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Yoga as a treatment for hypertension in primary health care

Yoga as a treatment for hypertension in primary health care

A quantitative and qualitative analysis
conducted in Sweden

Moa Wolff



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DOCTORAL DISSERTATION

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<p>Introduction: Persistent hypertension is a key risk factor for coronary heart disease, stroke and other cardiovascular diseases, such as heart failure. For primary care physicians, hypertension is the number one diagnosis for office visits and for our communities, the treatment of high blood pressure (BP) and its consequences constitutes a substantial economic burden.</p> <p>Aim: To evaluate yoga as a treatment for hypertension in primary care.</p> <p>Methods: The thesis is based on two quantitative studies and one qualitative study:</p> <ul style="list-style-type: none"> •A prospective three-arm single-centre study of two types of yoga (83 adult primary care patients diagnosed with hypertension). BP measurement, blood sampling and a questionnaire on self-rated quality of life (QOL) were carried out at baseline and after 12 weeks of intervention. There were two intervention groups and one control group. The groups were matched based on baseline systolic BP (SBP). (Papers I and II) •A three-centre parallel group randomized controlled trial (RCT) with follow-up after 12-week intervention completion (191 adult primary care patients diagnosed with hypertension). At baseline and follow-up, the participants underwent standardized BP measurements and completed questionnaires on QOL, stress, anxiety and depression. (Paper III) •A qualitative study based on individual semi-structured interviews with 13 participants from the intervention group of the RCT. We used a semi-structured interview guide according to Kvale. Qualitative analysis was conducted by systematic text condensation inspired by Malterud. (Paper IV) <p>Results: Paper I: The patients who performed a short home-based yoga programme 15 minutes daily had a decline in diastolic BP (DBP) of 4.4 mmHg ($p < 0.05$) and a significant improvement in self-rated QOL compared to the control group ($p < 0.05$). Paper II: We recorded no evidence that yoga altered inflammatory biomarkers or metabolic risk factors in our study population. Paper III: There was a significant reduction in SBP and DBP for both groups (-3.8/ - 1.7 mmHg for yoga and - 4.5/ - 3.0 mmHg for control groups, respectively). However, the BP reduction for the yoga group was not significantly different from control. There were small but significant improvements for the yoga group in some of the QOL and depression measures compared with control. Paper IV: Most patients expressed a wish to find alternative ways to treat their high blood pressure. The positive experiences of doing yoga were described in terms of tranquility and increased agility. The drawbacks were mainly linked to the time required to perform the exercises.</p> <p>Conclusions: The patients in our qualitative study described several benefits from doing yoga but they also pointed out difficulties in implementing yoga as a regular and permanent lifestyle change. The RCT, which is the largest study from an OECD country (Organization for Economic Co-operation and Development) to date, does not show that the yoga intervention (MediYoga) lowers BP compared to control. However, it is of great importance that we continue to evaluate the effects as well as the experiences of "new" alternative and complementary therapies.</p>		
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Yoga as a treatment for hypertension in primary health care

A quantitative and qualitative analysis
conducted in Sweden

Moa Wolff



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To my family

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Abstract

Introduction: Persistent hypertension is a key risk factor for coronary heart disease, stroke and other cardiovascular diseases, such as heart failure. For primary care physicians, hypertension is the number one diagnosis for office visits and for our communities, the treatment of high blood pressure (BP) and its consequences constitutes a substantial economic burden.

Aim: To evaluate yoga as a treatment for hypertension in primary care.

Methods: The thesis is based on two quantitative studies and one qualitative study:

- A prospective three-arm single-centre study of two types of yoga (83 adult primary care patients diagnosed with hypertension). BP measurement, blood sampling and a questionnaire on self-rated quality of life (QOL) were carried out at baseline and after 12 weeks of intervention. There were two intervention groups and one control group. The groups were matched based on baseline systolic BP (SBP). (Papers I and II)
- A three-centre parallel group randomized controlled trial (RCT) with follow-up after 12-week intervention completion (191 adult primary care patients diagnosed with hypertension). At baseline and follow-up, the participants underwent standardized BP measurements and completed questionnaires on QOL, stress, anxiety and depression. (Paper III)
- A qualitative study based on individual semi-structured interviews with 13 participants from the intervention group of the RCT. We used a semi-structured interview guide according to Kvale. Qualitative analysis was conducted by systematic text condensation inspired by Malterud. (Paper IV)

Results: Paper I: The patients who performed a short home-based yoga programme 15 minutes daily had a decline in diastolic BP (DBP) of 4.4 mmHg ($p < 0.05$) and a significant improvement in self-rated QOL compared to the control group ($p < 0.05$). Paper II: We recorded no evidence that yoga altered inflammatory biomarkers or metabolic risk factors in our study population. Paper III: There was a significant reduction in SBP and DBP for both groups ($-3.8/ - 1.7$ mmHg for yoga and $- 4.5/ - 3.0$ mmHg for control groups, respectively). However, the BP reduction for the yoga group was not significantly different from control. There were small but significant improvements for the yoga group in some of the QOL and depression measures compared with control. Paper IV: Most patients expressed a wish to find

alternative ways to treat their high blood pressure. The positive experiences of doing yoga were described in terms of tranquillity and increased agility. The drawbacks were mainly linked to the time required to perform the exercises.

Conclusions: The patients in our qualitative study described several benefits from doing yoga but they also pointed out difficulties in implementing yoga as a regular and permanent lifestyle change. The RCT, which is the largest study from an OECD country (Organization for Economic Co-operation and Development) to date, does not show that the yoga intervention (MediYoga) lowers BP compared to control. However, it is of great importance that we continue to evaluate the effects as well as the experiences of “new” alternative and complementary therapies.

Abbreviations

ACEI	Angiotensin-converting enzyme
AMI	Acute myocardial infarction
ARB	Angiotensin receptor blocker
BB	Beta blocker
BMI	Body mass index
BP	Blood pressure
CCB	Calcium channel blocker
CHD	Coronary heart disease
CI	Confidence interval
CVDs	Cardiovascular diseases
DBP	Diastolic blood pressure
ESC	European Society of Hypertension
ESH	European Society of Cardiology
FP	Fasting plasma
FP-glucose	Fasting plasma glucose
GABA	γ -aminobutyric acid
GP	General practitioner
HADS	Hospital Anxiety and Depression Scale
HDL	High-density lipoproteins
hs-CRP	High-sensitive C-reactive protein
IL-6	Interleukin 6
IL-10	Interleukin 10
IMY	Institute for Medical Yoga
ITT	Intention to treat
LDL	Low-density lipoproteins
MetS	Metabolic syndrome
OC	Observed cases
OECD	Organization for Economic Co-operation and Development
PPS	Per protocol set
PSS	Perceived Stress Scale
QOL	Quality of life
RAAS	Renin angiotensin aldosterone system
RCT	Randomized controlled trial
SBP	Systolic blood pressure
SE	Standard error of the mean
TGs	Triglycerides
TIA	Transient ischemic attack
WHO	World Health Organization

Original papers

The thesis is based on the following papers, referred to in the text by their Roman numerals:

- I. **Wolff M**, Sundquist K, Larsson Lönn S, Midlöv P. Impact of yoga on blood pressure and quality of life – a controlled trial in primary care, matched for systolic blood pressure. *BMC Cardiovascular Disorders* 2013, 13:111.
- II. **Wolff M**, Memon AA, Chalmers JP, Sundquist K, Midlöv P. Yoga's effect on inflammatory biomarkers and metabolic risk factors in a high risk population – a controlled trial in primary care. *BMC Cardiovascular Disorders* 2015:15:91.
- III. **Wolff M**, Rogers K, Erdal B, Chalmers JP, Sundquist K, Midlöv P. Impact of a short home-based yoga programme on blood pressure in patients with hypertension: a randomized controlled trial in primary care. *Journal of Human Hypertension* doi:10.1038/jhh.2015.123.
- IV. **Wolff M**, Brorsson A, Midlöv P, Sundquist K, Strandberg EL. Yoga – A laborious way to well-being: a qualitative study about patients' experience of yoga as a treatment for hypertension. Submitted.

Prologue

Why yoga?

Do you do yoga yourself?

When I talk about my research I meet great interest and enthusiasm from most people. Yoga seems to concern or engage almost everyone in some way! As a researcher, I am by definition meant to be an objective observer and interpreter. Maybe that is why I nearly always get the two questions above: *Why yoga?* and *Do you do yoga yourself?* Or maybe it is just pure curiosity? Anyway, I will tell you why. And I will tell you about my own relation to yoga today.

I never planned to be a researcher but in 2008 I was looking for a scientific project for my exams as a general practitioner. My mother, Kristin Eckerlund, who at that time was working as a general practitioner in Stockholm, told me enthusiastically about an instructor course in Medical Yoga/MediYoga that she had attended. She had started to practise some of the yoga exercises on her patients and thought it was a good complement to our western “traditional care”. And her patients seemed to be happy about the new possibility they were offered. Inspired by her experience, I arranged a lecture about MediYoga for resident physicians in Lund and Malmö that year. When I attended the lecture, I did have some hopes that something would turn up for my exam project.

When the lecturer, Göran Boll (founder of MediYoga), told us that left nostril breathing would lower blood pressure (BP), I realized that I had found my scientific project! Göran Boll showed great interest in my ideas and came up with an intervention programme with two yoga exercises for me to evaluate. In summary, my scientific project, a study with 19 hypertensive patients in Svedala 2009, showed interesting BP-lowering tendencies. But most important of all, several of the participants told me that they had experienced other positive effects from the yoga exercises, e.g. less hip pain, less tinnitus, less anxiety or “It just makes me feel good”. My curiosity was awakened and I felt a great desire to examine the effects of the intervention further.

After my first yoga intervention study as a doctoral student, I wanted to deepen my own knowledge about yoga. I attended a yoga instructor course in 2013 given by the MediYoga Institute. The course comprised six days of practical and theoretical

lectures spread over six months. During that time, I did yoga one hour daily as part of the self-studies. It was very interesting and I experienced it as something positive for both body and mind. For me, however, it is not realistic to incorporate *that much* yoga as a routine in my everyday life. Nowadays, I do yoga from time to time and I see it as a tool to be used whenever I need it.

Introduction

Hypertension

Hypertension, or high blood pressure (BP), is defined as persistent systolic and/or diastolic BP equal to or above 140/90 mmHg.¹ The worldwide prevalence of hypertension among adults (>25 years) was around 40% in 2008, with a slightly lower prevalence in high-income countries.² In Sweden, approximately 2 million adults have hypertension and high BP is the most prevalent reason for visits to primary care.³ Hypertension is important not only because of its high prevalence, but also because it is the largest single modifiable risk factor for cardiovascular disease and mortality worldwide.^{4,5} Furthermore, the direct and indirect costs for treatment of hypertension and its consequences constitute a substantial economic burden for our communities.⁶

The beneficial effects of lowering BP on morbidity and mortality are very well documented (Table 1).^{7,8} A decrease in systolic BP (SBP) by 10 mmHg or diastolic BP (DBP) by 5 mmHg reduces coronary heart disease (CHD) events (fatal or non-fatal) by about a quarter, stroke by about a third and heart failure by about a quarter.⁸

Table 1.
Beneficial effects of lowering SBP on mortality⁷

Reduction in SBP mm Hg	% Reduction in mortality		
	Stroke	CHD	Total
2	6	4	3
3	8	5	4
5	14	9	7

The specific cause of hypertension is unknown for more than 90% of the cases, so-called *primary (essential) hypertension*.⁹ However, we know of several social determinants (age, education etc.) and behavioural risk factors that can contribute to the development of primary hypertension, e.g. unhealthy diet, physical inactivity, overweight and harmful use of alcohol.¹⁰ The prevalence of hypertension varies between population groups and over time and is influenced primarily by the lifestyle factors of the population. This means that migrants from communities with a lower prevalence of hypertension are likely to increase their prevalence as they adapt to

the new lifestyle of the “modern” urbanized society.¹¹ Thus, individualized lifestyle modification is the cornerstone for the prevention and treatment of hypertension and its comorbidities (Table 2).¹²

Table 2.

