

## Review

# A Review of Yoga Programs for Four Leading Risk Factors of Chronic Diseases

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Yoga, a form of physical activity, is rapidly gaining in popularity and has many health benefits. Yet healthcare providers have been slow to recognize yoga for its ability to improve health conditions, and few interventions have been developed that take full advantage of its benefits. The purpose of this article is to review published studies using yoga programs and to determine the effect of yoga interventions on common risk factors of chronic diseases (overweight, hypertension, high glucose level and high cholesterol). A systematic search yielded 32 articles published between 1980 and April 2007. The studies found that yoga interventions are generally effective in reducing body weight, blood pressure, glucose level and high cholesterol, but only a few studies examined long-term adherence. Additionally, not enough studies included diverse populations at high risk for diabetes and its related common health problems.

**Keywords:** yoga – chronic disease – risk factors – overweight – hypertension – glucose – cholesterol

Chronic diseases such as heart disease, stroke and diabetes are leading causes of death in the US (1). Common conditions for these chronic diseases are overweight, high blood pressure (BP), high glucose and high cholesterol. These conditions are commonly associated with each other. According to a prospective cohort study focusing on men (2), there were positive relationships between body mass index (BMI) and hypertension incidence. Men with a higher BMI have a higher likelihood to have diabetes and high cholesterol. Another study with men and women showed that overweight is linked to type 2 diabetes (3). Even among patients newly diagnosed with type 2 diabetes, the Hypertension in Diabetes Study found that ~40% had hypertension, and that hypertension considerably increased mortality in people with type 2 diabetes (4). Another recent study found a 79% rate of hypertension in patients who had received outpatient care for type 2 diabetes for at least 2 years (5). Individuals with impaired glucose tolerance also are more likely to have risk factors for

cardiovascular disease such as elevated levels of triglycerides and low-density lipoprotein (LDL) and low levels of high-density lipoprotein (HDL) (6).

Promising in this regard is appropriate physical activity because it can reduce body weight, BP, glucose level and cholesterol (7,8). Yoga, a form of physical activity consisting of various postures (Asana) and breathing and meditation techniques (Pranayama) (9), has been shown to have therapeutic benefits for individuals with a wide range of health conditions, including hypertension (10) and diabetes (11). Yoga also appears to be effective in reducing stress (12) and improving exercise tolerance as it is related to cardiovascular response (13).

The number of people practicing yoga in the US increased significantly between 1997 and 2002 (14). According to the 2002 National Health Interview Survey (14), 5% of American adults practiced yoga in the month previous to the study. Yoga also is well received as a therapeutic intervention; for example, participants in a yoga intervention for insomnia found that it was easily learned and performed (15). Despite its popularity and positive physiologic effects, however, yoga has not been widely recognized in efforts to prevent and treat major chronic health conditions. The purpose of this article is to

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review published studies using yoga practice to determine the effects of yoga on common health problems, such as overweight, hypertension, high glucose level and high cholesterol.

## Methods

Articles were retrieved from electronic databases (CINAHL, Ovid MEDLINE and PsychInfo) using *yoga* as a keyword. This initial retrieval, performed in April 2007, yielded 2349 articles, of which 861 have been published since 1980. A search within those 861 articles, using the keywords *overweight*, *blood pressure*, *glucose* and *cholesterol*, identified 56 research articles. After the author had read the full text of the 56 articles and identified those that met the purpose of the study, 24 articles were excluded, mainly because they described outcome variables and characteristics of yoga that were irrelevant. Poor quality was not a reason for exclusion, but studies were excluded if they focused only on meditation or relaxation (Pranayama) or if they were case studies. This process resulted in a final total of 32 articles to be reviewed.

The review comprised studies involving yoga interventions and using an experimental or quasi-experimental design. In addition, observational studies were included because they often supply important information beyond the results of clinical trials (16). Studies that used yoga as a control, not as an intervention, were included as long as they provided evidence of the effectiveness of yoga on variables of interest (overweight, BP, glucose and cholesterol).

