

# EVALUATION OF THE EFFECT OF YOGA POSTURES ON BLOOD PRESS

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## Abstract

**Introduction:** Yoga appears to exert its effect against high blood pressure primarily through the associated breathing and meditation techniques.

**Objective:** To compare the blood pressure lowering effect of yoga interventions with and without yoga postures in patients with arterial hypertension.

**Methods:** 75 patients taking medication for arterial hypertension (72 % women, mean age  $58.7 \pm 9.5$  years) were randomized into three groups.

**Results:** 24-hour systolic blood pressure was significantly lower in the control group (group difference =  $-3.8$  mmHg).

**Conclusions:** Yoga is safe and effective for patients taking high blood pressure medication.

**Keywords:** yoga, arterial hypertension, intervention, physical exercise, meditation. Source: DeCS.

## Resumen

**Introducción:** El yoga parece ejercer su efecto contra la hipertensión arterial principalmente a través de las técnicas de respiración y meditación asociadas.

**Objetivo:** comparar el efecto reductor de la presión arterial de las intervenciones de yoga con y sin posturas de yoga en pacientes con hipertensión arterial.

**Métodos:** 75 pacientes que tomaban medicamentos para la hipertensión arterial (72 % mujeres, edad media  $58,7 \pm 9,5$  años) fueron aleatorizados en tres grupos.

**Resultados:** la presión arterial sistólica de 24 horas fue significativamente más baja en el grupo de control (diferencia de grupo = -3,8 mmHg)

**Conclusiones:** El yoga es seguro y efectivo en pacientes que toman medicamentos para la hipertensión arterial.

**Palabras Clave:** yoga, hipertensión arterial, intervención, ejercicios físicos, meditación. Fuente: DeCS.

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## Introduction

The average blood pressure of the Ecuadorian population is decreasing and an increasing proportion of people with hypertension are receiving treatment. However, hypertension remains a serious health problem<sup>(1)</sup>. Worldwide, 9.4 million deaths yearly are caused by excessively high blood pressure. The World Health Organization has identified hypertension as a leading cause of premature morbidity and mortality in developed and developing countries<sup>(2)</sup>.

International medical guidelines recommend lifestyle changes for patients with hypertension, e.g., physical activity and stress management. Yoga may comprise a lifestyle-modifying intervention. In Western societies, yoga is generally associated with specific body postures, breathing, and meditation techniques; several schools have developed with varying degrees of emphasis on yoga's physical and mental aspects<sup>(3,4)</sup>.

Three-quarters of residents of Ecuador who practice yoga say they do so primarily for health reasons, and clinical studies have shown that the positive effects include a beneficial influence on physical and mental risk factors for hypertension<sup>(5-7)</sup>. However, no studies have yet been conducted in this country to determine the effect of yoga on hypertension, and the guidelines do not consider existing evidence from other countries on yoga and related interventions<sup>(8)</sup>. For example, a recent meta-analysis of studies on arterial hypertension and prehypertension conducted in different countries showed that yoga significantly reduced systolic and diastolic blood pressure. However, in subgroup analyses, these effects were confirmed only for arterial hypertension<sup>(9)</sup>. In studies that included both prehypertensive and hypertensive patients, the effects did not reach significance (mean difference: 0.9 mmHg systolic and 0.1 mmHg diastolic).

Furthermore, the effects were demonstrated in studies that allowed individual antihypertensive medication but not in those that excluded it. Finally, yoga was effective only in studies that included breathing techniques and meditation, but not yoga postures<sup>(10-13)</sup>. Studies that included yoga postures (alone or accompanied by breathing techniques and meditation) showed no significant effects. However, we are unaware of any studies in which the blood pressure-lowering effects of different styles of yoga were directly compared. Therefore, we set out to investigate the efficacy of yoga interventions with and without yoga postures, as an accompaniment to antihypertensive medication, in reducing 24-hour blood pressure in patients with arterial hypertension. We hypothesized that systolic and diastolic blood pressure would be lower after an intervention without yoga postures than in the absence of a specific intervention or after an intervention with yoga postures.

