# High blood pressure and associated cardiovascular risk factors in France

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*Objective* To estimate, with respect to age and gender, the prevalence of high blood pressure (BP) in treated and non-treated subjects and its association with other cardiovascular risk factors.

*Design* A cross-sectional study.

*Setting* Healthcare centres in the centre of France.

*Participants* All subjects ($n = 61\,108$) who had a free health check-up, between February 1995 and September 1996.

*Main outcome measures* High BP (systolic blood pressure (SBP) > 140 mmHg, diastolic blood pressure (DBP) > 90 mmHg or antihypertensive therapy); diabetes (fasting glucose plasma concentration > 1.26 g/l or antidiabetic therapy); hypercholesterolaemia (total cholesterol > 2 g/l or lipid-lowering therapy); hypertriglyceridaemia (fasting triglycerides plasma concentration > 2 g/l or triglyceridaemia-lowering therapy); overweight (body mass index $\geq 25$ kg/m$^2$); abdominal fat distribution (waist to hip ratio > 0.9 in males and > 0.8 in females).

*Results* Prevalence of high BP was 37.7% in males and 22.2% in females. BP was normalized in 29.7% of treated males and 44.1% of treated females. High BP was associated with at least another cardiovascular risk factor in 83.8% of the males and 76.7% of the females with high BP. Hypercholesterolaemia was the most frequently associated risk factor. Except smoking, the prevalence of each cardiovascular risk factor was shown to increase with the severity of hypertension. Two or more other cardiovascular risk factors were present in 22.9% of the males and 9.8% of the females with high BP.

*Conclusions* Rate of high BP, even in treated subjects, is high. More than three out of four subjects with high BP have at least one other cardiovascular risk factor. *J Hypertens* 19:1727–1732 © 2001 Lippincott Williams & Wilkins.

## Introduction

Cardiovascular diseases (CVD) are the most prominent cause of premature death in industrialized countries [1]. High blood pressure (BP) is one of the most important modifiable risk factors for CVD and it has been shown that the reduction of highly or moderately elevated BP levels results in a decrease in the risk of cardiovascular complications, including stroke, coronary heart disease and renal insufficiency [2,3]. Consequently, primary prevention of CVD should focus on screening and correction of high BP levels, for which international guidelines have been issued [2,3]. Nevertheless, results from several epidemiological studies have shown that screening for hypertension is less common than would be desirable and that the management of this disease in the general population is sometimes insufficient, resulting in persistent low rates of normalization.

France is known to have low rates of coronary heart disease [4–6]. However, little information is available on the prevalence and treatment of hypertension in the French population. Furthermore, most of the studies did not consider the associated modifiable cardiovascular risk factors, despite the fact that it is now well established that decisions about the management of hypertensive patients should not be based on the level of BP alone, but also on the presence of other risk factors [2,3,7,8].

In order to collect more informative data in France, the prevalence of high BP and associated cardiovascular risk factors and the rate of controlled patients were assessed among subjects examined in healthcare centres in the centre of France.

## Methods
### Data collection
The French national healthcare system (Sécurité So-

ciale/Caisse Nationale d'Assurance Maladie and Caisse Primaire d'Assurance Maladie) provides all working or retired persons and their family members older than 16 with a free health check-up every 5 years. This retrospective cross-sectional study was carried out among all subjects who had such a free health check-up, between February 1995 and September 1996, at healthcare centres of the Institut Régional de Santé in the west centre of France. Eight centres were involved, located in the following geographical subdivisions: Calvados, Indre, Indre et Loire, Maine et Loire, Orne, and Sarthe. Briefly, these geographical subdivisions include middle-sized and small towns, and rural areas.

The check-up comprised a clinical examination, including BP, height, weight, waist and hip measurements, and a fasting blood sample for glucose, total cholesterol and triglycerides plasma concentrations. All blood samples were analysed in the same laboratory (agreement number 3221 and validated according to ISO9001 and ISO9002 norms): fasting glucose plasma concentration was assessed on oxalated plasma with a DAX 24 Technicon® analyser, using the glucose oxidase–peroxidase method; serum total cholesterol and triglycerides were measured on a DAX 24 Technicon® analyser, using the enzymatic method. All subjects completed a questionnaire for the assessment of their cardiovascular drug intake and smoking status (current smoker, nonsmoker, former smoker).