## Findings

Of the 32 articles reviewed, 12 described experimental studies, 18 described quasi-experimental studies and two described observational studies. Only 2 of the 12 true experimental studies (17,18) described the randomization method. Even though risk factors for chronic health conditions were used as keywords in the search strategy, many of the studies used healthy adult samples; only half of the 32 studies actually focused on subjects with diabetes (19–23), hypertension (10,11,18,24–27), or cardiovascular disease (28–31). Seven of the studies were conducted in the US; the others, in India and other countries.

## Content of Yoga Programs

Other than duration and frequency, most articles did not describe the yoga sessions in detail. Only a few articles (17,20,22,31,32) provided details of the yoga sequences used. Some listed the names of postures and breathing techniques. Of the few articles that identified the type of yoga studied, the most common was Hatha yoga, a popular form of yoga in the Western world.

The Compendium of Physical Activities, (33) a coding scheme that classifies physical activity based on energy expenditure, does not define energy expenditure while performing various types of yoga. However, Hatha yoga is classified as a conditioning exercise, in the same category as stretching, which has a metabolic equivalent (MET) of 2.5 (1 MET equals the amount of energy used for resting). A recent study (34) found that when young adult women (19 to 40-years old) performed a 30-min session of Hatha yoga, the MET was 2.17. However, if the session was made more active using Sun Salutations, a flowing series of physical postures, the MET increased to 3.74 (SD = 0.70).

## Frequency and Duration of Yoga Sessions

The total dose of yoga training, which depends on both the duration and frequency of yoga sessions, also needs to be considered in evaluating and comparing yoga studies. The most common duration and frequency of yoga sessions in the studies were 30–60 min per session and sessions meeting daily for 4–10 weeks, but many studies used sessions meeting 2–3 times per week for 8–12 weeks. Some yoga programs met more frequently than others but for a shorter time span. For example, in a study by Damodaran *et al.* (24), persons with essential hypertension received 1 h of yoga training daily for 3 months, which is counted as 84 h of training, whereas Ray *et al.* (32) studied healthy young adults who received 1 h of yoga training three times a week for 10 months, for a total of 120 h.

Some findings can be useful in trying to determine effective durations of yoga sessions. For example, in one study, 1 h daily yoga practice was associated with significant reductions in body weight and cholesterol levels after 4 weeks, and those significant effects lasted for 14 weeks (28). In a study of 20 patients with essential hypertension, daily 30-min sessions of yoga led to a decrease in BP by the fifth day (27).

## Adherence to the Yoga Program

Any persistent benefits from yoga would rely on long-term adherence, which was examined in only a few of the reviewed studies. In some studies, after yoga training, subjects were asked to continue their programs with daily home practice (28,35). One of these (35) compared adherence to yoga practice after a 10-week yoga intervention between white and black American adults (mean age: 69 years for whites and 70 years for blacks). Although the dropout rate did not differ significantly (16% for whites, 22% for blacks), the black participants did not engage in yoga at home as frequently as whites. A different study (36) found greater compliance with subsequent home practice among participants in a yoga class that met three times per week than in those who attended a weekly yoga class (86% versus 65%,  $P < 0.05$ ). However, found no

difference in compliance with home practice between groups engaged in yoga or aerobic exercise (36).

### Weight Decreased

According to a retrospective observational study of 15,550 adults aged 53–57 years (37), regular yoga practice for 4 or more years was significantly associated with weight loss by overweight participants. Several intervention studies (10,26,29,31,38–41) also showed that yoga practice was effective in reducing body weight. After 4-day residential yoga practice followed by 14 weeks of 1 h daily home practice, one study (28) found a significant loss in mean body weight from 72.26 to 70.48 kg among subjects with risk factors for coronary artery disease (CAD). Other studies found that yoga was associated with significant weight loss by subjects with CAD (29–31) and subjects without CAD (30). Manchanda *et al.* (29) showed a 7% loss of body weight among adult men with CAD after 1 year of yoga practice, and in a study by Schmidt and colleagues, healthy adults lost an average of 5.7 kg after 3 months of yoga practice (39). All overweight adults studied by Yogendra *et al.* reached a normal weight within 1 year after initiating yoga-based lifestyle modifications (31). However, this article did not show the effect size of this change.