## Methods

### Study design

The study was a three-arm, single-center, randomized controlled trial from 2019- 2020. Data acquisition was performed in a blinded fashion. The conduct of the study adhered to the tenets of the Declaration of Helsinki, and the report was written following the CONSORT 2010 Statement. This study was approved by the Universidad Regional Autónoma de Los Andes (UNIANDES).

Participants were recruited through appeals in the local press and e-mail distribution lists of local companies. Patients were recruited who presented and met the inclusion criteria. They received detailed written and verbal information about the study before signing a consent form indicating their participation agreement.

### **Inclusion criteria**

To be included in the study, patients had to be at least 18 years of age with primary arterial hypertension (>140 mmHg systolic blood pressure and >90 mmHg diastolic blood pressure). In addition, they had to be receiving antihypertensive medication from their primary care physician or specialist at the time of the investigation. In addition, they had to accept the following conditions:

- No alteration of your antihypertensive medication in the next 7 months
- Participation in at least 10 of the 12 yoga sessions of the syllabus
- Additional unsupervised yoga sessions at home.
- Reasons for exclusion included the following diseases and circumstances:
  1. secondary hypertension
  2. Severe psychiatric comorbidities (major depression, dependency disorders or psychosis)
  3. Coronary artery disease, myocardial infarction, pulmonary embolism or stroke within the previous 3 months
  4. NYHA stage heart failure = I
  5. Peripheral arterial occlusive disease stage = 1
  6. Stage >2 renal failure with glomerular filtration rate (GFR) <60 ml/min/1.73 m<sup>2</sup>.
  7. Participation in any other clinical studies at the time of the start of our trial or planned participation in such studies in the next 28 weeks
  8. Pregnancy or lactation.

The same two yoga instructors delivered the two interventions. Each intervention comprised a 90-minute session once a week for 12 weeks. In the intervention that included yoga postures, each session consisted of 45-minute yoga postures and 45-minute breathing, meditation, and relaxation techniques, as well as brief presentations and question-and-answer rounds. The yoga intervention without yoga postures consisted only of breathing, meditation and relaxation techniques, brief presentations, and question-and-answer rounds (electronic supplement).

Study participants were encouraged to practice yoga and meditation daily at home, but no minimum duration was recommended. The exercises to be performed at home were explained in detail in the yoga sessions. In addition, patients received audio recordings of the yoga sessions and training manuals to support their unsupervised exercises. During the 12-week intervention period, participants recorded in a diary how many minutes they spent on their exercises each day. At the end of the study (week 28), patients were asked to indicate the average weekly duration of their exercises during the follow-up period.

### **Control group**

Study participants assigned to the control group were placed on a waiting list. They did not participate in any yoga intervention in the first 12 weeks of the study and were asked not to begin any yoga exercise or other new physical

activities during this time. At the end of week 28 of the study, members of the control group were offered the opportunity to participate in an intervention corresponding to either of the other two study groups.

### **Performance measures**

The person acquiring the data was not involved in patient recruitment, group assignment, or interventions and was blinded to group assignment throughout the study. Twenty-four-h systolic and diastolic blood pressure were defined as primary outcome measures and were determined using an internationally accepted digital blood pressure monitor. Systolic and diastolic blood pressure at week 28 were documented as secondary outcome measures. The first measurement, at week 1, was performed within the week immediately before the start of the intervention and the second measurement, at week 12, was performed in the week after the end of the intervention. Blood pressure measurement began at the same time of day at all three documentation points. Standardized algorithms automatically eliminated incorrect measurements in the blood pressure monitor software.

Any participant who experienced an adverse event was asked to consult the study physician so that they could assess the severity of the event and take appropriate action. At weeks 12 and 28, participants were asked open-ended questions to document any adverse events not mentioned above. Patients were asked to report all adverse events during the study period, whether or not they had any possible connection to the study intervention.