### BP measurement

BP was recorded using a standardized protocol. All measurements were performed, in the supine position, by a trained physician, following the WHO guidelines [3].

### Definition of cardiovascular risk factors

High BP was defined according to the JNC VI [2] and WHO [3] guidelines. Criteria for high BP were a systolic blood pressure (SBP) > 140 mmHg or a diastolic blood pressure (DBP) > 90 mmHg or the existence of an ongoing pharmacological treatment. Stage I (mild hypertension) was defined as a SBP between 140 mmHg and 159 mmHg or a DBP between 90 and 99 mmHg. Stages II and III (moderate and severe hypertension) were defined as a SBP $\geq$ 160 mmHg or a DBP $\geq$ 100 mmHg. Subjects receiving an antihypertensive pharmacological treatment and presenting with a normalized BP level (< 140/90 mmHg) were identified.

Criteria for diabetes were a fasting glucose plasma concentration > 1.26 g/l or an antidiabetic treatment [9]. Hypercholesterolaemia was defined as a total cholesterol > 2 g/l or a lipid-lowering drug intake [10, 11], and hypertriglyceridaemia as fasting triglycerides plasma concentration > 2 g/l or a triglyceridaemia-lowering treatment [12]. A body mass index (BMI)

$\geq$ 25 kg/m$^2$ was a criterion for overweight [13–15], and the abdominal fat distribution, determined by the waist to hip ratio (WHR), was considered abnormal when shown to be > 0.9 in males and > 0.8 in females [15].

### Statistical analysis

Statistical analysis was performed using the Number Cruncher Statistical System software [16]. Independent analyses were performed in each gender. Age was subdivided into four categories: 16–30 years, 31–50 years, 51–65 years, > 65 years. Mean, standard deviation, median, minimal and maximum values and percentages were estimated on the whole population and in each category of age. Because of the small numbers of treated subjects with BP < 140/90 mmHg, all subjects with BP < 140/90 mmHg were grouped in the same 'normotensive' category for the analysis of other cardiovascular risk factors.

## Results

### Characteristics of the studied population

During the study period 61 108 subjects had a health check-up, 48.6% were males. Eleven percent had a health check-up in Calvados, 9% in Indre, 18% in Indre et Loire, 27% in Maine et Loire, 10% in Orne and 25% in Sarthe.

Males were 40.2 ± 12.4 years old (16–86 years) and females were 39.9 ± 12.8 years old (16–90 years). Less than 1% (113 subjects) of the population was older than 75. Mean values of cardiovascular risk factors, except heart rate, increased with age (Tables 1 and 2). Females, especially the younger ones, had a mean BP level lower than males, but the difference between genders was shown to decrease with age, especially in the older patients. Pulse pressure (PP) increases after the age of 50 in both genders. Heart rate was lower in men. Mean fasting cholesterol plasma concentration values were quite similar in both genders, while fasting triglyceride plasma concentration, fasting glucose plasma concentration, weight and WHR were higher in males. BMI was lower in younger females than in males but the difference disappeared after 65 years. In the younger age class, 35% of females and 42% of males were current smokers.

### Prevalence and control of high BP

Prevalence of high BP was 37.7% in males and 22.2% in females (Table 3). Prevalence of high BP was higher in males than in females, especially in the younger age classes, where there were three males with high BP for one female with high BP, this difference decreased with age. About 70% of the high BP subjects had stage I hypertension (74% in males; 68% in females). The severity of the stage of hypertension increased with age. Stages II–III were more frequent in men than in