Recommended lifestyle changes for hypertensive patients¹²

Recommendations
Salt restriction to 5–6 g/day
No more alcohol than 20–30 g/day for men and 10–20 g/day for women
Increased consumption of vegetables, fruits and low-fat dairy products
Reduction of weight to BMI ≤ 25 kg/m ² and of waist circumference to <102 cm in men and <88 cm in women
Regular exercise, i.e. at least 30 min of moderate dynamic exercise 5–7 days per week
Quit smoking

In addition to lifestyle change there are a number of antihypertensive drugs with extensive documentation regarding BP-lowering effect, prevention of comorbidities and with a relatively low frequency of side effects.¹³ Despite this arsenal of treatment possibilities only about 50% of the hypertensive patients in the western world reach their target BP ($\leq 140/90$ mmHg).^{14,15}

One reason for this may be the largely asymptomatic nature of hypertension¹⁶ which gives the primary care physician a considerable challenge in educating the patients about the importance of well-controlled BP. It is indeed a difficult task to convince asymptomatic patients to forego immediate pleasures (salt, calories, etc.), to increase their physical activity and to start medication for the benefit of distant, hypothetical gains. Even more so if the medication cause unwanted side effects.

Pathogenesis of primary hypertension

To understand the pathogenesis of hypertension, knowledge of the physiological factors that influence BP is essential. The BP level is a function of blood flow (cardiac output) and peripheral vascular resistance, meaning that increased blood flow and/or increased peripheral vascular resistance will lead to higher BP and vice versa.¹⁷

$$\text{Blood pressure} = \text{cardiac output} \times \text{peripheral vascular resistance}$$

The mechanisms by which BP is raised vary depending on the individual (e.g. hereditary factors, age and gender) and on lifestyle factors. Although we might not have the full picture yet, four main pathways have been identified in the pathogenesis of primary hypertension.¹⁸

1. **Sympathetic activation/overdrive**, which via neurotransmitters raises BP by increasing cardiac output and systemic vascular resistance, by reducing/altering the sensitivity of the baroreceptors and by stimulating renin release from the kidneys (see point 4).¹⁹
2. **Renal mechanisms**. A defective ability to excrete excessive sodium will cause expanding plasma volume in the body, leading to increased cardiac output which in turn triggers autoregulation with increased systemic vascular resistance.¹⁸
3. **Vascular mechanisms**. Impaired release of relaxing factors and enhanced release of constricting and pro-inflammatory factors and reactive oxygen species in the endothelium of the arteries leads to increased vascular resistance (increased DBP). With advancing age, elevated BP causes remodelling of the blood vessels which further perpetuates the hypertension: Large artery stiffness (increased SBP) and decreased lumen diameter in the small peripheral arteries (small vessel disease).¹⁸
4. **Hormonal mechanisms**. Activation of the renin-angiotensin-aldosterone system (RAAS) is one of the most important factors leading to hypertension. The activation of the angiotensin 1 receptor through angiotensin II leads to sympathetic activation, release of reactive oxygen species (inhibiting relaxing factors of the arteries), inflammation, cell growth (remodelling) and to the release of aldosterone which in turn causes sodium retention and cardiac and renal fibrosis.¹⁸

Yoga

Yoga – a brief history

Yoga is a mind-body practice in complementary and alternative medicine with origins in ancient Indian philosophy.²⁰ The early yoga (1800 BC to about 200 AD) was primarily a technique to keep the mind focused while performing different rituals. Later on, the physical body came into focus in the ritual exercise.²¹

The word *yoga* comes from the Sanskrit word *yuj*, which means yoke or union – union between the mind and the body. Yoga aims literally to take on the yoke, to make the effort and discipline oneself, to achieve self-awareness through the complete balance between body, mind and soul.

There are a number of yoga schools and common to all is that they include a combination of physical postures, breathing techniques and meditation/relaxation. Hatha yoga, which is the most commonly practised yoga school in Europe and the

United States, emphasizes postures (asanas) and breathing exercises (pranayama). Some of the major styles of Hatha yoga include Kundalini, Iyengar, Ashtanga, Vini and Bikram.²⁰

The form of yoga practised in the present study is MediYoga, with roots in Kundalini yoga, developed at the MediYoga Institute (IMY) in Stockholm.²² MediYoga is relatively easy to perform compared with other forms of yoga and is suitable for all ages and levels of fitness. In most exercises the yoga movement is combined with powerful deep breathing. MediYoga is said to be more intense than the classical Hatha yoga and Iyengar yoga, but less physically demanding than Ashtanga yoga. A typical MediYoga class always incorporates the following five elements; 1) Tune-in with mantra, 2) Physical exercises or postures and breathing exercises, 3) Deep relaxation, 4) Meditation, 5) Tune-out with mantra.

Yoga is gaining popularity in the western world and an increasing number of yoga practitioners are using yoga for health reasons. According to a recent national statistics health report from the USA, approximately four out of five yoga users said that they used yoga for general wellness or disease prevention.²³

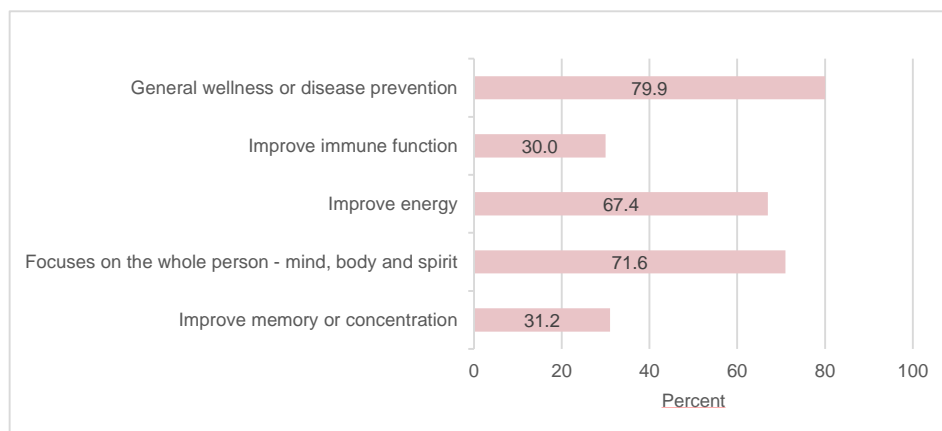


Figure 1. Wellness-related reasons for use of yoga among users aged 18 and over; United States, 2012²³

According to the yogic philosophy, diseases are caused by blockages or imbalance in the internal energy flows of the human body (the chakra system, figure 2). Through regular practice of yoga and meditation the energy flows are thought to be facilitated, leading to diminished or vanished symptoms. From the yogic point of view, diseases should not be feared and quickly eradicated, but are to be seen as teachers and friends, telling us that we need to change our lifestyle and way of thinking to become healthier.²⁴

Unlike many other natural methods of healing, most yoga schools accept all systems of therapy which are valid and useful. Modern medicine is seen as a great science, just like yoga. The idea is that yoga as a therapy should work in conjunction with, and not as a replacement for, drugs, surgery or any other necessary form of treatment.²⁵

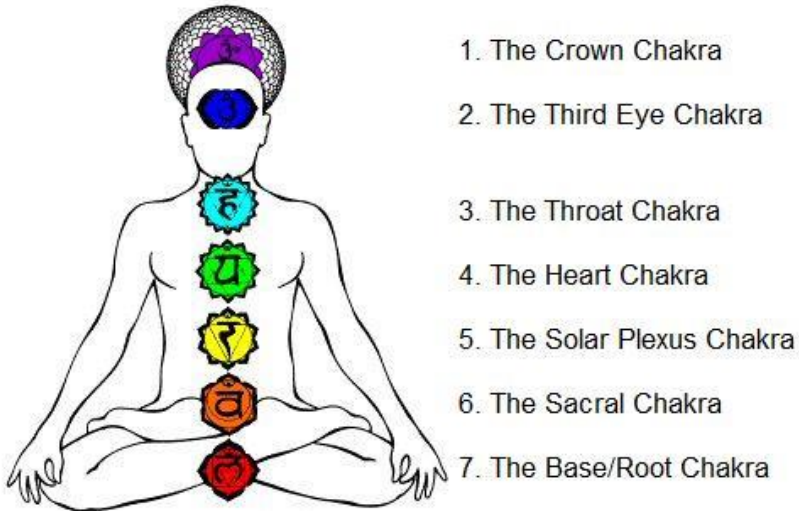


Figure 2.
The chakra system (wikipedia.org)

Yoga and hypertension/cardiovascular disease

In several studies, yoga has been shown to reduce BP.²⁶⁻³⁰ In general however, these studies have been small and of questionable power to determine clinically relevant (that is, 4–5 mmHg) changes in BP^{26-28,30}, and the need for larger randomized trials has been highlighted.³¹

A Cochrane review from 2015, aiming at determining the effectiveness of yoga for the secondary prevention of CHD, found that no RCTs met the inclusion criteria for the review.³²

Thus, the effectiveness of yoga on hypertension and cardiovascular health remains uncertain and high-quality RCTs are needed.

How yoga might work to lower blood pressure

We know that regular physical activity reduces high BP.³³ An observational study found that the metabolic costs of a typical Hatha yoga session (which is comparable to the MediYoga programmes in our studies) represented a level of physical activity equivalent to walking on a treadmill at 3.2 km/h.³⁴ This low level of physical activity does not meet the common recommendations for improving or maintaining health or cardiovascular fitness³⁵, meaning that the yoga intervention in our studies is unlikely to exert its alleged effect on BP through the effects of the physical activity.

There are several other theories about how BP is affected by yoga. According to a previous study, slow breathing increases baroreceptor sensitivity and reduces sympathetic activity and chemoreflex activation.³⁶ Yoga exercise can increase heart rate variability, indicating an increase in parasympathetic activity.³⁷ Increased thalamic γ -aminobutyric acid (GABA) levels (a transmitter that regulates the baroreceptor neurons) have been associated with yoga practice,³⁸ indicating another possible mechanism of action for yoga on hypertension. It has also been shown in a previous study that yoga can reduce levels of cortisol in saliva.³⁹ The mechanisms by which cortisol raises BP remain unknown, but it is suggested that it might be through inhibition of the vasodilator nitric oxide system and through increased vasoconstrictor erythropoietin concentration.⁴⁰

The metabolic syndrome

The metabolic syndrome (MetS) is a combination of certain risk factors that multiply the risk of heart disease, diabetes and stroke.⁴¹ The worldwide prevalence of MetS ranges from <10% to 84%, depending on the region and composition (sex, age, race, and ethnicity) of the population studied.⁴² Higher socioeconomic status, sedentary lifestyle, and high body mass index (BMI) are significantly associated with MetS.

To fulfil the criteria for MetS, a patient has to have at least three of the following five conditions:⁴¹

1. Central obesity (waist circumference ≥ 102 cm and ≥ 88 cm in male and female respectively)
2. Blood pressure $\geq 130/85$ mmHg (or receiving drug therapy for hypertension)
3. Triglycerides ≥ 1.7 mmol/L (or receiving therapy for hypertriglyceridemia)
4. HDL < 1.0 mmol/L or < 1.3 mmol/L in male and female respectively
5. FPG-glucose ≥ 5.6 mmol/L (or receiving drug therapy for hyperglycemia)

Each condition above defines a certain diagnosis (obesity, hypertension, dyslipidemia and diabetes) but the threshold is lower for MetS than for each diagnosis alone. MetS has not yet been approved as a diagnosis by the WHO and there are no drugs specifically developed for MetS. Despite this, there is widespread use of the term because it gives a clear indication of increased cardiovascular risk. For the doctor, it may also be easier to explain the importance of a syndrome than that of a number of risk factors.

Yoga and the metabolic syndrome

Previous studies have shown that dietary intervention combined with yoga has a favourable effect on some of the metabolic biomarkers of the MetS.^{43,44} The effects of yoga on metabolic risk factors have not, however, been studied in a primary care setting.

Quality of life and self-rated health

Several studies have shown that the health-related QOL of individuals with hypertension is generally worse than that of normotensive individuals.⁴⁵ This is important since patients' self-rated health has been recognized as a strong and independent predictor of both morbidity and mortality.^{46,47} In this thesis, we used the WHOQOL-BREF to evaluate QOL and self-rated health. WHOQOL-BREF is a validated QOL questionnaire containing 26 items, which measure the following four domains: physical health, psychological health, social relationships and environment.^{48,49} The first two items (WHO1 and WHO2) are so-called global items that can be analysed separately. They measure overall QOL and overall health satisfaction, respectively.

Yoga, quality of life and self-rated health

There are several studies indicating that yoga can increase self-related health and QOL.^{30,50,51} However, none of these studies have been made in a primary care setting with hypertensive patients.