### Blood Glucose Level Lowered

Of the six studies that examined blood glucose, all found that yoga was effective in reducing blood glucose level (11,19–22,31). For example, after 4 months of yoga practice, fasting glucose fell significantly (from 144 to 119 mg dl<sup>-1</sup>,  $P < 0.005$ ) in a group of adults with type 2 diabetes, (19). Another sample of 24 adults with type 2 diabetes had significantly decreased fasting glucose (from 190.1 to 141.5 mg dl<sup>-1</sup>,  $P < 0.001$ ) after 40 consecutive days of yoga practice, (20). Adults with normal blood glucose levels (11) also had significantly lower glucose levels after 3–4 h of yoga practice for 8 days ( $P < 0.001$ ).

### BP Decreased

This review found ample evidence that yoga was effective in reducing BP. In a group of low-income elderly people, effects on systolic BP did not differ between a yoga class and an aerobic exercise class, both held three times a week for 10 weeks (36). However, eight other studies found that yoga practice was effective in lowering BP in healthy samples, regardless of the type of yoga (13,32,38–44). Yoga practice also significantly improved BP among people with hypertension (10,11,18,24–27), cardiovascular disease (28–31) or type 2 diabetes (19–23). For example, in 13 patients, aged 41–60 years, with essential hypertension (25), BP dropped significantly during the third week of a 4-week yoga program (1 h per day, 6 days per week), and it fell further after the program. For example, systolic BP

dropped from 141.7 to 127.9 mmHg by the third week and to 120.7 mmHg by the fourth week.

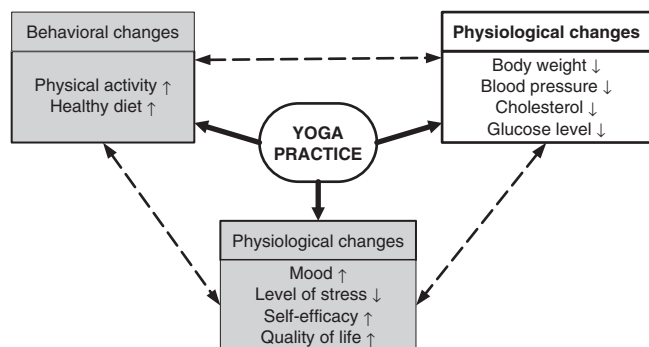
### Cholesterol Level Improved

The practice of yoga was associated with significant decreases in cholesterol among subjects with cardiovascular disease (28,29), hypertension (11) or type 2 diabetes (19). One study (28) examined a regimen involving 4 days of a yoga program at a residential course, followed by 1 year of yoga practice at home. In both men with angina and asymptomatic participants with CAD risk factors, all lipid variables except HDL decreased beginning the fourth week of yoga practice (e.g. total cholesterol fell from 206.6 to 193.6 mg dl<sup>-1</sup>), and the level of total cholesterol continued falling to 176.06 mg dl<sup>-1</sup> at 14 weeks. A study of subjects at risk for cardiovascular disease and diabetes (11) found significant improvements ( $P < 0.01$ ) in total cholesterol, triglycerides, LDL, HDL and very-LDL (VLDL, defined as total cholesterol minus LDL minus HDL) after short-term intensive yoga practice (3–4 h per day for 8 days). Notably, for subjects whose baseline total cholesterol was 200 mg dl<sup>-1</sup> or higher, the reduction in triglycerides (from 151.5 ± 48.9 to 132.7 ± 50.5 mg dl<sup>-1</sup>,  $P < 0.001$ ) and VLDL (from 36.7 ± 13.8 to 30.2 ± 14.6 mg dl<sup>-1</sup>,  $P < 0.001$ ) was significantly greater than in subjects with lower baseline total cholesterol (triglycerides falling from 113.6 ± 46.5 to 110.5 ± 38.1 mg dl<sup>-1</sup>,  $P > 0.05$ ; VLDL from 23.7 ± 12.8 to 23.2 ± 12.5 mg dl<sup>-1</sup>,  $P > 0.05$ ). Finally, a study of healthy adults over 40 years old found that 5 years of yoga practice reduced age-related deterioration in cardiovascular functions (45). Although the article describing this observational study did not detail the type of yoga performed nor the frequency or intensity of the yoga sessions, the data showed a long-term change indicating the effectiveness of yoga on cardiovascular functioning.

