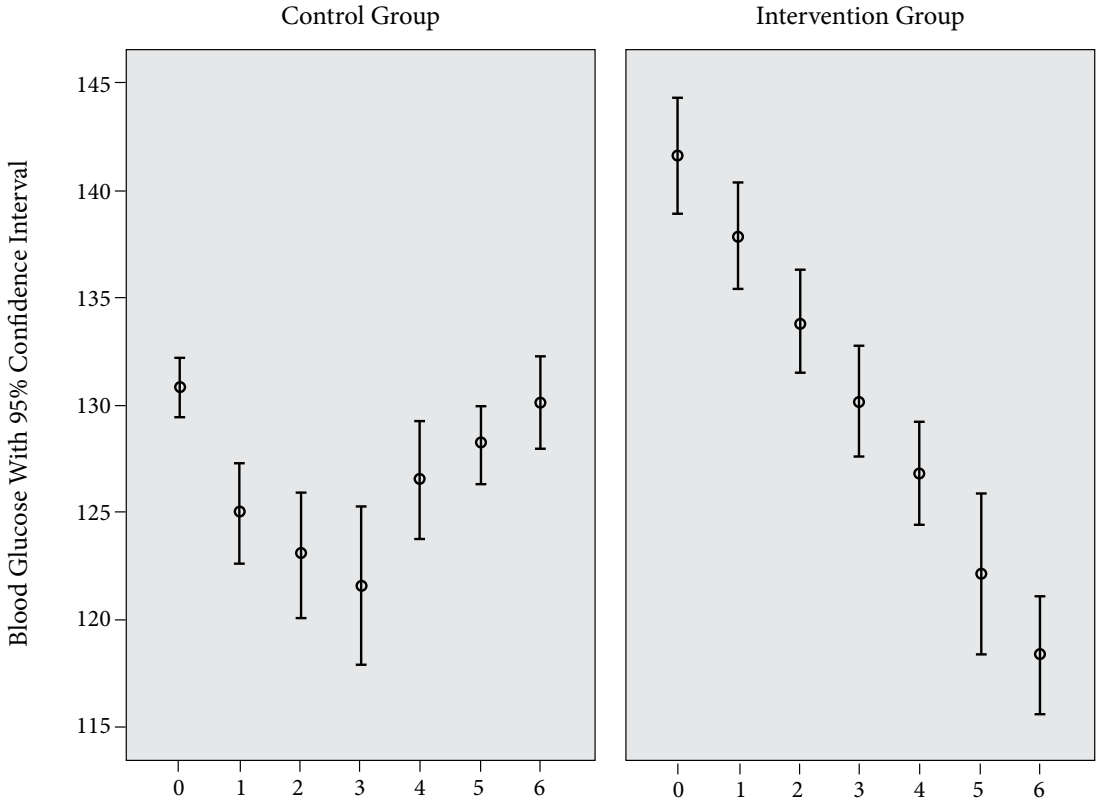
A pragmatic, 6-month sample of patients aged 30 to 60 years with a diagnosis of type 2 diabetes were invited to take part in yoga classes to improve diabetes control. The patients had no previous experience with yoga but fulfilled the diagnostic criteria for DM according to the National Diabetes Data group and the World Health Organization (WHO).[7] Patients were recruited from the same geographic location and social groups but other forms of bias were not systematically excluded.

Patients were excluded from the pilot if they (1) were already on oral hypoglycemic drugs or on insulin; (2) had alcohol-dependency syndrome; (3) had blood-glucose levels of more than 300 mg/dL; and (4) had end-organ damage such as retinal detachment, nephropathy, and peripheral neuropathy.

Intervention

The patients in the intervention group were enrolled in a program at the Central Council for Research in Yoga and Naturopathy in Janakpuri, Delhi, India, under the supervision of Dr B. T. Chidananda Murthy. Patients participated in a program with a qualified yoga trainer who used yoga asanas tailored to their diagnoses. The program lasted for 1 hour daily, 5 days per week, for the duration of 1 month. At the end of the month, the patients began following the yoga exercises independently.

Figure 1. Fasting Glucose[a] in the Control Group and Intervention Group for the Duration of the 6-Month Study



[a]Unit of measure = mg/dL; mean, confidence interval.

The elements of the yoga program included (1) *kapalabathi* breathing, (2) sun salutation (*surya namaskar*), (3) cobra pose (*bhujangasana*), (4) locust pose (*shalabhasana*), (5) seated-forward bend (*paschimottasana*), (6) tree pose (*tadasana*), (7) triangle pose (*trikonasana*), (8) *pavan muktasana*, (9) *matsyasana*, (10) *halasana*, (11) *naukasana*, (12) *mandukasana*, and (13) *mayurasana*.