Stress, anxiety and depression

Psychosocial stress is recognized as an independent risk factor for hypertension and there is some evidence that stress management through transcendental meditation is associated with a significant reduction in BP.⁵²

Anxiety and depression are common in the general population and even more prevalent in patients with hypertension or cardiovascular disease.⁵³ There are theories about a biological association between psychiatric morbidity and cardiovascular disease, and it is speculated whether this could be linked to the serotonin transmitter levels or to a sympathetic overdrive.⁵³

We used the perceived stress scale 14 (PSS-14⁵⁴) and hospital anxiety and depression scale (HADS⁵⁵) questionnaires in the RCT (paper III) to measure stress and depression/anxiety, respectively.

The PSS-14 is a self-reported questionnaire that is designed to measure the degree to which individuals appraise situations in their lives as stressful.⁵⁴ The instrument is a 14-item scale with 7 positive items and 7 negative items rated on a 5-point Likert scale.

The HADS was originally developed to identify cases (possible and probable) of anxiety and depression among patients in non-psychiatric hospital clinics, but has since also been found to perform well in assessing outpatient populations.⁵⁶ The scale consists of 14 items that can be divided into an Anxiety subscale (HADS-A) and a Depression subscale (HADS-D). Each single item is scored 0–3, where 0 means a low and 3 means a high level of anxiety or depression. Participants with a score on HADS-A of ≥ 8 and/or HADS-D of ≥ 8 were classified as a case of anxiety or depression, respectively.

Yoga and stress, anxiety and depression

Previous studies have shown positive effects of yoga on stress²⁹, anxiety^{29,57} and depression.^{57,58} A recent systematic review on the effects of yoga on stress measures and mood concludes that preliminary evidence suggest that yoga practice leads to a decrease in depressive and anxious symptoms in a range of populations.⁵⁹

Primary health care in Sweden

The Swedish health care system is financed by a social insurance that provides all citizens with subsidized health care through the government. There are both public and private providers of health care. Primary care is handled mainly through local primary health care centres. The primary care services are comprised of general medical practitioners offering medical examinations, care and treatment of most medical conditions. In addition, primary care offers health and medical care by specialist nurses, physiotherapists and occupational therapists. Patient fees vary from SEK 100–200 (i.e. 10–20 Euro) between the different counties. There is a high-cost ceiling, meaning that a patient does not have to pay more than SEK 1,100 in patient fees/year. There is a similar ceiling for prescription medication of SEK 2,200 in a given 12-month period.⁶⁰

In Sweden, a vast majority of patients with hypertension are treated in primary health care. When it comes to hypertension, the tasks for the primary care physician are to detect and treat hypertension, to detect and control risk factors for cardiovascular disease among these patients and to refer patients with therapy-resistant hypertension or with secondary hypertension if there is a need for specialized care.

If the hypertension is well-controlled, the primary care physician typically meets the patient once a year for a medical check-up, blood tests and medical prescription renewal.

Importance

In recent years there has been a rapid increase in the range of yoga therapies in health care. At several hospitals and primary health care centres throughout Sweden physiotherapists offer yoga for treatment and rehabilitation, and there are yoga therapist training courses particularly aimed at health care professionals. The increased range of yoga therapies is a direct reflection of an increased interest and demand in the population. Unfortunately, the treatments often have weak scientific support, and guidelines on how they should be performed are vague or absent, which leaves too much room for discretion.⁶¹

In several previous studies yoga has been shown to have a BP-lowering effect. To date, however, only our research group has focused on studies that describe whether yoga can be used as a treatment for hypertension in primary care, where patients with hypertension are normally treated.

Several qualitative studies describe patients' experiences of yoga as a treatment but none of them are about yoga as a treatment for high blood pressure or yoga as a treatment in primary care.

Yoga is a side-effect-free and inexpensive alternative to conventional BP treatment. Patients who have difficulty engaging in physically demanding sports can instead try the simple yoga programme, which can be adapted for people with mobility problems. If yoga can replace or complement drug treatment, it will bring savings to both patients and society.

Aims of the thesis

The general aim of this thesis was to evaluate yoga as a treatment for high BP in hypertensive patients in primary care.

The specific aims were:

- To determine the potential effects of yoga on BP and QOL in patients in primary health care diagnosed with hypertension. (Paper I)
- To investigate whether there was a difference in effect if yoga was practised on a regular basis in a group led by a yoga instructor or if the patient practised a shorter yoga programme individually at home. (Paper I)
- To assess the benefit of yoga on inflammatory biomarkers and metabolic risk factors. (Paper II)
- To evaluate the impact of a short home-based yoga programme on BP and QOL and on stress, depression and anxiety in primary care patients with hypertension. (Paper III)
- To gain a better understanding of how primary care patients with hypertension experience yoga as a treatment method and to investigate patients' experiences of living with hypertension. (Paper IV)

Materials and Methods

The dissertation comprises two quantitative studies and one qualitative study. Papers I and II are based on the first quantitative study, a matched controlled trial (the YHIP study). Paper III is based on the second quantitative study, a randomized controlled trial (RCT). The last paper, paper IV, is a qualitative interview study with patients from the intervention group of the RCT. An overview of the papers is presented in Table 3.

Table 3.
Overview of the four papers

Paper	I	II	III	IV
Design	Matched controlled trial		RCT	Qualitative
Participants	Primary care patients, 20–80 years old, with hypertension diagnosis (N=83)		Primary care patients, 30–80 years old, with hypertension diagnosis (N=192)	A purposeful sampling of patients from the intervention group of the RCT (N=13)
Outcomes	Change in BP Change in self-rated QOL	Change in blood inflammatory and metabolic risk factor levels	Change in BP Change in self-rated QOL Change in self-rated stress, depression and anxiety	Experiences of yoga as a treatment method Experiences of living with hypertension
Data collection method	BP measurements Questionnaire on self-rated QOL	Blood samples, drawn in the morning after fast since midnight	BP measurements Questionnaires on self-rated QOL, stress, depression and anxiety	Individual semi-structured interviews
Data collection period	2011	2011	2013–2014	2014
Data analysis	ANCOVA Multiple linear regression analysis	One-way ANOVA Kruskall-Wallis test Paired samples t-test Wilcoxon Independent samples t-test Mann-Whitney U-test	Paired samples t-test ANCOVA Multiple linear regression analysis	Systematic text condensation

Study settings, participants and recruitment

All studies were conducted in Skåne County, the southernmost county of Sweden, with approximately 1,300,000 inhabitants (2015). Patients from four different health care centres in rural areas close to Malmö and Lund were involved in the studies.

Papers I and II

Papers I and II are based on the YHIP study (Yoga for Hypertension In Primary care study), a prospective three-arm single-centre study of two types of yoga. The YHIP study was designed as a matched controlled open clinical trial. There were two yoga intervention groups and one control group. BP measurements, blood sampling and assessments of lifestyle, health status and quality of life were carried out at baseline and after 12 weeks of intervention.

In January 2011, adult patients (20–80 years old) diagnosed with hypertension were identified by electronic charts search at Svedala Health Care Centre in Southern Sweden. The patients were invited to the health care centre for baseline assessments if their BP when most recently measured at the health care centre was between 120–160/80–100 mmHg (e.g. normal, high normal and grade 1 hypertension, table 4¹²).

Table 4.

Grades of hypertension, European Society of Cardiology (ESH)/ European Society of Hypertension (ESC) 2013¹²

Category	Systolic		Diastolic
Optimal	<120	and	<80
Normal	120–129	and/or	80–84
High normal	130–139	and/or	85–89
Grade 1 hypertension	140–159	and/or	90–99
Grade 2 hypertension	160–179	and/or	100–109
Grade 3 hypertension	≥180	and/or	≥110
Isolated systolic hypertension	≥140	and	<90

Inclusion criteria

- Age 20–80 years
- Hypertension diagnosis since at least one year
- BP 120–179/≤109 mmHg at the baseline assessment control

Exclusion criteria

- Adjustments in medication within four weeks prior to study start
- Expected inability to understand instructions about the yoga exercises (e.g. dementia, aphasia)
- Physical or mental incapacity to carry out the yoga exercises (e.g. hemiplegia, mental retardation, palliative cancer)
- Language problems/interpreter needs

As shown in Figure 1, 406 patients were identified by data record screening. They were invited by mail to participate in the study. Two weeks later they were contacted by telephone. In March 2011, the patients who agreed to participate were invited to the health care centre for baseline assessments.

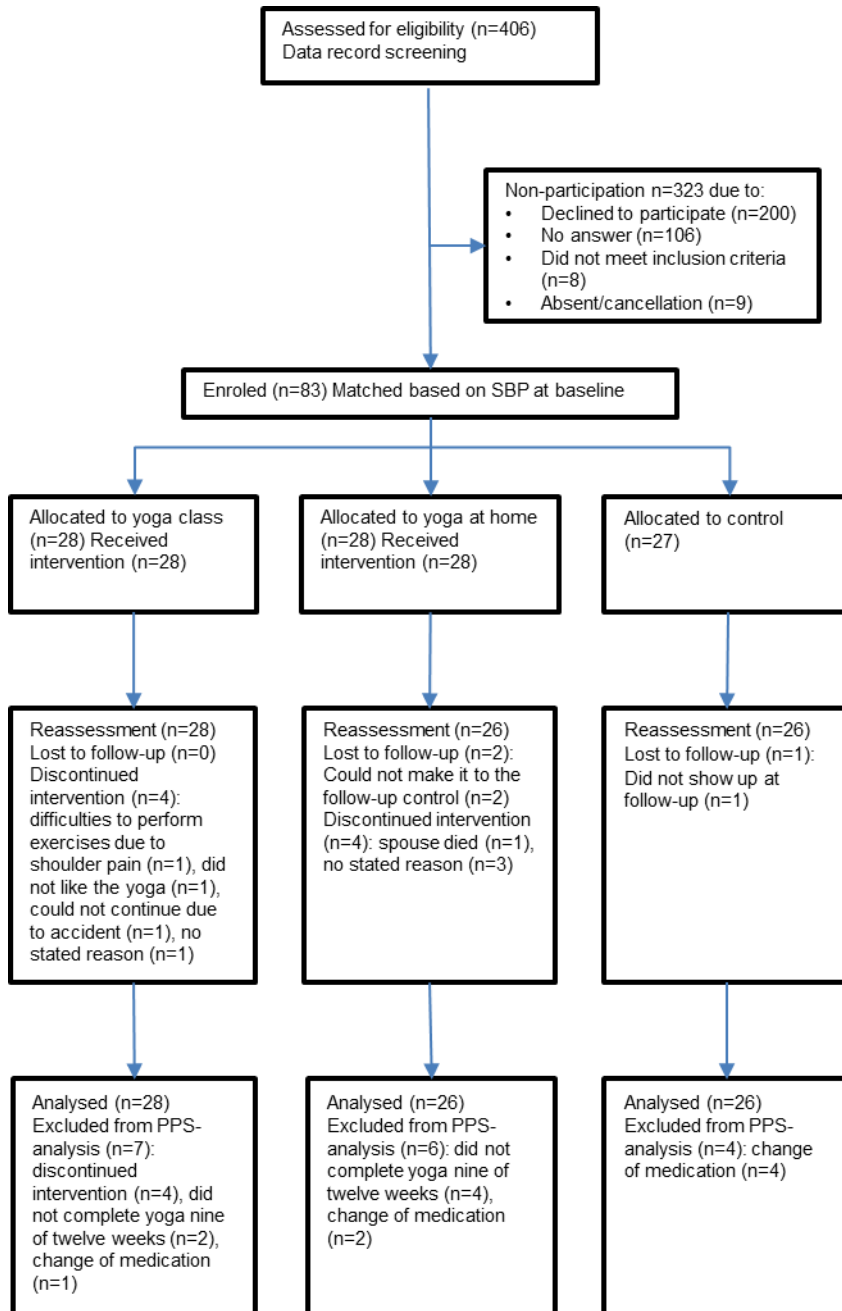


Figure 3
Flow chart outlining recruitment, allocation and follow-up for the patients in paper I-II

Paper III

Paper III is based on a RCT, performed in 2013–2014, with patients from three different health care centres. The study was designed to evaluate yoga's impact on BP and QOL and on stress, depression and anxiety in patients with hypertension in a primary care setting. The intervention group performed a short home-based Kundalini yoga programme 15 min twice daily during the 12-week intervention period. At baseline and follow-up, the participants underwent standardized BP measurements and completed questionnaires on QOL, stress, anxiety and depression.