Table 1  Distribution of cardiovascular risk factors in male subjects

| Cardiovascular risk factors | 16–30 years (n = 6999) | 31–50 years (n = 16 593) | 51–65 years (n = 5599) | > 65 years (n = 501) | All n = 29 692 |
|---|---|---|---|---|---|
| SBP (mmHg) | 128 ± 11 | 131 ± 12 | 139 ± 15 | 145 ± 17 | 132 ± 14 |
| DBP (mmHg) | 75 ± 9 | 80 ± 10 | 83 ± 10 | 85 ± 10 | 79 ± 10 |
| MAP (mmHg) | 93 ± 8 | 97 ± 10 | 102 ± 11 | 105 ± 11 | 97 ± 10 |
| PP (mmHg) | 52 ± 10 | 51 ± 9 | 55 ± 11 | 61 ± 12 | 52 ± 10 |
| Heart rate (bpm) | 68 ± 11 | 67 ± 11 | 68 ± 10 | 68 ± 10 | 67 ± 11 |
| Cholesterol (g/l) | 1.88 ± 0.37 | 2.24 ± 0.40 | 2.31 ± 0.36 | 2.30 ± 0.35 | 2.17 ± 0.42 |
| Triglycerides (g/l) | 0.89 ± 0.67 | 1.22 ± 1.09 | 1.26 ± 0.85 | 1.18 ± 0.62 | 1.15 ± 0.97 |
| Glucose (g/l) | 0.94 ± 0.09 | 0.99 ± 0.14 | 1.04 ± 0.21 | 1.03 ± 0.19 | 0.99 ± 0.15 |
| Tobacco consumption | | | | | |
| Non-smoker (%) | 46 | 39 | 40 | 39 | 41 |
| Smoker (%) | 42 | 30 | 17 | 12 | 30 |
| Former smoker (%) | 11 | 30 | 43 | 48 | 28 |
| Weight (kg) | 70 ± 11 | 75 ± 11 | 76 ± 11 | 74 ± 10 | 74 ± 11 |
| BMI (kg/m$^2$) | 23 ± 3 | 25 ± 3 | 26 ± 3 | 26 ± 3 | 25 ± 3 |
| WHR | 0.85 ± 0.06 | 0.91 ± 0.06 | 0.95 ± 0.06 | 0.97 ± 0.06 | 0.90 ± 0.07 |

Values expressed as mean ± SD. SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; PP, pulse pressure; BMI, body mass index; WHR, waist to hip ratio.

Table 2  Distribution of cardiovascular risk factors in female subjects

| Cardiovascular risk factors | 16–30 years (n = 7851) | 31–50 years (n = 17 176) | 51–65 years (n = 5737) | > 65 years (n = 652) | All n = 31 416 |
|---|---|---|---|---|---|
| SBP (mmHg) | 120 ± 10 | 123 ± 13 | 133 ± 15 | 143 ± 17 | 152 ± 14 |
| DBP (mmHg) | 72 ± 9 | 75 ± 9 | 80 ± 9 | 82 ± 10 | 75 ± 10 |
| MAP (mmHg) | 88 ± 8 | 91 ± 10 | 98 ± 10 | 102 ± 11 | 92 ± 10 |
| PP (mmHg) | 48 ± 8 | 48 ± 9 | 53 ± 11 | 60 ± 13 | 49 ± 10 |
| Heart rate (bpm) | 72 ± 11 | 70 ± 10 | 69 ± 10 | 70 ± 10 | 70 ± 10 |
| Cholesterol (g/l) | 1.92 ± 0.33 | 2.08 ± 0.35 | 2.34 ± 0.37 | 2.39 ± 0.37 | 2.09 ± 0.38 |
| Triglycerides (g/l) | 0.80 ± 0.44 | 0.80 ± 0.47 | 0.97 ± 0.57 | 1.04 ± 0.55 | 0.83 ± 0.49 |
| Glucose (g/l) | 0.89 ± 0.09 | 0.93 ± 0.12 | 0.97 ± 0.17 | 0.98 ± 0.17 | 0.93 ± 0.13 |
| Tobacco consumption | | | | | |
| Non-smoker (%) | 55 | 67 | 87 | 90 | 68 |
| Smoker (%) | 35 | 19 | 5 | 4 | 20 |
| Former smoker (%) | 10 | 14 | 8 | 7 | 12 |
| Weight (kg) | 58 ± 10 | 61 ± 11 | 63 ± 11 | 63 ± 11 | 60 ± 11 |
| BMI (kg/m$^2$) | 22 ± 3 | 23 ± 4 | 25 ± 4 | 26 ± 4 | 23 ± 4 |
| WHR | 0.74 ± 0.06 | 0.78 ± 0.07 | 0.82 ± 0.08 | 0.86 ± 0.08 | 0.78 ± 0.07 |