The control group consisted of 50 patients fulfilling the inclusion and exclusion criteria above who did not agree to participate in the yoga program. Both groups were followed up monthly for 12 months in a routine outpatient program for patients with diabetes.

Outcome Measures

The primary outcome measure was fasting glucose (FBS), which was collected monthly. Postprandial glucose (PBS) and glycated hemoglobin (HbA_{1c}) were tested 3 times monthly.

Statistical Analysis

Data were collected prospectively. The Software Program for Social Sciences, version 21.0 (SPSS, IBM Corporation, Armonk, NY, USA) was used for statistical evaluation. $P<.05$ was regarded as statistically significant.

RESULTS

During the study, which took place from July 1, 2007, to December 30, 2007, 130 patients were recruited, of which 80 agreed to the study's intervention. Of those 80 patients, 36 (45%) were female. Of the 50 patients who were followed up as controls, 25 (50%) were female. The mean age of participants was 43.9 years (SD = 5) in the intervention group and 42.0 years (SD = 5) in the control group.

Groups were not evenly matched for fasting blood glucose at baseline. The intervention group had higher levels on entry into the program (difference, $P < .001$). Glucose levels in the intervention group improved after the first quarter and continued to improve more over the duration of the intervention ($P<.001$).

In that group, the mean value of FBS at baseline was 142 (SD = 12), which decreased gradually to 138 (SD = 11) at the end of the first month, 134 (SD = 11) at the end of the second month, 130 (SD = 12) at the end of the third month, 127 (SD = 11) at the end of the fourth month, 122 (SD = 17) at the end of fifth month, and 118 (SD = 12) at the end of the last month (Figure 1). In the control group, no such trend was observed.

For the intervention group, results were similar for postprandial glucose. Values improved from a baseline value of 214 (SD = 19) to a value at the end of the study of 179

(SD = 19) ($P < .001$) and for HbA_{1c}, for which values improved from a baseline value of 7.6% (SD = 0.4) to to a value at the end of the study of 6.3% (SD = 0.6) ($P < .001$). No statistically significant changes occurred in the control group. The postprandial glucose at baseline for the control group was 208 (SD = 5), which dropped to 195 (SD = 16) at the end of the third month, but at the end of 6 months remained unchanged at 204 (SD = 12) ($P > .001$). A similar trend for HbA_{1c} was also noted for this group. Baseline HbA_{1c} was 7.3% (SD = 0.3), which dropped to 6.9% (SD = 0.5) at the end of the third month but rose again at the end of 6 months to 7.2% (SD = 0.5) ($P > .001$).

DISCUSSION

The authors' pilot study showed that regular yoga can improve blood glucose control in patients with DM. Effects were visible after only 1 month and were sustained for the majority of participants during a 6-month period. Compliance was at least as good as that reported in trials of oral hypoglycemic drugs.[6] In the control group, no improvement was observed, making a Hawthorne effect unlikely to explain the success of the program; however, bias in the results cannot be excluded because of the pragmatic use of routine data in a study without external funding. This issue could include potential bias from differences in motivation and level of education for the intervention and control groups. Also, the intervention group had higher blood glucose levels at the start of the study. This finding could be caused by the absence of drug treatment in that group or by selection bias.

To the authors' knowledge, the effects of yoga on glucose control have not been investigated to date for longer periods or in large cohorts. Malhotra et al[8] showed a reduction in fasting glucose levels in a smaller uncontrolled study lasting 40 days. Baseline levels of fasting glucose in that study were higher, but the reduction in glucose levels was again approximately 30 mg/dL. Gordon et al[9] found improved glucose control, with evidence that this result may be related to alterations in oxidative stress.

The mechanism by which yoga might improve glycemic control was beyond the scope of the pilot study. Possible mechanisms could include a change in metabolic rate and neuro-endocrine mechanisms. Alternatively, participation in the program may have affected body composition, appetite, nutrition, attitude to exercise, self-control, or lifestyle in other areas. Although all of these changes would be desired effects, an understanding of the mechanisms would be useful to optimize the effect of the intervention for clinical trials.

The low price of the current intervention and the lack of adverse effects make yoga a potentially attractive alternative to an oral hypoglycemic drug for patients with only mildly to moderately raised glucose levels. It is less clear whether the observed effect depended on the familiarity of the study's population with yoga and its underlying philosophy.

The use of a contemporaneous control group and the excellent compliance adds to the impression that the observed effect of yoga was significant and likely to be translatable to improved glucose control for patients in a larger multicenter study or even in patients' daily lives.

AUTHOR DISCLOSURE STATEMENT

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