In September 2013, patients aged 30–80 years old with diagnosed hypertension were identified by electronic charts search at three health care centres in southern Sweden. The health-care centres were chosen on the basis that they had general practitioners (GPs) willing to commit time for research on yoga and hypertension. Participants were invited to participate if their BP when most recently measured at the health-care centre was between 130 and 160 mmHg (systolic) and 85 and 100 mmHg (diastolic), and thus fell within the range of high normal or grade 1 hypertension (Table 4).¹²

Inclusion criteria

- Age 30–80 years
- Hypertension diagnosis since at least one year
- BP 130–160 mmHg systolic and/or 85–100 mmHg diastolic at the baseline control

Exclusion criteria

- BP outside the range of 120–180 (systolic) or 80–110 mmHg (diastolic) at the baseline control; that is, below the definitions for optimal or above those for grade 3 hypertension, respectively.
- Adjustments in medication within four weeks prior to study start
- Expected inability to understand instructions about the yoga exercises (e.g. dementia, aphasia)
- Physical or mental incapacity to carry out the yoga exercises (e.g. hemiplegia, mental retardation, palliative care)
- Language problems/interpreter needs

The flow chart (Figure 4) shows the flow of participants through the study. The patients who met the inclusion criteria (n=1020) were invited by mail to participate in the study. After 2 weeks, they were contacted by telephone by a research assistant to provide further information about the study. Those who agreed to participate were invited for baseline assessment at their regular health-care centre.

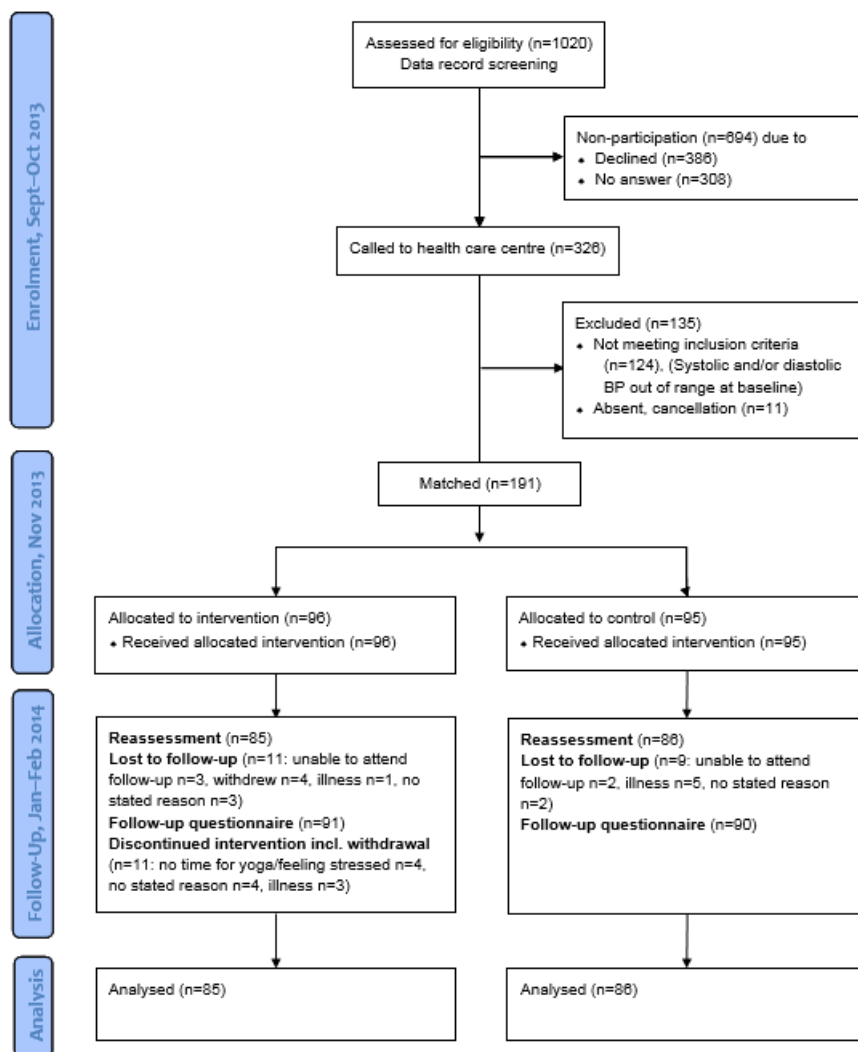


Figure 4. Flow chart outlining patient recruitment and the allocation of patients to different groups, paper III

Paper IV

Patients from the intervention group of the above RCT (paper III) were asked whether they were interested in participating in an interview study. A subset of those who agreed was selected. Eight women and five men (aged 35–79) who had practised the yoga intervention were interviewed. We chose to do a purposeful sampling with maximal variation regarding age, gender, health care centre

affiliation, effect on BP and effect on QOL (Item 1 WHOQOL-BREF) and self-rated health (Item 2 WHOQOL-BREF).

Procedure

Papers I and II

The assessments included standardized BP measurements performed by trained nurses using automated devices. The nurses also measured BMI and waist circumference and collected information about the patients' current medication. The participants completed a questionnaire on quality of life (WHOQOL-BREF⁴⁸) and a health status and lifestyle survey designed for the study (provided in the Appendix). Fasting blood samples were collected and analysed for HbA1c, FP-glucose, cholesterol, triglycerides (TGs), high-density lipoprotein (HDL), low-density lipoprotein (LDL) and high-sensitive C-reactive protein (hs-CRP). For each patient three additional cryo tubes with blood were frozen for future analysis of interleukin 6 (IL-6) and interleukin 10 (IL-10).

The inflammatory blood tests hs-CRP, IL-6 and IL-10 reflect the degree of inflammation in the body, and high levels of hs-CRP (≥ 2.78 mg/L) and IL-6 (≥ 3.19 pg/mL) have been associated with increased risk of death.⁶² Hs-CRP is also a biomarker for determining blood vessel inflammation and endothelial dysfunction,⁶³ and high levels seem to be a predictor of cardiovascular events.⁶⁴ IL-10 is a cytokine with anti-inflammatory effects. Some studies suggest that yoga practice lowers the levels of hs-CRP and IL-6^{65,66} and increases levels of anti-inflammatory proteins⁶⁷ that in turn increases IL-10 levels.

Baseline assessments and study questionnaires were completed after written informed consent was obtained from the participants. Data were collected at baseline and after completion of the 12-week intervention.

All participants were requested not to change their medication during the study, and any change in medication was registered at follow-up after 12 weeks.

The participants were matched at the group level based on SBP after baseline assessments in order to avoid large differences in SBP between the groups. The matching procedure was performed by an independent statistician.

Intervention group 1, the **yoga class group** (28 persons), was divided into three smaller groups, each consisting of 8–12 participants. Each group met once a week for 60 min at the health care centre to practise yoga with a yoga instructor. The participants were encouraged to practise yoga 30 min every day at home between

the yoga classes. The yoga classes comprised various yoga movements and positions, breathing techniques and meditation. Each yoga class programme incorporated the following six elements typical of Kundalini Yoga: 1) tune-in with mantra, 2) warm-up or breathing exercises, 3) physical exercises or postures and breathing exercises, 4) deep relaxation, 5) meditation, and 6) tune-out with mantra.

The participants in intervention group 2, the **yoga at home group** (28 persons), were each given a doctor's appointment (20 min) during which they received instructions for two yoga exercises to perform at home for a combined total of 15 min a day: (1) "Left nostril breathing" – deep breaths in and out through the left nostril while sitting or lying down, with the right nostril closed off by the right thumb or a nose plug (duration about 11 min); and (2) "spinal flex" – a movement that alternates between flexing the spine forwards (arching) and back in time with deep breaths while sitting on a chair or the edge of a bed (about 4 min). The yoga exercises of the yoga at home group are shown in figure 5.

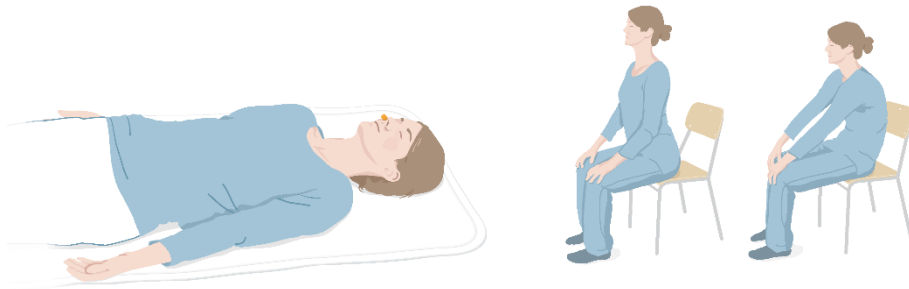


Figure 5. The yoga programme of the yoga at home group in the YHIP study.

The same yoga intervention was used in the RCT. Horizontal position: Left nostril breathing (11 minutes) with right nostril closed off by an noseplug. Sitting position: Back flex (4 minutes). Graphics: Paris Grafik

In order to evaluate compliance with yoga practice for the intervention groups, each participant received a yoga calendar in which to record when they did yoga.

No changes were made for the participants in the **control group** (27 persons) who received treatment as usual (treatment with the medication they were already taking and annual medical examination by the general practitioner).

Paper III

The assessments were performed at the patients' health care centres and included BP measurements with validated electronic BP devices, BMI, waist circumference and collection of data regarding current medication. If the patients fulfilled the inclusion criteria regarding BP, they were asked to complete questionnaires on self-rated QOL (WHOQOL-BREF⁴⁸), stress (PSS-14⁵⁴), anxiety and depression

(HADS⁶⁸). Data were collected at baseline and after completion of the 12-week intervention. The research assistants who collected the data were blinded to the group assignment.

Randomization to study groups occurred after completion of baseline assessments and questionnaires. To ensure allocation concealment, randomization to groups was undertaken by a research assistant not involved in recruitment using a computer-generated random number schedule with block size of four.

The **yoga intervention group** (96 persons) received information and instructions concerning a short home-based Kundalini yoga programme during a single 30 min general practitioner (GP) consultation. The same yoga programme was used as in the yoga-at-home group of the YHIP study (Figure 5). The participants were asked to perform these exercises for 15 min twice-daily (just after getting out of bed in the morning and just before going to bed in the evening). During the GP consultation, the patients also received a CD, a nose plug to use during the left nostril breathing exercise, a manual to facilitate their home exercises and a yoga diary in which to record details of when they had done yoga training. The participants were also able to listen to and download the audio-guided yoga programme to their smartphone or computer via a website specifically made for the study.

No changes were made for the **control group** (95 persons), which received “treatment as usual” (treatment with the medication they were already taking and annual medical examination by the GP).

Paper IV

The patients were interviewed individually using a semi-structured interview guide. The interview guide was developed according to Kvale.⁶⁹ The questions focused on three main areas: experiences of yoga (mental and physical); thoughts on yoga’s effect/lack of effect in the specific case; and thoughts on hypertension (Figure 5).

Interview guide

Researcher questions

How did the patient experience the yoga treatment?

Interviewer questions

How did you experience the yoga?

Summary of patients' narrative regarding experiences of yoga

Supplementary questions

Do you think yoga affected you mentally/physically and if so, how?

How did you motivate yourself/ what motivated you to do the exercises?

How often/how much do you think it's reasonable to do yoga?

How does the patient think about the effects or lack of effects of yoga?

What do you think affected your blood pressure/OQL/stress etc. during the study?

Summary of patients' narrative regarding changes in BP etc during the study and on effects/lack of effects of yoga

Did something happen during the study that could have affected the outcome?

How does the patient think about his/her hypertension disease?

I would like to know how you think about your hypertension

Summary of patients' narrative on living with hypertension

What is it like living with hypertension?

What is your attitude to/ feelings about medication for hypertension?

Figure 5.
Interview guide.

Open-ended questions were used to stimulate the respondents' own narrative. Supplementary questions were used when needed, to further encourage the patients to develop and deepen their reasoning. The interviews were conducted at the patient's regular primary health care centre or at an alternative place of the patient's suggestion. All interviews were conducted by the first author (MW).