### **Sample size calculation and statistical analysis**

The required sample size was calculated a priori based on a meta-analysis in which systolic blood pressure was 14.13 mmHg lower after the yoga interventions, corresponding to an effect size of  $d = 1.35$ . Based on this effect, 17 patients per study group would be required for a t-test with a bilateral significance level of  $\alpha = 0.05$ . This would allow the detection of a corresponding group difference with 80% power. To rule out the loss of potency that would result from a dropout rate of up to 30%, 75 patients (25 per group) were included in the study.

Outcome criteria were assessed on an intention-to-treat basis: all randomized patients were included in the analysis, regardless of whether the data were complete or the study protocol was followed correctly. This resulted in 50 complete data sets containing complete data for all 75 patients and were combined for analysis purposes.

All linear outcome measures (blood pressure, heart rate, questionnaire data) were assessed by univariate analysis of covariance (ANCOVA). The outcome measure (dependent variable) was modeled as a function of the following parameters:

This allowed the determination of overall effect estimates, the 95 % confidence interval and the p-value ANCOVA are recommended for evaluating clinical studies because they control for possible baseline differences and determine group differences for all group comparisons and all measurement times. In addition, they are more powerful than other statistical methods.

The database and statistical processing of the data were performed and analyzed in the statistical program SPSS 26 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used for the results collection, presentation and interpretation.

## **Results**

Seventy-five patients met all inclusion criteria and were included in the study after giving written informed consent. They were randomly assigned to the yoga group with yoga postures ( $n = 25$ ), the yoga group without yoga postures ( $n = 25$ ), or the control group ( $n = 25$ ). Five members of the yoga with yoga postures group (20.0%), three members of the yoga without yoga postures group (12.0%) and one patient of the control group (4.0%) did not complete the study program. Therefore, missing values were multiply imputed for six participants at week 12 and for nine patients at week 28. In addition, at each of these time points, missing blood pressure values had to be

imputed for three other patients who became uncomfortable with the measuring device and discontinued the measurement.

Patient characteristics are shown in Table 1.

Table 1: Effects on blood pressure and heart rate in a yoga group with yoga postures (group A), without yoga postures (group B) and the control group.

Final measurements	Group	1 week	12 weeks	28 weeks	Group difference compared with group A (95% CI) week 12	Group difference compared to control group (95% CI) week 12	Group difference compared to group B (95% CI) week 28	Group difference compared to group B (95% CI) week 28
24 h	A	135, (11,6)	136,9 (10,6)	131,3 (8,4)	0,2 (p=0,927)	3,2 (p=0,45)	-5,3 (p=0,022)	-4,6 (p=0,037)
	B	131,7 (11,3)	130,9 (9,2)	133,3 (11,9)	-3,8 (p=0,035)		-1,3 (p=0,602)	
	Control	133,3 (9,8)	135 (8,0)	134,81 (9,3)				
Diurnal	A	137,1 (11,5)	138,4 (10)	133,3 (8,2)	-0,1 (p=0,943)	3,3 (p=0,042)	-5,6 (p=0,023)	-4,9 (p=0,03)
	B	133,4 (11,7)	132,6 (9,0)	135,5 (11,9)	-3,8 (p=0,045)		-1,1 (p=0,669)	
	Control	135,5 (9,3)	137,2 (8,8)	137,1 (9,5)				
Nocturna	A	71,5 (12)	70,7 (11,5)	70 (7,9)	-1,2 (p=0,594)	-0,1 (p=0,975)	0,7 (p=0,722)	-0,8 (p=0,637)
	B	72,7 (9,3)	71,1 (11,7)	71 (7,9)	-0,4 (p=0,867)		-1 (p=0,588)	
	Control	71,2 (10,4)	70,8 (7,1)	70,7 (7,9)				

Source: statistical analysis.  $p \leq 0.05$ .

## Ambulatory blood pressure measurement

At 12 weeks, 24-h systolic blood pressure (a primary outcome measure) was significantly lower in the no yoga postures group than in the yoga postures group ( $p = 0.045$ ) or the control group ( $p = 0.035$ ). At 28 weeks, the opposite was found: 24-h systolic blood pressure in the yoga postures group was significantly lower than in the control group ( $p = 0.022$ ) and in the no yoga postures group ( $p = 0.037$ ). At no time point were there intergroup differences in 24-h diastolic blood pressure.

