



UNIVERSITY OF GOTHENBURG

# High blood pressure - determinants and risks

## Implications for treatment and prevention in a primary care setting

Akademisk avhandling  
som för avläggande av medicine doktorsexamen vid Sahlgrenska akademien vid  
Göteborgs universitet kommer att offentligen försvaras i hörsal 2119,  
Hälsövetarbacken, Arvid Wallgrens Backe, hus 2, Göteborg,  
Fredagen den 25 april 2014 kl 13.00  
av

**Jenny Eckner**

Fakultetsopponent:

Professor Lars Hjalmar Lindholm, Umeå Universitet

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

- I. Lindblad U, Ek J, **Eckner J**, Larsson CA, Guangliang S, Råstam L. Prevalence, awareness, treatment and control of hypertension - rule of thirds in The Skaraborg Project. *Scandinavian Journal of Primary Health Care* 2012;30:88-94.
- II. **Eckner J**, Larsson CA, Rastam L, Lindblad U. Blood pressure and global risk assessment in a Swedish population. *International Journal of Hypertension* 2012;2012:835812.
- III. **Eckner J**, Bennet L, Råstam L, Lindblad U, Larsson CA. Lifestyle and physiological characteristics in association with blood pressure categories in a Swedish population: a cross-sectional study (Submitted).
- IV. **Eckner J**, Larsson CA, Bennet L, Råstam L, Lindblad U. High normal blood pressure increases cardiovascular risk by three-fold in a Swedish population. (Manuscript).



## UNIVERSITY OF GOTHENBURG

**Aim:** The overall aim of this thesis was to study determinants and risks associated with increasing blood pressure categories based on a combination of systolic and diastolic blood pressure ranging from optimal blood pressure to manifest hypertension. Emphasis was placed on the importance of focusing on modifiable lifestyle factors and assessment of global risk. The ultimate aim was to identify targets for treatment and prevention. We set out to: 1) study the prevalence and control of hypertension in a representative Swedish population; 2) investigate the association between global risk (SCORE) and ESH/ESC blood pressure categories; 3) study the extent to which physiological factors and lifestyle factors such as physical activity, smoking and alcohol consumption contribute to higher blood pressure levels; 4) investigate the risk of cardiovascular disease associated with different blood pressure categories.

**Methods:** A random sample of residents aged 30-74 years in the municipalities of Vara and Skövde, southwestern Sweden, was surveyed for cardiovascular risk factors in 2002-2005, and 2816 individuals were enrolled (76%). Participants provided detailed information about their medical history and current medication, and completed a questionnaire about lifestyle. Blood pressure was categorized according to the 2007 ESH/ESC recommendations based on a combination of systolic and diastolic blood pressure ranging from optimal blood pressure to manifest hypertension. Information about fatal and non-fatal cardiovascular events was collected from national registers from baseline until end of 2011, and global risk was estimated using the Swedish SCORE chart.

**Results:** In paper I, the prevalence of hypertension in the age group 30-75 years was 20%. A "rule of thirds" emerged, as 1/3 of the participants were not previously known, 1/3 were treated but not controlled, and only 1/3 were treated and controlled. The largest proportion of high global risk was seen in subjects with both hypertension and diabetes (men 76%, women 61%), and a major proportion of patients with known hypertension with a blood pressure  $\geq 160/100$  mmHg were also at a high global risk (paper II). However, a large proportion of patients with mild hypertension had a low risk according to SCORE (paper II). In paper III, age, insulin resistance, BMI, and CRP showed strong age-adjusted associations with increasing blood pressure categories in both men and women ( $p$  values  $< 0.001$ ). In women, lipids ( $p < 0.001$ ), education ( $p = 0.009$ ), physical activity ( $p = 0.038$ ), and alcohol consumption ( $p = 0.002$ , inverse association) were also associated with blood pressure levels, whereas the same was not seen in men. In multivariate analyses, age, insulin resistance, BMI (both sexes), and alcohol consumption (females) remained significantly associated with blood pressure. In paper IV, distinct associations between blood pressure and risk of cardiovascular disease in both sexes were revealed already at levels from 120/80 mm Hg. Compared to those with optimal blood pressure, participants belonging to all other blood pressure categories had an increased cardiovascular risk, and the risks remained statistically significant even after adjustments for both lifestyle and physiological factors, except in the unstable category.

**Conclusions:** The results of this thesis emphasize that blood pressure is associated with a continuously increased risk of cardiovascular morbidity in men and women, which can be seen already at levels from 120/80 mm Hg. Patients with blood pressure above these levels should thus be identified and advised on lifestyle changes to prevent progression to manifest hypertension as well as future cardiovascular disease. Screening to increase awareness, assessment of global risk, and improvements in the implementation of expert guidelines in clinical practice, including pharmacological treatment when indicated, are important steps to achieve this. It is also vital to emphasize population-based prevention, e.g. within the educational system, to also target normotensive individuals.

**Keywords:** Awareness, blood pressure, cardiovascular disease, cohort study, control, ESH/ESC guidelines, gender differences, hypertension, insulin resistance, lifestyle, mechanisms, physical activity, population survey, prevention, primary care.

**ISBN:** 978-91-628-8961-6