The interviews were audio-recorded, professionally transcribed verbatim and anonymized. The analysis was performed by the co-authors Moa Wolff, Eva Lena Strandberg and Annika Brorsson stepwise according to Malterud.⁷⁰ First the text was read repeatedly individually. Preliminary themes were drawn from the interviews. Meaning units connected with the preliminary themes were then identified in the text. The meaning units were labelled with codes. The codes were merged into subcategories, categories and themes. The authors had recurrent meetings throughout the analysis process. In addition they returned to the interview text in several steps to make sure that the categories and themes reflected the content of the interviews.

Statistical analyses

Data were analysed using SAS software version 9.2 (paper I) and 9.4 (paper III) and SPSS Statistics 22 (papers II–III). We used an intention-to-treat approach in the analyses for both quantitative studies. Per protocol analyses were also performed.

Paper I

Assuming a mean treatment difference in SBP of 5 mmHg between the yoga at home and control groups, a standard deviation of 6 mmHg and a drop-out rate of 30%, 33 patients per group would have 80% power to detect a statistically significant difference at the 5% level using a two-sided test. Within-group differences and differences in mean BP change between the yoga and control groups were calculated by ANCOVA with baseline values as covariates. A corresponding model was used for quality of life (single items and domains). All tests were two-sided. We further investigated whether other baseline characteristics (age, sex and BMI) could influence the outcome using the same linear regression model as above and including the baseline characteristic of interest. However, the study was not sufficiently powered to do subgroup analyses or to detect statistically significant differences for other covariates.

Paper II

One-way ANOVA was used to determine whether there were any significant differences in baseline data between the groups. For the laboratory results that were not normally distributed (FP-glucose, HbA1c, hs-CRP, IL-10 and IL-6) we used the Kruskal-Wallis test instead. Differences in blood test parameters, BP and waist circumference between baseline and follow-up within each group were calculated by paired-samples Student's t-test. Differences in mean change between the yoga groups and the control group were calculated by independent samples Student's t-test. For the laboratory results that were not normally distributed (FP-glucose, HbA1c, hs-CRP, IL-6 and IL-10), the differences within and between groups were calculated by Wilcoxon test and Mann-Whitney U-test, respectively.

Paper III

An a priori sample size calculation determined that 200 patients were required (100 per group) to allow 80% power to detect as significant at the 5% level, a 5 mmHg between-group difference in systolic BP, allowing for 15% dropouts (two-sided test). Differences in BP, QOL, stress and continuously measured HADS-A and HADS-D variables between baseline and follow-up were calculated by paired-samples Student's t-test in each group (normally distributed data). Differences in mean change between the yoga and control groups were calculated by ANCOVA⁷¹ with baseline values as covariates. For change in mean systolic blood pressure (SBP), we also used regression analysis with adjustment for age, sex and body mass index (BMI). For differences in change from baseline to follow-up in dichotomized HADS-A and HADS-D scores, we used a marginal model (generalized estimating equation) with robust errors⁷² with a binomial distribution and log link (log-binomial model) and included an interaction between time of measurement and group to test whether there was an important change from baseline.

Paper IV

Since this paper is based on a qualitative study no statistical analyses were performed.

Ethical considerations

All studies in the dissertation have been approved by the Regional Ethics Board in Lund: Case number 2010/728 (papers I–II), case number 2013/262 (paper III) and case number 2013/895 (paper IV). The quantitative studies were registered at ClinicalTrials.gov (NCT01302535) (YHIP study) and (NCT01984593) (Yoga RCT).

Participation in the studies was voluntary and written informed consent was obtained from all participants.

In studies I and III, all patients were informed about their BP level and about the common target level for BP, i.e. $\leq 140/90$ mmHg. In cases of severely elevated BP at baseline and follow-up (SBP ≥ 180 mmHg and/or DBP ≥ 110 mmHg), a consultation with the responsible physician was arranged. In cases of moderately elevated BP at follow-up (SBP ≥ 160 mmHg and/or DBP ≥ 100 mmHg) the patients were encouraged to come to their health care centre within a month for a new BP measurement.

In the sampling process for paper IV, patients with a prior patient-doctor relationship to MW were removed from the selection process to avoid the patients getting into a position of loyalty towards their doctor that might prevent them from sharing all aspects of their experiences.

Data from the interviews were collected using a digital sound recorder and anonymized before the transcription.

Results

Papers I and II

The baseline characteristics of the participants are presented in Table 5. There was a predominance of women in all three groups. A majority of the patients (72%) were overweight (body mass index (BMI) > 25 kg/m²) and a total of 49 participants (60%) met the criteria for metabolic syndrome. All participants were diagnosed with hypertension at enrolment, and 92% were on hypertensive medication. At baseline, 37% of the patients were well controlled ($\leq 140/90$ mmHg).

Table 5.
Baseline characteristics

	Intervention group 1 Yoga class group n=28 Mean (SD)	Intervention group 2 Yoga at home group n=28 Mean (SD)	Group 3 Control group n=27 Mean (SD)
Age in years	66.2 (7.7)	64.0 (10.3)	60.8 (11.0)
Female, number (%)	19 (67.9)	20 (71.4)	16 (59.3)
Metabolic syndrome, number (%)	19 (67.9)	13 (48.1)	17 (63.0)
BMI (kg/m ²)	29.7 (7.0)	28.5 (7.3)	28.8 (4.0)
Waist circumference, (cm)	100.4 (14.5)	97.0 (15.2)	100.9 (9.9)
SBP (mmHg)	143.8 (14.9)	143.6 (14.2)	144.3 (14.5)
DBP (mmHg)	89.0 (7.6)	88.4 (6.2)	89.8 (7.3)
On medication (%)	96.4	92.9	85.2
Well controlled (%) §	39.3	35.7	37.0
Drugs §§	2.0 (1.1)	1.8 (1.0)	1.4 (1.0)
FP glucose (mmol/L)	5.5 (0.8)	5.4 (1.6)	5.9 (2.3)
HbA1c (mmol/mol)	40.9 (10.5)	40.0 (8.5)	39.6 (10.1)
Cholesterol (mmol/L)	5.2 (1.0)	5.4 (1.1)	5.3 (1.2)
LDL (mmol/L)	3.3 (0.9)	3.5 (1.0)	3.4 (1.1)
HDL (mmol/L)	1.3 (0.4)	1.5 (0.4)	1.4 (0.4)
TGs (mmol/L)	1.3 (1.0)	1.2 (0.8)	1.5 (1.2)
LDL (mmol/L)	3.3 (0.9)	3.5 (1.0)	3.4 (1.1)
HDL (mmol/L)	1.3 (0.4)	1.5 (0.4)	1.4 (0.4)
WHO 1†	3.59 (0.8)	4.07 (0.7)*	3.96 (0.7)
WHO 2‡	3.04 (0.9)	3.61 (0.9)*	3.31 (0.7)

§ BP $\leq 140/90$ mmHg at baseline

§§ Number of different antihypertensive drugs

†WHO 1: How would you rate your quality of life? Very poor (1), poor (2), neither poor nor good (3), good (4), very good (5).

‡WHO 2: How satisfied are you with your health? Very dissatisfied (1), dissatisfied (2), neither satisfied nor dissatisfied (3), satisfied (4), very satisfied (5).

*Significant difference compared to control ($p < 0.05$)

SD, standard deviation; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CCB, calcium receptor blocker; BB, beta blocker

Table 6 shows changes in SBP, DBP, waist circumference and blood parameters for the three groups. The yoga class group showed no improvement in BP or self-rated

QOL, while in the yoga at home group there was a decline in DBP of 4.4 mmHg ($p<0.05$) compared to the control group. Moreover, the yoga at home group showed significant improvement in self-rated QOL compared to the control group ($p<0.05$).

Table 6.

Change from baseline and difference vs. control for SBP, DBP, waist circumference and blood parameters

	Intervention group 1 Yoga class group		Intervention group 2 Yoga at home group		Group 3 Control group	
	OC n=28	PPS n=21	OC n=26	PPS n=20	OC n=26	PPS n=23
SBP (mmHg)						
Change from baseline	0.3 (2.6)	-0.2 (3.1)	-6.8 (2.7)	-6.1 (3.2)	-2.3 (2.7)	-1.9 (3.0)
Difference vs. control	2.6 (3.7)	1.7 (4.3)	-4.4 (3.8)	-4.2 (4.4)		
DBP (mmHg)						
Change from baseline	0.2 (1.6)	0.3 (1.9)	-4.4 (1.6)	-3.9 (1.9)	0.8 (1.6)	1.01 (1.8)
Difference vs. control	-0.6 (2.5)	-0.8 (2.6)	-5.2 (2.3)	-4.9 (2.6)		
Waist circumference (cm)						
Change from baseline	-0.4 (0.7)	-0.4 (0.7)	0.6 (1.0)	0.6 (1.0)	-0.0 (0.9)	-0.0 (1.1)
Difference vs. control	-0.4 (1.3)	-0.4 (1.3)	0.6 (1.5)	0.6 (1.5)		
Cholesterol (mmol/L)						
Change from baseline	0.3 (0.1)**	0.2 (0.1)	-0.1 (0.1)	-0.1 (0.1)	0.0 (0.1)	0.1 (0.2)
Difference vs. control	0.3 (0.2)	0.2 (0.2)	-0.1 (0.2)	-0.1 (0.2)		
LDL (mmol/L)						
Change from baseline	0.1 (0.1)	0.1 (0.1)	-0.2 (0.1)	-0.1 (0.1)	0.0 (0.1)	0.0 (0.2)
Difference vs. control	0.2 (0.2)	0.1 (0.2)	-0.2 (0.2)	-0.2 (0.2)		
HDL (mmol/L)						
Change from baseline	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.1)
Difference vs. control	0.0 (0.0)	0.0 (0.1)	0.0 (0.1)	0.0 (0.1)		
TGs (mmol/L)						
Change from baseline	0.3 (0.1)	0.3 (0.1)	0.1 (0.1)	0.1 (0.1)	-0.3 (0.2)	-0.3 (0.2)
Difference vs. control	0.6 (0.2)	0.6 (0.2)	0.4 (0.2)	0.4 (0.2)		
FP-glucose (mmol/L)						
Change from baseline	0.1 (0.2)	0.0 (0.2)	-0.1 (0.1)	-0.1 (0.2)	-0.4 (0.3)	-0.4 (0.4)
Difference vs. control	0.5 (0.4)	0.5 (0.4)	0.4 (0.4)	0.3 (0.4)		
HbA1c (mmol/mol)						
Change from baseline	-1.4 (1.2)	-1.9 (1.4)	-0.2 (0.6)	0.3 (0.7)	-0.8 (0.6)	-0.9 (0.6)
Difference vs. control	-0.5 (1.4)	-0.4 (1.5)	0.6 (0.8)	0.7 (0.9)		
hs-CRP (mg/L)						
Change from baseline	-0.8 (0.6)	-0.6 (0.8)	0.2 (0.4)	0.1 (0.5)	0.4 (0.8)	0.5 (0.9)
Difference vs. control	-1.2 (1.0)	-1.3 (1.1)	-0.2 (0.9)	-0.3 (1.0)		
IL-6 (pg/mL)						
Change from baseline	-0.8 (0.7)	-0.8 (0.8)	1.1 (0.6)	1.1 (0.7)	1.0 (0.9)	1.2 (0.9)
Difference vs. control	0.2 (1.1)	-2.0 (1.2)	0.2 (1.1)	-0.1 (1.2)		
WHO1 §						
Change from baseline	0.12 (0.09)	0.17 (0.10)	0.35 (0.09)	0.37 (0.10)	0.06 (0.1)	0.01 (0.1)
Difference vs. control	0.06 (0.13)	0.15 (0.14)	0.29 (0.13)	0.36 (0.13)		
WHO2 §						
Change from baseline	0.15 (0.11)	0.22 (0.14)	0.39 (1.12)	0.43 (0.14)	0.11 (0.1)	0.14 (0.1)
Difference vs. control	0.04 (0.16)	0.08 (0.19)	0.28 (0.16)	0.30 (0.19)		
Yoga sessions during intervention†	47.2	52.7	63.9	72.6		

Means (SE) unless stated otherwise

Statistically significant findings are marked in bold. *($p<0.05$)

†According to yoga calendar (yoga class sessions and yoga at home sessions)

§For questions (WHOQOL, Items 1-2), refer to Table 5.