Values expressed as mean ± SD. SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure; PP, pulse pressure; BMI, body mass index; WHR, waist to hip ratio.

Table 3  Prevalence of high BP and stage of hypertension in male and female subjects, according to age

| | | 16–30 years | 31–50 years | 51–65 years | > 65 years | All |
|---|---|---|---|---|---|---|
| n | M | 6999 | 16 593 | 5599 | 501 | 29 692 |
| | F | 7851 | 17 176 | 5737 | 652 | 31 416 |
| Normal BP (%) | M | 78.5 | 64.6 | 39.4 | 19.68 | 62.4 |
| | F | 92.6 | 81.4 | 52.4 | 26.0 | 77.8 |
| High BP | | | | | | |
| Normalized* BP (%) | M | 0.3 | 1.6 | 3.9 | 6.2 | 1.8 |
| | F | 0.5 | 2.7 | 7.2 | 8.1 | 3.1 |
| Hypertension stage I (%) | M | 18.5 | 26.6 | 40.8 | 50.7 | 27.8 |
| | F | 6.1 | 12.9 | 31.2 | 45.4 | 15.2 |
| Hypertension stage II–III (%) | M | 2.7 | 7.2 | 15.9 | 23.6 | 8.1 |
| | F | 0.8 | 3.0 | 9.2 | 19.6 | 3.9 |
| Prevalence (%) | M | 21.5 | 35.4 | 60.6 | 80.5 | 37.7 |
| | F | 7.4 | 18.6 | 47.6 | 73.1 | 22.2 |

*and treated subjects. No hypertension or normalization: SBP/DBP < 140/90 mmHg; hypertension stage I: SBP between 140 and 159 mmHg or DBP between 90 and 99 mmHg; hypertension stage II–III: SBP ⩾ 160 mmHg or DBP ⩾ 100 mmHg. Prevalence: BP > 140/90 mmHg. M: male; F: female subjects; BP: blood pressure

women (8 versus 4%) and were present in 20–24% of the older patients.

In addition, 6.1% (*n* = 1799) of males and 7.0% (*n* = 2203) of the females in the whole population were receiving an antihypertensive pharmacological treatment (0.6% in subjects < 30 years, and about 30% in those > 65 years). Among the treated patients, BP was normalized in 29.7% of the males and 44.1% of the females. Forty-seven per cent of treated males and 40% of treated females had a stage I hypertension, 23% of the treated males and 16% of the treated females had a stage II–III hypertension.

### High BP and other cardiovascular risk factors
In 83.8% of high BP males and 76.7% of high BP females, high BP was associated with at least one other cardiovascular risk factor. The prevalence of the association of high BP with another cardiovascular risk factor increased with age in both genders (Fig. 1): after 65 years, high BP was associated with at least one cardiovascular risk factor in 87.5% of high BP males and 91.0% of high BP females, compared to 61.0 and 59.7%, respectively, in the younger age category. Hypercholesterolaemia was shown to be the most frequently associated risk factor. High BP was associated with two or more other cardiovascular risk factors in 22.9% of the high BP males and 9.8% of the high BP females.

