

# Determinants of white-coat hypertension

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**Background** The prevalence of white-coat hypertension (WCH) is considerable in patients referred with elevated office blood pressure. Failure to recognise this phenomenon can lead to the inappropriate use of antihypertensive medications. We undertook this study to determine the profile of patients with WCH.

**Methods** Baseline clinic and daytime ambulatory blood pressures were available from 5716 patients referred over a 22-year period. Individuals were considered to have WCH if they had an elevated clinic blood pressure measurement greater than 140/90 mmHg and normal daytime mean ambulatory blood pressure. Mean age was 53.6 years and 53.2% were female.

**Results** The overall prevalence of white-coat hypertension was 15.4%. A higher prevalence was seen amongst older adults, females, and non-smokers.

## Introduction

Blood pressure measurements in the clinical setting may not reflect blood pressure behaviour away from the medical environment [1]. White-coat hypertension (WCH) is the most commonly used term to describe individuals whose blood pressure is only high in the medical setting. Twenty-four-hour ambulatory blood pressure monitoring (ABPM) by providing frequent readings during routine daily activities gives an accurate assessment of blood pressure behaviour, [2] and the technique is now recognized as the most effective means of detecting WCH. Guidelines on hypertension list WCH as one of the few indications for ABPM [3–5]. White-coat hypertension has a relatively benign outcome compared to sustained mild hypertension, which means that failure to recognize the condition may lead to the inappropriate use of antihypertensive medications [6,7]. Unfortunately, patients with WCH have few characteristics other than an elevated blood pressure in the medical environment to assist in suspecting the condition so as to allow greater selection for ABPM. We undertook this study to evaluate the determinants of WCH in a referred population.

## Methods

### Study population

This study analysed blood pressure data of patients referred to the Blood Pressure Unit since 1 June 1980. For this analysis, we selected all patients who had both clinic

**Conclusion** Multivariate logistic regression analysis confirmed these characteristics as independent predictors of WCH. *Blood Press Monit* 9:307–309 © 2004 Lippincott Williams & Wilkins.

*Blood Pressure Monitoring* 2004, 9:307–309

**Keywords:** white-coat hypertension, ambulatory blood pressure measurement, clinic blood pressure measurement, clinical characteristics

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Received 24 August 2004 Accepted 24 September 2004

and ABPM available from their initial visit, along with other baseline characteristics (smoking history and BMI). A total of 5716 patients referred because of elevated clinic blood pressure, who had been instructed to stop antihypertensive medication prior to the initial visit, were eligible for inclusion.

### Ambulatory blood pressure measurement

Ambulatory measurements were made every half-hour throughout the 24-h period using SpaceLabs 90202 and 90207 monitors (SpaceLabs Inc., Redmond, Washington, USA; SpaceLabs Berkshire, UK), which have previously been validated [8,9]. All data were transferred into a specialised software package, (dabl<sup>®</sup> ABPM, DABL Limited, Dublin, Ireland) [10] allowing calculation of systolic and diastolic blood pressures and heart rate in the white-coat window (maximum reading in the first hour recording), daytime pressures (average of readings between 0900 and 2100 h, with the white-coat window excluded), and night-time pressures (average of readings between 0100 and 0600 h) [11]. Ambulatory blood pressure monitoring recordings were regarded as satisfactory if at least 14 daytime readings and six night-time readings were available.

### Clinic blood pressure measurement

The attending nurse in the Blood Pressure Unit performed clinic blood pressure measurement, when

the patient arrived for ABPM. The mean of three clinic measurements was calculated in the non-dominant arm after 5 min of quiet sitting in accordance with the recommendations of the British Hypertension Society [5], using either a standard mercury sphygmomanometer or a the automated Omron HEM-705CP, which has been validated [12].

### Diagnosis of white-coat hypertension

The definition of WCH used in this study was in accordance with European Society of Hypertension guidelines [4], namely a clinic blood pressure greater than 140/90 mmHg and daytime mean ABPM less than 135/85 mmHg.

### Statistical analysis

SAS software (SAS Institute, Cary, North Carolina, USA), version 8.1 was used for statistical analysis. Data are reported as mean  $\pm$  standard deviation. In univariate analysis, proportions were compared by the chi-squared test. In multivariate analysis, a multiple logistic regression analysis model was used. Gender, age, body mass index, smoking history and clinic systolic blood pressure were entered into this model and considered as possible independent determinants of WCH. *P* values  $< 0.05$  were considered statistically significant.