No serious adverse events occurred during the study. Nine patients (36.0 %) in the yoga postures intervention group experienced a total of 15 minor adverse events, while in the no yoga postures group, four patients (16.0 %) reported five minor adverse events. Two patients (8.0 %) in the control group had four minor adverse events.

## Discussion

In this randomized controlled trial, a 12-week yoga intervention consisting solely of breathing and meditation techniques without yoga postures reduced the pooled primary outcome of 24-hour systolic blood pressure by a greater amount than either no treatment or an additional exercise intervention. However, the other joint primary outcome, 24-hour diastolic blood pressure, was not reduced. These results are consistent with the findings of a meta-analysis<sup>(14)</sup>, although the effect sizes in our trial were smaller (-3.8 mmHg, 95 % confidence interval [-7.5; -0.3] versus -14.1 mmHg, 95 % confidence interval [-24.7; -3.6]). These differences with previous studies are likely due to differences in inclusion criteria, methods of blood pressure recording (clinical versus ambulatory), and the country in which the study was conducted.

Interestingly, although based only on secondary outcome measures, the pattern was reversed at week 28. At this final week of the study, the group that had received the yoga postures intervention showed greater reductions in ambulatory systolic blood pressure than the group without yoga postures.

Compared to the untreated control group, 13 patients had to be treated with yoga to achieve substantial improvement in one patient.

A simultaneous increase in parasympathetic activity and a decrease in sympathetic activity have been postulated as an important mechanism of action of therapeutic yoga<sup>(14-16)</sup>. In this context, in particular, the yoga techniques of slow breathing and meditation may produce a short-term enhancement of parasympathetic activity. In experimental studies in which yoga relaxation techniques were supplemented with yoga postures, no further potentiation of parasympathetic activity occurred. Together with the findings of the meta-analysis, this led to breathing and meditation techniques, rather than yoga postures, being seen as the main mechanism of action of yoga in patients with arterial hypertension. While this hypothesis was certainly confirmed immediately after the yoga interventions' end, our trial's results indicate that long-term positive effects on high blood pressure can only be achieved with the integration of yoga postures. The adoption of yoga postures can be seen as a form of isometric training, whereas dynamic yoga sequences (e.g., the well-known sun salutation) add an element of aerobic training<sup>(15,17-20)</sup>. Both isometric and aerobic training can reduce blood pressure. These may be the mechanisms responsible for the long-term effect of an intervention involving yoga postures<sup>(18-20)</sup>.

However, the main reason for the long-term group differences may also lie in a discrepancy in treatment adherence after the end of the interventions: a higher proportion of patients in the yoga postures group than in the non-yoga postures group continued to practice the techniques they had been taught after study week 12. The yoga postures group also practiced for much longer each week. It may be that yoga postures are easier to integrate into daily activities than yoga breathing and meditation techniques<sup>(7)</sup>. However, in interpreting the findings in this way, it should be kept in mind that the long-term group differences were larger in the intention-to-treat analysis than in the per-protocol analysis.

Our study had some limitations. First, the wait-list group did not control for patient expectations, time spent, or instructor attention. In addition, study participants were not blinded to the intervention they received. Participants were predominantly female and well-educated and thus tended to be more typical of yoga practitioners than of

patients with hypertension. This reduced the generalizability of the findings. Finally, no effects of the interventions on diastolic blood pressure were detected, the overall reduction in systolic blood pressure was only slight, and only 8% of patients with hypertension would benefit substantially from a yoga intervention.

## Conclusions

Only yoga without yoga postures had an immediate effect on 24-hour systolic (but not diastolic) blood pressure; yoga with yoga postures had no such action. However, including yoga postures seems necessary if effects are to be maintained beyond the end of the intervention. Since we found yoga in patients with hypertension effective and safe, yoga can be recommended as an adjunct to this group's medication for systolic blood pressure reduction.

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