Four studies used aerobic training as an intervention and yoga as a control (38,43,46,47). One of these, a study of healthy active people aged 65 years or older (38), found that aerobic exercise produced no significant reduction in weight or BP, whereas 4 weeks of yoga practice did lead to some reduction in weight or BP (for example, systolic BP decreased from 146 to 139 mmHg). DiPietro *et al.* (47) found no change in glucose and insulin responses in their yoga control group. However, the yoga control group was monitored to ensure that pulse rates did not exceed 90 beats per min during yoga practice (47). Therefore, this restriction should be considered in interpreting this result.

### Discussion

The reviews showed that yoga had beneficial effects on body weight, BP, blood glucose level and cholesterol level (Fig. 1). Nonetheless, several shortcomings in research on



**Figure 1.** The possible effects of yoga on behavioral, psychological and physiological measures are illustrated. This article focuses on current evidences for physiological changes.

this topic need to be addressed, in order for clinical programs to capitalize on these health benefits.

Of the articles describing interventions, only a few provided details regarding the yoga programs or the names and sequence of yoga postures. Asana and Pranayama provide different types of health benefits, and therapeutic yoga programs can involve various combinations of these two components. An optimal comparison of study results thus requires knowing the combination of Asana and Pranayama used. The sequence of yoga postures can be inferred from the list of posture names, but more straightforward information is essential to future studies seeking to replicate or generalize the results. A related issue that remains to be resolved is how to standardize yoga exercises for research purposes.

The optimal duration and intensity required to maximize the effectiveness of yoga need to be determined, as does the need for a booster to provide long-term effects. Because the MET of yoga is low, increasing the frequency may increase the benefits. However, these factors cannot be judged from the reviews studies; many articles did not clearly identify the dosage of the yoga program studied, and they focused on the short-term health benefits of yoga. Only a few studies included follow-up data beyond 6 months. It also remains to be determined whether more intensive training, that is, a greater dosage, improves the likelihood of adopting and maintaining active behavior in the long run.

The samples in the reviewed studies pose additional dilemmas. It was not a surprise that a large portion of the studies were conducted in India, where the philosophy and practice of yoga originated. However, this focus on one geographical region, where yoga is particularly ingrained in the culture, limits the generalizability of results. Few studies have addressed variables of interest specific to minorities in the US (Blacks, Hispanics and Asians), which are populations believed to be more vulnerable to type 2 diabetes (48,49) and physical inactivity (8).

Yoga has beneficial effects on various health conditions. A large portion of the reviewed studies analyzed the

effects of yoga with healthy samples. There is evidence that yoga practice was more effective in lowering triglycerides among people with higher cholesterol than those with a lower cholesterol level (11). Therefore, it is important to consider participants' health conditions because there are possible differences in the effects of yoga by their health severity.

## Conclusions

Analyses of yoga intervention should be designed and conducted to identify programs best suited for diverse populations and for specific populations with high-risk factors for chronic health conditions. Such studies could guide the development of more practical and effective interventions.

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