OC, observed cases; PPS, per protocol set; SE, standard error of the mean; SBP, systolic blood pressure; DBP, diastolic blood pressure, LDL, low-density lipoprotein; HDL, high-density lipoprotein; TGs, triglycerides; hs-CRP, high-sensitivity C-reactive protein

The PPS consists of all patients who (1) practised yoga at least once a week for nine weeks or more and (2) had no change in medication during the study period.

The increase in TG level was significantly higher in the yoga class group compared to the control group ($+0.3 \pm 0.6$ vs. -0.3 ± 1.1 mmol/L). No significant between-group differences in change from baseline were detected for any of the other metabolic or inflammatory blood factors or for waist circumference. We also did separate analyses for those patients whose BP decreased during the study (in intervention groups one and two), without finding any significant change in any of the blood tests before and after intervention (data not shown).

Compliance with yoga practice (number of yoga sessions) was lower in the yoga class group than in the yoga at home group (Table 6). However, the average total time spent on yoga practice was higher in the yoga class group (about 24 hours vs. 16 hours). Both yoga groups reported mainly positive experiences concerning the yoga practice, and only three participants stated that they would not continue with yoga after the study.

Paper III

The baseline characteristics are presented in Table 7. The sample of 191 participants consisted of 92 men and 99 women aged 34–79. A majority of the patients were overweight (BMI 25 kg/m^2); and the criterion for central obesity was fulfilled for 67.7% of the women (≥ 88 cm) and for 55.4% of the men (≥ 102 cm). Less than one-third of the patients (29.4%) stated that they completed more than 1 h of vigorous exercise a week.

Table 7.
Baseline characteristics

	Yoga group n=96	Control group n=95
Age (years)	64.7 (9.2)	64.8 (7.6)
Female gender, n (%)	52 (54.2)	47 (49.5)
BMI (kg/m ²)	28.4 (3.8)	28.3 (4.2)
Waist circumference (cm)	98.1 (11.3)	99.1 (12.2)
SBP (mmHg)	148.8 (11.6)	150.0 (10.6)
DBP (mmHg)	88.3 (6.1)	88.1 (5.7)
Well controlled $\leq 140/90$ mmHg, n (%)	26 (26.3)	16 (16.8)
On BP medication, n (%)	85 (89.5)	86 (90.4)
Number of antihypertensive drugs	1.5 (0.9)	1.5 (0.9)
Medical conditions		
Stroke/TIA, n (%)	12 (13.2)	5 (5.5)
Diabetes, n (%)	3 (3.3)	6 (6.5)
AMI or cardiac intervention, n (%)	3 (3.7)	7 (7.5)
WHO 1 (Quality of Life)§	4.1 (0.8)	4.1 (0.8)
WHO 2 (Health satisfaction)§§	3.5 (1.0)	3.5 (0.8)
Perceived stress scale score	21.6 (7.7)	20.2 (7.6)
HADS, total score	8.3 (6.5)	7.4 (6.3)
HADS-A, anxiety score	5.5 (4.1)	4.8 (3.9)
HADS-D, depression score	2.9 (3.0)	2.6 (2.8)

Notes: Means (SD) unless stated otherwise.

AMI; Acute Myocardial Infarction; BMI, Body Mass Index; DBP, Diastolic Blood pressure; HAD, Hospital Anxiety and Depression Scale; SBP, Systolic Blood Pressure; TIA, Transient Ischemic Attack

§WHO 1: How would you rate your quality of life? Very poor (1), poor (2), neither poor nor good (3), good (4), very good (5).

§§WHO 2: How satisfied are you with your health? Very dissatisfied (1), dissatisfied (2), neither satisfied nor dissatisfied (3), satisfied (4), very satisfied (5).

There were no significant differences in mean change of either SBP or DBP between the control and yoga groups (Table 8). However, we detected small but significant improvements for the yoga group in some of the QOL and depression measures ($P < 0.05$, HADS-D) compared with control. Despite a significant change in the continuous HADS-D score, when examined as defined cases, there were no important differences between groups in change of the proportions fulfilling the criteria for depression ($P = 0.087$).

Table 8.

Outcome values after intervention and adjusted mean change

	Yoga group ITT, n=85	Control group ITT, n=86
SBP (mmHg), mean (SD)	145.4 (13.4)	145.2 (12.8)
Change from baseline	-3.8** (-6.5 to -1.2)	-4.5** (-7.0 to -1.9)
Difference vs. control	0.5 (-3.0 to 3.9)	
DBP (mmHg), mean (SD)	86.3 (7.7)	84.9 (7.7)
Change from baseline	-1.7* (-3.3 to -0.2)	-3.0** (-4.6 to -1.4)
Difference vs. control	1.4 (-0.7 to 3.4)	
WHO1§ score , mean (SD)	4.2 (0.6)	4.2 (0.8)
Change from baseline	0.1 (-0.0 to 0.2)	0.1 (-0.1 to 0.2)
Difference vs. control	0.0 (-0.1 to 0.2)	
WHO2§ score , mean (SD)	3.8 (0.8)	3.6 (0.8)
Change from baseline	0.3** (0.1 to 0.4)	0.0 (-0.1 to 0.2)
Difference vs. control	0.2** (0.1 to 0.4)	
PSS score Mean (SD)	19.7 (7.6)	18.6 (8.2)
Change from baseline	-1.8** (-3.1 to -0.7)	-1.3 (-2.7 to 0.1)
Difference vs. control	-0.4 (-1.9 to 1.6)	
HADS-A anxiety score Mean (SD)	4.4 (3.3)	4.1 (3.6)
Change from baseline	-0.9** (-1.5 to -0.3)	-0.5 (-1.0 to 0.1)
Difference vs. control	-0.2 (-1.0 to 0.5)	
% Anxiety case (≥8)		
Baseline	23%	23%
Follow-up	17%	18%
HADS-D depression score Mean (SD)	1.8 (2.2)	2.5 (3.0)
Change from baseline	-0.8** (-1.1 to -0.4)	0.2 (-0.2 to 0.6)
Difference vs. control	-0.9** (-1.5 to -0.4)	
% Depression Case (≥8)		
Baseline	6%	7%
Follow-up	3%	10%

Complete case analysis. Notes: Means (95% CI) unless stated otherwise.

Statistically significant findings are marked in bold.

* ($p < 0.05$)

** ($p < 0.01$)

ITT, intention to treat; PSS, perceived stress scale; HAD, hospital anxiety and depression scale; SE, standard error of the mean; SBP, systolic blood pressure; DBP, diastolic blood pressure.

§For questions (WHOQOL, Items 1-2), refer to Table 7.

The mean number of yoga sessions completions during the 12 weeks was 118.6 (that is, 1.4 yoga sessions/day), ranging from 3 to 195. The most cited reasons for barriers to compliance were lack of time/holiday (27 persons) and physical barriers such as illness/cold/stuffed nose (20 persons).

Almost three quarters (73.9%, n = 65) of the participants reported positive or very positive physical experience and 71.1% (n = 62) reported positive or very positive mental experience of the yoga intervention. Forty-nine participants (56.3%) felt confident they would continue doing the yoga after study completion. The control participants were also able to rate their experience of taking part in the study, and 64 (74.4%) rated it as positive or very positive. According to the lifestyle survey, there were no significant changes in level of physical activity during the intervention period either within or between the groups.

Paper IV

Two main themes emerged during the analysis process: *Yoga – a laborious way to well-being* and *Hypertension – a silent disease*. Each theme originated from three categories as shown in table 9.

Table 9
Categories and themes

Categories	Themes
Harmony	Yoga – a laborious way to well-being
Doing something that is good for me	
Ambivalence/Resistance	
Stigma	Hypertension – the silent disease
Anxiety	
Insight on lifestyle impact	

Yoga – a laborious way to well-being

The patients emphasized that there were several positive aspects associated with doing yoga. The time spent doing yoga would sometimes serve as a refuge, free from external demands, and would thus give a sense of tranquillity and harmony.

“I thought you almost became a bit like, you came into some sort of great calmness and it was your own moment. It was positive. I felt quite good from it.” (IP 2)

Several patients described how the back-flex exercise made the back more agile, and how previous back pain diminished or disappeared completely. However, one participant omitted the back-flex exercise since she thought it increased her back pain and her physiotherapist advised against it. A few participants reported that they fell asleep more easily at night after doing yoga. However, this was not always desirable. One participant stated that doing the yoga programme in bed interfered with the intimacy with the spouse in a negative way.

All participants expressed a desire to avoid medication and to find alternative ways to influence their health. Practising yoga made them feel good because they were doing something that was positive for their health. For some, yoga became a tool which they used to achieve tranquillity, recover or to get rid of tension at work or on other occasions.

A vast majority of the participants expressed some form of resistance or ambivalence to doing yoga. Mostly the resistance concerned time – duration or time of day. Either twice daily was considered to be too much, or doing yoga in the morning/evening did not fit into the daily routines of the patient. Sometimes this would lead to restlessness or an inability to relax during yoga, or even make the patient skip the exercises.

“...it is perhaps a bit much, I don’t know. Even if it sounds like a piece of cake – fifteen minutes in the morning and then another fifteen. Yes, it’s difficult. Some people might think it works fine for them.” (IP 12)

A few patients described themselves as “morning people” i.e., not able to perform yoga in the evening because they would only fall asleep. In contrast, there were patients who preferred doing yoga in the evening. Most patients thought that yoga twice daily was too frequent, and they felt that yoga once daily would have been more moderate and easier to implement as a permanent daily routine. One patient expressed doubts as to whether the exercises could really lower blood pressure. The most cited physical barrier to compliance was blocked nose due to cold or nasal septum deviation. Other obstacles to performing yoga mainly concerned making it fit into the patient’s daily routine with work, children and other activities.

Hypertension – a silent disease

We were surprised by the patients’ negative narratives about what it is like living with high blood pressure. Without exception they expressed an unwillingness to take medication. The medication was also sometimes linked to a feeling of being old and sick. Some patients described how, when the diagnosis of hypertension was

revealed to them, they went from feeling healthy to feeling anxious and paying attention to every symptom from the body.

“And it was not exactly fun, for there you suddenly felt sick, from not having to think about anything and the second after I simply felt sick.” (IP1)

The anxiety seemed partly due to the fact that hypertension is non-symptomatic – a silent invisible threat.

The patients were well aware of the risks associated with hypertension, sometimes because of a family history of stroke and other cardiovascular disorders. At the same time the patients were optimistic about being able to influence their health. They knew about lifestyle changes that could affect their blood pressure in a positive way. Some patients thought they had already done everything they could and felt it was unfair that they still had hypertension. Others described the lifestyle change as a mission impossible, which made them feel burdened by guilt.

We found no correlation between the patients’ statements about yoga and their change in BP.

Discussion

Summary of the main findings

Paper I: The results demonstrated a significant reduction in DBP in the patients who practised yoga at home compared with controls ($p < 0.05$). The yoga at home group also showed a greater improvement in QOL than the control group ($p < 0.05$). Patients who practised yoga in a group with an instructor, however, did not experience significant improvements in BP or self-rated QOL compared with controls.

Paper II: The yoga interventions performed in the YHIP study did not affect inflammatory biomarkers or metabolic risk factors associated with CVD in the study population.

Paper III: We recorded no evidence that the yoga intervention decreased SBP or DBP more than usual care. However, both yoga and control groups had a significant within-group decrease in SBP and DBP. We found a small improvement in the HAD depression score (HADS-D) for the yoga group compared with controls. Significant improvements were also found for some of the QOL measures (health satisfaction, physical health, psychological health and environment).

Paper IV: The patients described several positive experiences from the yoga intervention; mainly that it provided a sense of tranquillity and that it increased agility. However, most of the patients felt that doing yoga twice daily was too big a commitment.

The patients' thoughts on living with hypertension became a central part of the patient narrative. For a majority of the participants, living with high BP and having to medicate entailed a stigma and caused concerns for future cardiovascular disorders.

Meaning of findings

Although there is emerging evidence that yoga, especially yoga breathing, can be a useful adjunct intervention in the management of hypertension,³¹ the evidence is of low quality and the need for well-powered randomized studies to further evaluate the effect of yoga on hypertension has been emphasized.^{31,73-75}

This thesis contributes to the field of research from both a quantitative and a qualitative perspective. Furthermore, it assesses the effects of yoga on BP in a primary health-care setting, where most patients with hypertension are evaluated and managed.

The findings of this thesis do not support the hypothesis that yoga (MediYoga) lowers BP in hypertensive patients.