The prevalence of cardiovascular risk factors according to the stage of hypertension is presented in Table 4. Except for smoking, the prevalence of each cardiovascular risk factor increased with the severity of hypertension. Except in young females, the percentage of current smokers decreased with the severity of hypertension. In males the percentage of former smokers



Fig. 1
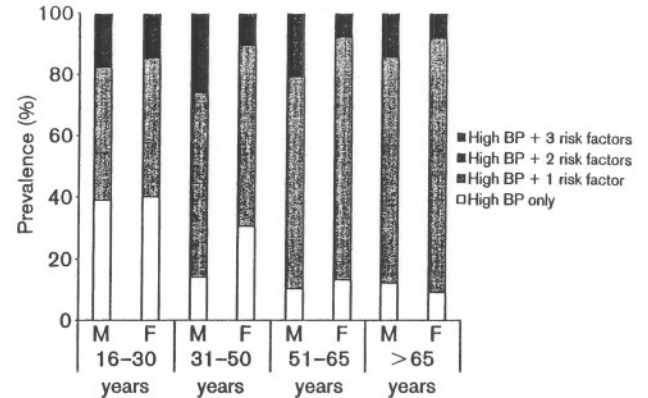
Prevalence of associated cardiovascular risk factors in high blood pressure (BP) subjects, according to age. M, male; F, female subjects.

increased with the level of BP (results not shown). Prevalence of hypercholesterolaemia increased with age in both genders and was higher than 70% in subjects over 65 years, but was not associated with the severity of hypertension in this age category (results not shown).

## Discussion
This study showed a high prevalence of patients with high BP levels among included subjects: 37.6 and 22.2% in males and females, respectively.

The observed rate of high BP patients among the studied population falls within the range of that from neighbouring countries [17–19], and is only a little higher than that reported in subjects in the Paris area who had a free health check-up around the same period of time (1992–1997): 31.1 and 27.4% in males and females, respectively [20].

**Table 4**  Prevalence of associated cardiovascular risk factors according to the stage of hypertension in both genders

|  |  | BP < 140/90 mmHg | Hypertension stage I | Hypertension stage II–III | All |
|---|---|---|---|---|---|
| *n* | M | 19 049 | 8245 | 2398 | 29 692 |
|  | F | 25 403 | 4779 | 1234 | 31 416 |
| Cardiovascular risk factor |  |  |  |  |  |
| Cholesterol > 2 g/l* | % M | 60.0 | 73.5 | 80.0 | 65.4 |
|  | % F | 53.2 | 71.2 | 75.4 | 56.8 |
| Triglycerides > 2 g/l* | % M | 11.4 | 20.4 | 28.3 | 15.3 |
|  | % F | 4.9 | 13.7 | 16.6 | 6.7 |
| Cholesterol > 2 g/l* or triglycerides > 2 g/l* | % M | 60.9 | 74.8 | 81.4 | 66.4 |
|  | % F | 53.5 | 71.7 | 76.2 | 57.1 |
| Glucose > 1.26 g/l* | % M | 1.4 | 4.3 | 7.9 | 2.7 |
|  | % F | 0.6 | 3.1 | 5.0 | 1.2 |
| Tobacco | % M | 32.9 | 26.3 | 24.7 | 30.4 |
|  | % F | 22.2 | 11.7 | 9.3 | 20.1 |
| BMI ⩾ 25 kg/m² | % M | 35.7 | 58.5 | 72.1 | 45.0 |
|  | % F | 21.9 | 48.9 | 59.6 | 27.5 |
| WHR > 0.9 | % M | 37.6 | 56.1 | 67.6 | 45.1 |
| WHR > 0.8 | % F | 24.3 | 43.5 | 53.4 | 28.3 |

*or treatment. BMI, body mass index; WHR, waist to hip ratio.

Less than 7% of patients in the studied population were receiving antihypertensive drug treatment; this is much lower than the 24% estimated in French general practice [21]. This discrepancy may be due to the fact that in the latter study the population studied was of patients visiting general practitioners, thus *a priori* unhealthy subjects, whereas in the present study, the population was theoretically healthy.

In the present population, prevalence of non-normalization of BP in treated hypertensive patients was high.