The approval of the local Hospital Ethics Committee was obtained and the management of all data was in keeping with best practice guidelines

## Results

### Patient characteristics

A total of 5716 patients were included in the study of which 53.2% were female. Mean age was 53.6 years with a range of 17–92 years. In all, 23.9% were current smokers, and body mass index averaged 27.3 kg/m<sup>2</sup>. Females had higher clinic systolic blood pressure but lower mean daytime mean systolic ambulatory pressures (Table 1).

### Determinants of WCH

The overall prevalence of WCH in the study cohort was 15.4%. Older patients had a higher prevalence of WCH (Table 2). There was a higher prevalence of WCH among non-smokers, females, and patients with lower clinic systolic blood pressure had a higher prevalence of WCH. Logistic regression analysis showed that age ( $P < 0.01$ ), gender ( $P < 0.001$ ), and smoking history ( $P < 0.001$ ) were independent predictors of WCH.

### Discussion

Suspected WCH is an established indication for ABPM in a number of hypertension guidelines [3–5]. Understanding the likely profile of individuals with the condition could assist in the selection of patients for ABPM. Only a few studies have evaluated the probability of WCH based

**Table 1 Baseline characteristics according to gender**

	All	Male	Female
<i>n</i>	5716	2676	3040
Age (years)	53.6 (14.9)	52.4 (14.5)	54.6 (15.1)
BMI (kg/m <sup>2</sup> )	27.3 (4.9)	27.5 (4.1)	27.1 (5.5)
Current smokers (%)	23.9	25.2	22.8
Clinic SBP	162.0 (27.7)	160.8 (27.3)	163.1 (28.9)
Clinic DBP	93.0 (14.8)	93.8 (15.2)	92.4 (14.4)
Day SBP	145.9 (18.7)	147.3 (16.6)	144.8 (18.7)
Day DBP	88.8 (12.6)	90.9 (12.9)	86.9 (12.0)
Night SBP	128.6 (20.0)	129.6 (19.2)	127.8 (20.6)
Night DBP	75.0 (12.8)	77.2 (13.0)	73.2 (12.4)

Mean values (standard deviation). BMI, body mass index. SBP, systolic blood pressure, DBP, diastolic blood pressure.

**Table 2 Prevalence of white-coat hypertension (WCH) according to patient characteristics**

Characteristic	Grouping	<i>n</i>	Percentage with WCH (%)	<i>P</i> value
Gender	Female	3040	16.8	$< 0.001$
	Male	2676	13.7	
Age	$< 35$ years	682	12.1	$< 0.001$
	35–50 years	1574	14.3	
	50–65 years	2194	16.4	
	$> 65$ years	1266	16.9	
Current smoking	No	4348	16.7	$< 0.001$
	Yes	1366	11.3	
Body mass index	$< 25$ (kg/m <sup>2</sup> )	2096	15.9	NS
	25–29.9 (kg/m <sup>2</sup> )	2271	15.4	
	$> 30$ (kg/m <sup>2</sup> )	1399	15.1	
Clinic SBP	140–159 mmHg	1497	31.2	$< 0.001$
	160–170 mmHg	1543	18.7	
	$< 180$ mmHg	1521	11.8	

*P* values relate to chi-squared test. SBP, systolic blood pressure.

on the clinical characteristics of subjects with the condition and some of these have shown conflicting results [13]. Female sex, young age and brief known duration of hypertension were among independent predictors of WCH in a study carried out in 292 subjects with office diastolic blood pressure between 90 and 104 mmHg [14]. In an international database of 2492 subjects with clinic blood pressure greater than 140 mmHg systolic and/or 90 mmHg diastolic, the probability that hypertensive subjects had an average 24-h ABPM below the 95th centile of a normotensive control group was greater among women and older adults [15].

In our large cohort of patients referred for further evaluation of elevated clinic blood pressures, age, smoking history and gender were independent predictors of WCH. In keeping with other studies WCH was present in a significant proportion of these patients – more than 15%, and nearly a third of patients with clinic systolic blood pressures between 140–159 mmHg had WCH [6,14]. Given that the cohort was taken from a population referred to a hypertensive clinic, the prevalence of WCH observed is probably higher than in a normal population. Also a more conservative cut-off for daytime mean ABPM, as used in other studies, would have reduced the observed prevalence [16].

The findings of this study emphasize the importance of using ABPM in the initial evaluation of patients referred for assessment of elevated clinic blood pressure, particularly in older patients, non-smokers and females.

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