The two quantitative studies on yoga's effect on BP and QOL had partially contradictory results. Our conclusion, based on the following arguments, is that the findings of the RCT are more reliable, and that the results from the YHIP study are more subject to confounding and bias: In the RCT, we increased the intervention from 15 min daily to 15 min twice daily and we also increased the sample size from 83 to 191. Furthermore, the RCT was a fully randomized clinical trial, whereas the YHIP study was a matched controlled study. The RCT was a three-centre study with three different therapists, which diminished the risk of therapist's bias.

The participants in our interview study expressed a desire to avoid medication and to find alternative ways to influence their health. For patients with hypertension who are not able or willing to do demanding physical exercise, yoga could be an appealing alternative if it proves to be effective. At present, GPs don't have much to offer these patients except oral medication.

Findings compared to other studies and literature

The home-based intervention programme in our studies differs from most comparable studies by having shorter daily sessions and by not offering formal yoga classes led by an instructor.

Papers I and III

A recent, large randomized controlled trial from India on the effectiveness of yoga in hypertensive patients reported a very large reduction in SBP (-14 mmHg, $p=0.001$) and DBP (-8 mmHg, $p=0.001$).²⁹ There are a number of differences with

respect to our studies, which might contribute to the different result. The Indian study practised another form of yoga, and the intervention period started with an instructor-led intensive course for 5 days. The patients were younger (30–60 years) and were recruited by means of announcements on radios and newspaper which could have led to a selection bias. The participants of the Indian study also had a much stronger compliance than we found, with all participants in the yoga group (n = 118) reporting 100% commitment to the yoga programme.

Another Indian study from 2009, comparing slow and fast breathing yoga exercises to control in adults with grade 1 hypertension, showed a significant reduction in SBP and DBP for both breathing exercise groups.⁷⁶ The exact sizes of the BP reduction for the two groups are not presented in the paper. The breathing exercises were taught during daily lessons for 14 consecutive work days, and the patients were then instructed to perform the programme at home 15 min twice daily throughout the 3-month intervention period.

A recent review on yoga trials showed that RCTs on yoga conducted in India have about 25 times the odds of reaching positive conclusions as those conducted elsewhere.⁷⁷

There could be several reasons for this finding. First, Indian yoga interventions are often more intense,⁷⁸ which means that the BP reduction could be due to vigorous physical activity rather than the consequence of a specific yoga effect. It is also likely that Indian patients, being familiar with the spiritual and philosophical tradition of yoga, find it easier to incorporate yoga into daily life. The understanding of the spiritual part of yoga may also influence the impact that yoga can have. Indian yoga instructors may well be more skilled and/or dedicated than yoga instructors from other countries, resulting in better outcomes. These differences make it difficult to generalize the effectiveness of Indian yoga trials to hypertensive patients in other countries.

Three American RCTs have evaluated yoga for pre-hypertensive and hypertensive patients, compared with active control groups.²⁶⁻²⁸ In these studies, the change in BP was evaluated with 24 h ambulatory BP after 12 (and 24²⁷) weeks of intervention, which is the most accurate method to detect BP change. Unfortunately, the studies were underpowered, with group sizes of around 30 patients. Two of the studies also suffered from large dropout rates (20 of 46 in the yoga group²⁶ and 34% of all randomized patients²⁷ withdrew, respectively), causing a major selection bias. The interventions consisted of instructor-led yoga classes for at least 60 min weekly plus home practice. The first study showed significant within-group reductions for both SBP (–6 mmHg, $p < 0.05$) and DBP (–5 mmHg, $p > 0.001$), but these were not significant compared with control.²⁶ The second study presented a significant within-group reduction for DBP that remained significant only for night time DBP in the between-group comparisons (-5.17 ± 15.70 vs -0.85 ± 15.80 , $P < 0.038$).²⁸ In

the third study there was a small but significant within group decrease in both SBP (-2.91 mmHg, $p \leq 0.001$) and DBP (-2.58 mmHg, $p \leq 0.001$) from baseline to 24 weeks but there were no significant between-group changes at follow-up after 24 weeks.²⁷

BP measurement is relatively easy and cheap to perform, and there are probably many studies with other main outcomes that include measurements of BP. However, if the results of the BP change are not positive, then they might well not be highlighted and may be difficult to find.⁷⁹

Paper II

Previous studies have shown that yoga practice can reduce levels of inflammatory factors such as hs-CRP and IL-6.^{80,81} However, none of these studies focused on patients with hypertension or metabolic syndrome, but on patients with chronic heart failure and with breast cancer. Nor did they look at yoga's effect on BP and metabolic risk factors, but on exercise capacity, mood and fatigue.

There are studies suggesting that antihypertensive treatment alone attenuates circulating levels of IL-6.⁸² Since 92% of the study participants were already on antihypertensive medication at baseline, the possibility of further reducing IL-6 levels could thus have been adversely affected.

Other studies have looked at yoga's effect on metabolic parameters such as glucose and lipid levels in patients with CVDs.^{43,44,81} In these studies, in contrast to our study, the yoga interventions were combined with other measures such as changes in diet. Two out of the three studies showed effects on the metabolic parameters.^{43,44} One explanation for the lack of significant results of our study could be that the patients have already influenced their biomarker levels through their medication (BP-lowering, anti-inflammatory aspirin and lipid lowering statins) to the extent that yoga has no additional effect.

Paper IV

There are no previous qualitative studies on experiences of yoga for hypertension or of yoga as a treatment in primary care. However, several studies describe patients' experiences of yoga as a treatment method. One of these studies regards experiences of yoga as a treatment for chronic pain, and one as rehabilitation after stroke.^{83,84} Obviously the incentives to do yoga and the effects and experiences of the interventions will therefore be difficult to compare with our study. The positive aspects of yoga in these studies are, in brief, described as increased body awareness, increased pain acceptance, calmness and decreased pain. There is one previous

qualitative study on perceived benefits from yoga in older adults at risk of CVD.⁸⁵ This study, which offered two instructor-led yoga classes per week for eight weeks, showed improved physical function and capacity, reduced stress/anxiety and enriched quality of sleep as the most pronounced benefits of yoga. The reporting of negative experiences of yoga is absent in these studies.

Other methodological considerations

Adherence to the home-based yoga intervention was 79% in the YHIP study and 78% in the RCT, which indicates a fairly good compliance. However, since lack of time was the most frequently cited barrier to adherence in the RCT, yoga once daily might have led to better compliance and a better effect. Compared with other yoga studies in OECD countries, the adherence to intervention was good.²⁶⁻²⁸

Since the home-based intervention was changed from 15 minutes once (YHIP) to twice daily (RCT), conclusions regarding the effects must be drawn with caution. One possible explanation for the lack of an additional BP reduction in the yoga group of the RCT could be that the participants considered doing yoga twice daily too time consuming and stressful, and that this might have counteracted the BP reduction of the yoga intervention. However, according to the causal principle, it can be argued that there should be a dose-response relationship, i.e. more yoga should lead to increased BP reduction.

At baseline 26% of the yoga patients in the RCT were well controlled ($\leq 140/90$ mmHg) compared with 17% in the control group. As it is easier to lower a BP that is high, this could have contributed to the lack of BP reduction in the yoga group compared with controls. On the other hand, mean BP values were equal between the groups at baseline; and SBP and DBP were normally distributed within the groups. Furthermore, by analysing the results with ANCOVA, with baseline BP as a covariate, we have adjusted for this effect.

Strengths and limitations

This thesis is based on four different studies which offer both strengths and limitations.

A key strength of the thesis is that all four studies have the same overall aim – to evaluate yoga as a treatment for hypertensive patients in primary care. Hence, study planning was based on findings, strengths and limitations of previous studies from the thesis. Another key strength is that the interventions were evaluated in an

appropriate setting, namely primary health care, where a vast majority of Swedish patients with hypertension are treated.

A common limitation for all four studies is that they are limited to evaluating a single form of yoga (MediYoga). It may be that other schools of yoga or other yoga programmes have a better impact on BP and on the other outcomes. However, a recent review and meta-analysis of yoga for hypertension states that yoga breathing interventions seem to be more effective than those that include physical postures.³¹

The self-reported data (yoga calendar) is another source of uncertainty, which is a problem in all studies of this kind.

No patients reported adverse events from the yoga training in any of the two intervention studies. In the interview study however, one participant reported that she had omitted the back-flex exercise since it increased her back pain. Although the participants were encouraged to describe their physical experiences of yoga at follow-up, a specific question about adverse effects would have been useful.

In both intervention studies we measured BP on two occasions, before and after the 12-week interventions. Given that BP varies considerably within individuals over time, a 24-h ambulatory BP is the most accurate method to measure the patient's actual BP and to avoid the impact of white coat hypertension on the results.⁸⁶ This is, however, time-consuming and expensive, and requires a much larger effort from the participants, possibly causing more dropouts.

The patients who chose to participate in our studies were probably open-minded about complementary and alternative therapy. In view of this selection bias, the study results are probably not applicable to all patients in primary care with hypertension. However, this is the case in most other comparable yoga studies.

We have no follow-up data after the intervention period of 12 weeks. It could be that 12 weeks is too short a period to be able to detect the changes that the yoga intervention exerts. However, 12 weeks is a common duration for interventions in previous yoga studies.^{26,28,29,76} It is also well-known that adherence to lifestyle recommendations among patients at risk of coronary heart disease is poor⁸⁷ and that any new behaviour will often decline as the intervention is withdrawn.⁸⁸

Papers I and II

Strengths of the YHIP study include excellent adherence with minimal attrition: only 3 of 83 patients failed to attend the follow-up. The study is more comprehensive than other similar yoga studies since it investigated the effect of yoga on a large number of biomarkers and risk factors.

Limitations specific to this study include the matching of participants. Randomized allocation is superior to matching in most studies. Our rationale for matching the groups was that we wanted to ensure similar SBP values at baseline. It is unlikely that randomization would have made a difference to the outcome of the blood parameters since there was no change in blood factor levels in any of the groups throughout the study.

Paper III

The study has a number of strengths. Primarily, it is the largest randomized controlled trial in the western world to date on yoga's effect on BP with BP as the primary outcome. It also examined several other secondary outcomes. Another major strength of the study is that it is a fully randomized clinical trial with adequate random sequence generation and adequate allocation concealment. Blinding was performed as far as possible to avoid performance bias and detection bias (physical assessments at baseline and follow-up were conducted by personnel who remained blinded to group allocation throughout the study).

The study measured stress, anxiety and depression parameters in a population of hypertensive patients in primary care. The results of these secondary outcomes might well have been different in a population of patients with diagnosed depression/anxiety or stress. Hence, from our study we cannot draw conclusions about yoga's effect on stress, anxiety or depression in other study populations.

Paper IV

We acknowledge that the participants were volunteers in a second stage of a study (having accepted participation in the RCT and the interview-study), which may have increased the selection bias with patients that were open-minded about complementary and alternative medicine. This could lead to over-reporting of positive experiences and/or underreporting of bad experiences. Considering the climate of the dialogue with the informants and that reporting of all kinds of experiences was encouraged and requested, we think that the underreporting of negative experiences has been minimized.

A limitation of our study is that the results only reflect the experiences of yoga during and immediately after the yoga programme. We have no information about the long-term experiences and effects.

Suggestions for further research

There is a need for larger, rigorous RCTs with longer follow-up duration to further evaluate the effect of yoga on BP and other risk factors for CVDs.

Furthermore, for yoga to be considered a viable and accepted adjunct treatment for patients with high BP, we need research that can not only show yoga's effects on BP, but also help us understand its mechanism of action.

To develop interventions that ensure good compliance, patients' experiences and opinions are invaluable. Hence, there is also a need for more qualitative studies evaluating patients' experiences of yoga as a treatment.

It is important that the future research on yoga and hypertension is performed in an appropriate setting, that is, where most patients with hypertension are treated.

Conclusions

Many patients with hypertension in Swedish primary care seem to be interested in trying alternative treatments to control blood pressure. The participants in our qualitative study described several benefits from doing yoga but they also pointed out difficulties in implementing yoga as a regular and permanent lifestyle change.

The two quantitative studies on yoga's effect on BP and QOL had partially contradictory results. The RCT, which is the largest study on yoga and hypertension from an OECD country to date, did not show that the yoga intervention (MediYoga) lowers BP compared to control. However, the patients in the yoga group had significant improvements regarding health satisfaction and depression measures.