Data from epidemiological studies in industrialized countries show conflicting results in the trend of controlled BP among treated hypertensive subjects [18,19]. Population studies from several countries have shown that the proportion of controlled hypertensive patients was less than 30%, when controlled hypertension is defined as a mean BP level below 140/90 mmHg [22,23]; a recent survey in the UK indicated that only 6% of hypertensive subjects presented with such BP levels [24]. In the USA (NHANES III), 14, 25 and 24% of Hispanic, Afro-American, and white non-Hispanic patients, respectively, achieved control of their hypertension [25]. The Scottish survey performed in 1990 reported a 50% rate of controlled hypertensive men, but the target BP level was < 160/95 mmHg [26]. In France, the rate of treated patients achieving the target BP level < 140/90 mmHg was estimated to be 24% in a study conducted in general practice [21]; the study performed in Paris between 1992 and 1997 [20] reported percentages of treated normalized subjects of 24% of male and 30% of female subjects. Despite the higher normalization rates reported in the present study (29.7% of male and 44.1% of female subjects), the current results confirmed that the prevalence of hypertension and uncontrolled BP level in treated hypertensives is high, even in apparently healthy people who come for a simple health check-up.

This study also showed that adequate BP control is achieved more frequently in treated hypertensive females than in their male counterparts. These findings are in agreement with results from previous studies in other countries [17,25–30] and in France [31] and indicate that this is a general trend. The reasons for the discrepancy between genders are not straightforward [31].

The increased prevalence of high BP with age has been shown in other studies [3] and is of public concern because of the ageing of Western populations [32,33]. However, this study does not allow a specific analysis in elderly people as the upper age class includes few people older than 75.

One limitation of the present study was that BP was assessed at only one visit, as in most published epidemiological studies, where the prevalence of hypertension relies on a single visit with one or two BP measurements [20,21,26–32,34] and this may result in an overestimation of the prevalence of hypertension. On the other hand, in clinical practice, after initiation of a pharmacological treatment, adaptation of therapy is usually based on a single BP evaluation; for the same reason, i.e. the risk of 'white coat' hypertension, this single measurement may lead to an underestimation of therapeutic success and of the proportion of patients with adequately controlled BP [35].

The estimation of high BP prevalence, following the current guidelines for the management of hypertension [2,3], was essentially based on SBP and DBP measurements, two specific inflection points of the BP wave, which are usually considered in isolation. However, BP propagates through the arterial tree as a repetitive continuous wave and is more accurately described as consisting of a pulsatile component, the pulse pressure (PP) and a steady component (mean pressure). PP was recently identified as an independent risk factor [36]. The Hypertension Detection and Follow-up Program reported that all-cause mortality increased by 11% per 10 mmHg increment in PP [37]. The present study showed that PP increased after the age of 50 in both genders. Few studies on hypertension have reported results on PP, and no recommendation exists yet on an optimal target PP level [38]. Consequently, no cut-off level allowing a definition of high PP could have been used in this study.

Another limitation of the present study is that the estimation of the absolute cardiovascular risk was not planned. A patient's prognosis depends more on the sum of their risk factors than on their BP [39]. The present study confirmed that high BP is often associated with other cardiovascular risk factors [2,40]. More than three out of four high BP patients had at least one other cardiovascular risk factor. This high prevalence may be explained partly by environmental factors, such as alcohol drinking pattern [41-43], associated both with BP and other cardiovascular risk factors, or with cardiovascular risk factors such as overweight or diabetes [18,44], linked to hypertension. This emphasizes the need to treat hypertension together with environmental factors by lifestyle measures and pharmacological treatment if needed. The inverse relationship between current smoking and high BP that has been reported previously [30] in addition to the increase in the prevalence of former smokers with the level of BP in males, support the effective intervention for smoking cessation in hypertensives.

In conclusion, these results indicate that, even in a relatively highly motivated population, the percentage

of patients with elevated BP levels is high, as well as the percentage of uncontrolled hypertension in treated patients. Furthermore, the observed increase in PP after 50 years would probably have given even worse results on the estimation of BP control, if PP could have been taken into account. Another important conclusion of the present analysis is the high prevalence of associated cardiovascular risk factors in subjects with high BP.

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