We found no evidence that yoga altered inflammatory biomarkers or metabolic risk factors for CVD in our study population.

It is of great importance that we continue to evaluate the effects as well as the experiences of "new" alternative and complementary therapies.

Although the number of studies of yoga's effect on hypertension has increased substantially during the last decade, only very few meet the requirements of acceptable methodological quality. Several systematic reviews have called for larger, more rigorous studies. This thesis provides one piece of evidence for the big puzzle that eventually will describe yoga's effect on BP. Finally, it should be kept in mind that "absence of evidence is not evidence of absence".⁸⁹

Svensk sammanfattning

Bakgrund: Högt blodtryck är den enskilt största riskfaktorn för hjärtkärlorsakad sjukdom och död. De vetenskapliga bevisen för att blodtryckssänkning leder till minskad sjukdom och dödlighet är omfattande och oomtvistade. I Sverige beräknas cirka 35 % av alla vuxna över 25 år ha högt blodtryck. Detta gör högt blodtryck till den vanligaste besöksorsaken på svenska vårdcentraler.

Grunden i all blodtrycksbehandling är livsstilsförändringar (ökad motion, viktnedgång, rökstopp m.m.). Utöver det finns ett flertal läkemedelsgrupper med god blodtryckssänkande effekt. Trots detta utbud av blodtrycksbehandlingar är det bara cirka 50 % av de svenska blodtryckspatienterna som når behandlingsmålet ($\leq 140/90$ mmHg). En orsak till det kan vara att högt blodtryck huvudsakligen är ett asymtomatiskt tillstånd. För vårdcentralsläkaren är det en grannliga uppgift att övertyga sin asymtomatiska blodtryckspatient att minska på några av livets njutningsämnen (såsom god mat, sötsaker, salt och alkohol), öka sin fysiska aktivitet och påbörja medicinering för att minska risken för en eventuell hjärtkärlsjukdom i en avlägsen framtid.

Yoga som behandling bygger på flertusenåriga traditioner med ursprung i indisk filosofi. I västvärlden har yogans popularitet som alternativ/komplementär behandling vid olika sjukdoms- och smärttillstånd ökat betydligt de senaste årtiondena. Flera studier har visat att yoga kan sänka blodtrycket, men ofta har studierna kritiserats för att vara för små och för att inte hålla tillräckligt hög vetenskaplig kvalitet.

Syfte: Avhandlingens övergripande syfte var att undersöka om yoga kan fungera som ett behandlingsalternativ/tillägg i svensk primärvård, för patienter med högt blodtryck.

Metod: (Artikel I) Våren 2011 rekryterades 83 hypertoni-patienter från Svedala vårdcentral i Skåne till en studie där effekten av två olika typer av yoga på blodtryck och livskvalitet undersöktes. Deltagarna delades in i tre grupper: *yogaklassgruppen* (där deltagarna träffades för yogaundervisning av instruktör en timme per vecka, och dessutom förutsattes öva hemma på egen hand 30 minuter dagligen), *hemyogagruppen* (där deltagarna fick en kort introduktion av läkare till ett 15 minuters yogaprogram som de uppmanades utföra 15 minuter en gång dagligen) och

kontrollgruppen (som fick leva vidare som tidigare och uppmanades att inte påbörja någon yogaträning under studiens gång).

Före och efter interventionen mättes blodtryck, längd, vikt och bukomfång. Patienterna lämnade information om sin medicinering och fyllde i enkäter om levnadsvanor, sjukhistoria och självupplevd livskvalitet. Fasteblodprover togs för analys av metabola parametrar och för infrysning för framtida analys av inflammatoriska parametrar. Efter baslinjekontrollen matchades patienterna på gruppnivå baserat på systoliskt blodtryck. Interventionerna pågick i 12 veckor.

(Artikel II) Deltagarna från den ovan beskrivna studien analyserades med avseende på riskfaktorer för hjärtkärlsjukdom och inflammatoriska parametrar före och efter yogainterventionen för att undersöka om interventionen medfört någon förändring.

(Artikel III) Under hösten 2013 rekryterades 192 patienter med hypertoni från tre vårdcentraler i sydvästra Skåne (Hjärup, Löddeköpinge och Bara) till en 12 veckor lång studie med syftet att undersöka effekten av ett kort hembaserat yogaprogram (15 minuter morgon och kväll) på blodtryck, livskvalitet, stress samt oros- och depressionsparametrar. Efter baslinjekontrollen randomiserades deltagarna till yoga eller kontroll.

Yogainterventionen lärdes ut av tre olika läkare (en per vårdcentral) vid ett enskilt 30 minuter långt besök.

(Artikel IV) Omedelbart efter att interventionen från studien i artikel III avslutats, intervjuades ett urval av 13 deltagare från yogagruppen enskilt. De fick beskriva sina upplevelser av yogan generellt och även specifikt som behandlingsform mot högt blodtryck. De fick också berätta om sina tankar och upplevelser av att leva med högt blodtryck.

Resultat: (Artikel I) Den korta hembaserade yogainterventionen hade en blodtryckssänkande effekt som var signifikant avseende det diastoliska blodtrycket och en signifikant ökad självskattad livskvalitet. Yogaklass-interventionen hade ingen effekt på varken blodtryck eller livskvalitet.

(Artikel II) Ingen av yogainterventionerna i den första studien ledde till någon förändring av metabola riskfaktorer för hjärtkärlsjukdom eller av inflammatoriska biomarkörer i studiepopulationen.

(Artikel III) Yogainterventionen i den randomiserade kontrollerade studien ledde inte till blodtryckssänkning jämfört med kontroll. Däremot sågs små men signifikanta förbättringar avseende självskattad hälsa och depressionsparametrar i yogagruppen jämfört med kontroll.

(Artikel IV) Två huvudteman utkristalliserades under analysen av intervjuerna. Dessa var: ”Yoga – en mödosam väg till välbefinnande” och ”Högt blodtryck – den tysta sjukdomen”. De positiva erfarenheterna av yogan beskrevs i termer av

lugn/harmoni och ökad smidighet. Nackdelarna var framförallt kopplade till tidsaspekten (för lång tidsåtgång och/eller för ofta). Patienternas utsagor om att leva med högt blodtryck var huvudsakligen negativt präglade. Dels upplevdes högt blodtryck vara förbundet med stigma och skuld över att vara drabbad av en vällävnadssjukdom. Dels gav blodtryckssjukdomen oro för följsjukdomar, och det faktum att sjukdomen är asymtomatisk bidrog till en känsla av ovisshet och osäkerhet.

Slutsatser: (Artikel I–IV) Svenska primärvårdspatienter med högt blodtryck tycks i ganska stor utsträckning vara intresserade av att prova alternativa behandlingar för att nå blodtryckskontroll. Deltagarna i vår kvalitativa intervjustudie beskrev ett flertal positiva effekter av yogan, men pekade också på svårigheter med att implementera det aktuella yogaprogrammet som en regelbunden varaktig livsstilsförändring. De två kvantitativa studierna om yogas inverkan på blodtryck och livskvalitet uppvisade delvis motsägelsefulla resultat. Den randomiserade kontrollerade studien (Artikel III), som till dags dato är den största yoga-blodtrycksstudien från ett OECD-land, ger inte stöd för hypotesen att yoga sänker blodtrycket jämfört med kontroll. Vi fann inte heller något stöd för att yoga påverkar inflammatoriska biomarkörer eller metabola riskfaktorer i en hypertoni population (Artikel II). Däremot sågs positiva effekter på livskvalitet (Artikel I och III), självskattad hälsa och depressionsparametrar (Artikel III) hos yogautövarna jämfört med kontroll. Det är av stor vikt att vi fortsätter att vetenskapligt utvärdera både effekter och upplevelser av ”nya”, alternativa och komplementära behandlingar när de gör sitt intåg i den traditionella västerländska sjukvården.

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Appendices

Health status and lifestyle survey, English and Swedish version

Below are questions about your health and your lifestyle. Select the most suitable option.

Thank you!

		<2 years	2-5 years	5-10 years	10-20 years	>20 years
1	How many years ago did you get diagnosed with high blood pressure?					

		No	Yes
2	Do you have one or more biological relatives who have or have had high blood pressure?		

If yes, what kind of relationship? (e.g., parent, sibling, uncle, cousin, etc.):

		No	No, but I have in the past	Yes
3	Do you smoke?			

		No	No, but I have in the past	Yes
4	Do you use snuff?			

		No, or <1 glass/ w	Yes, 1-5 glasses/ w	Yes, 5-9 glasses/ w	Yes, 10-14 glasses/ w	Yes, 15-19 glasses/ w	Yes, >19 glasses/ w
5	Do you drink alcohol? (wine, beer or spirits) See explanation below of the term "standard glass of alcohol"						

A standard glass of alcohol corresponds to a glass of table wine (12-15 cl), a bottle of beer (33 cl, 5 percent), a small glass of dessert wine (8 cl) or a measure (almost 4 cl of spirits).

		No time	0-30 min	30-60 min	60- 120 min	>120 min
6	How much time do you spend during a typical week doing physical exercise, which will make you feel short of breath, such as running, fitness classes, ball sports?					

		No time	0- 30 min	30- 60 min	1-2 hours	2-3 hours	3-5 hours	>5 hours
7	How much time do you spend during a typical week doing everyday exercise, such as walking, cycling, gardening? Adding together all the time (at least 10 minutes at a time)							

	Do you have or have had any of the following conditions?	Yes	No	I don't know
8	Cerebral infarction/stroke?			
9	Cerebral haemorrhage?			
10	Transient symptoms of stroke, TIA-attack?			
11	Angina?			
12	Coronary heart attack?			
13	Diabetes?			

	Have you had any of the following surgeries?	Yes	No	I don't know
14	Insertion of so called stents in any of the coronary arteries?			
15	Balloon angioplasty in any of the coronary arteries?			
16	Bypass surgery of the heart?			

Do you have any comments on this questionnaire?

THANKS FOR YOUR COOPERATION!

Här följer frågor som handlar om din hälsa och dina levnadsvanor. Markera det mest passande alternativet.

Tack för hjälpen

		<2 år	2-5 år	5-10 år	10-20 år	>20 år
1	För hur många år sedan fick du diagnosen högt blodtryck?					

		Nej	Ja
2	Har du någon eller några biologiska släktingar som har eller har haft högt blodtryck?		

Om ja, vilken typ av släktskap? (t ex förälder, syskon, morbror, kusin etc.):

		Nej	Nej, men har rökt förr	Ja

3	Är du rökare?			
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		Nej	Nej, men har snusat förr	Ja
4	Är du snusare?			

		Nej, eller <1 glas/v	Ja, 1- 5 glas/v	Ja, 5- 9 glas/v	Ja, 10-14 glas/v	Ja, 15-19 glas/v	Ja, >19 glas/v
5	Dricker du alkohol? (vin, öl eller sprit) Se nedan förklaring av begreppet "standardglas"						

Ett standardglas alkohol motsvarar **ett glas bordsvin** (12-15 cl), **en flaska starköl** (33 cl, 5 procent), **ett litet glas dessertvin** (8 cl) eller **en grogg** (knapp 4 cl sprit).

		Ingen tid	0-30 min	30-60 min	60- 120 min	>120 min
6	Hur mycket tid ägnar du en vanlig vecka åt fysisk träning, som får dig att bli andfådd, t ex löpning, motionsgymnastik, bollsport?					

		Ingen tid	0- 30 min	30- 60 min	1- 2 tim	2- 3 tim	3- 5 tim	>5 tim
7	Hur mycket tid ägnar du en vanlig vecka åt vardagsmotion, t ex promenader, cykling, trädgårdsarbete? Räkna samman all tid (minst 10 min åt gången)							

	Har eller har du haft någon av följande sjukdomar?	Ja	Nej	Vet inte
8	Hjärnfarkt/stroke?			
9	Hjärnblödning?			
10	Övergående symtom på stroke, sk TIA-attack?			
11	Kärlkramp			
12	Hjärtinfarkt			
13	Diabetes			

	Har du genomgått någon av följande operationer?	Ja	Nej	Vet inte
14	Inläggning av nät (sk stent) i något av hjärtats kranskärl?			
15	Ballongvidgning av kranskärl i hjärtat?			
16	Bypassoperation i hjärtat?			

Har du några kommentarer till detta frågeformulär?

TACK FÖR DIN MEDVERKAN!

