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Article

Trends in hypertension management in Type I diabetes across Europe, 1989/1990 – 1997/1999

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Abstract *Aims/hypothesis* Our aim was to examine the change in the management of hypertension in patients with Type I (insulin-dependent) diabetes mellitus in Europe, between 1989–1990 and 1997–1999.

Methods Seven-year changes in hypertension treatment and control (defined as blood pressure <130/85 mmHg) were examined in a large sample of Type I diabetic patients recruited from 26 centres involved in the EURODIAB Prospective Complications Study. Hypertension was defined as a systolic and/or diastolic blood pressure greater than 140 and/or 90 mmHg respectively, and/or use of blood pressure lowering drugs.

Results Of 1866 Type I diabetic patients, 412 had hypertension at baseline and 631 at follow-up. A greater proportion of hypertensive patients were treated at follow-up (69% vs 40%, $p<0.0001$), which persisted after adjustment for age or centre. Of those who were treated, a modest increase in the proportion of those controlled for hypertension was found (41% vs 32%, $p=0.048$), which disappeared after adjustment for age. Among hypertensive patients with albuminuria, the proportions treated also increased, from 35% to 76% ($p<0.0001$) in microalbuminuric and 64% to 95% ($p<0.0001$) in macroalbuminuric patients. Control of hypertension in albuminuric patients did not change significantly and was below 50%. The use of more than one anti-hypertensive drug increased over a 7-year period, from 19% to 33% ($p<0.0001$), and a marked increase was shown in the proportion of those taking an ACE inhibitor (from 57% to 82%, $p<0.0001$).

Conclusion/interpretation The management of hypertension in Type I diabetic patients across Europe has improved over a 7-year follow-up period. Optimal levels of blood pressure treatment and optimal levels of control have not yet been achieved.

Keywords Hypertension · Type I diabetes mellitus · albuminuria · control · blood pressure · treatment

Abbreviations

CCB Calcium channel blocker

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In Type I (insulin-dependent) diabetes mellitus, raised blood pressure has been shown to be related to an increased risk of retinopathy [1, 2, 3], and cardiovascular disease [4, 5] in several prospective studies independent of other risk factors. It is estimated that 30 to 75% of diabetic complications can be attributed to hypertension, which is twice as common in diabetic patients than in non-diabetic people [6].

Several BP lowering trials have shown a reduction in microvascular and macrovascular complications in patients with Type II (non-insulin-dependent) diabetes mellitus [7, 8]. Other recent trials have shown that, independent from BP lowering effects, the progression of diabetic nephropathy can be reduced by angiotensin II receptor blockers in Type II diabetic patients with hypertension and albuminuria [9, 10, 11]. In Type I diabetes, the progression of retinopathy [12]

and nephropathy [13, 14] has also been reduced with the use of ACE inhibitors in normotensive subjects.

Since the overall risk of developing cardiovascular complications in diabetic patients is higher than in non-diabetic people and, given the importance of increased BP in the pathogenesis of diabetic complications, several expert groups have made specific recommendations on the management of hypertension in diabetic patients (Table 1). All these guidelines stress that a diagnosis of hypertension should be based on repeated measurements, management decisions should consider the presence of cardiovascular, renal and retinal end-organ damage, and that a trial period of non-pharmacological intervention is appropriate in those with mild hypertension. The guidelines recommend treating diabetic patients to a lower target BP than in the non-diabetic population, especially in the presence of proteinuria.

[Table 1. will appear here. See end of document.]

Previous studies on hypertension treatment and control in non-diabetic cohorts in Europe and in the United States [15, 16, 17, 18, 19, 20, 21] have shown improvements over time, but inadequate management of hypertension. However, few studies have examined the management of hypertension specifically in diabetic patients [22, 23].

The purpose of our study is to evaluate the impact of hypertension guidelines on the management of hypertension in Type I diabetic patients in the EURODIAB Prospective Complications Study. We have previously published data on the management of hypertension at baseline in the EURODIAB IDDM Complications Study cohort [24]. This study examines how hypertension management has changed after a 7-year period and to what extent this is independent of the cohort getting older.

Subjects and methods

Study design and subjects. Full details of the design, methods and recruitment in the EURODIAB PCS have been published elsewhere [25, 26, 27]. The baseline cross-sectional clinic-based study was carried out in 1989–1991. It was set up to explore risk factors for diabetic complications in 3250 randomly selected people with Type I diabetes of 15 to 60 years of age and attending 31 diabetic clinics in 16 European countries. Sampling was stratified by age, sex and diabetes duration. Type I diabetes was defined as diabetes diagnosed before the age of 36 years with a continuous need for insulin within 1 year after diagnosis. Of those invited 85% participated. Those with

diabetes for less than 1 year and pregnant women were not recruited into the study. At each clinic informed consent from all subjects and ethics committee approval for the study was obtained.

Follow-up. Approximately 6 to 8 years after the baseline examinations the study participants were traced and invited back for re-examination. Of the 3250 subjects at baseline, 460 were from centres who did not participate at follow-up. Five centres did not participate in assessments on the management of hypertension at follow-up. Of the remaining 2790 subjects, 2334 subjects were traceable, 99 had died and 357 were lost at follow-up, 1880 had vital status data, of which 1866 subjects were examined for hypertension related assessments, from 26 diabetic clinics in 14 European countries (France, Poland, Croatia, Italy, Finland, Portugal, Austria, Germany, Luxembourg, Belgium, the Netherlands, England, the Republic of Ireland and Greece).

Measurements. The same methods were used at baseline and at follow-up. Patients were asked whether they had had high BP, angina, a heart attack or stroke at any time in the past, diagnosed by a doctor or a nurse. Blood pressure was measured by a random zero sphygmomanometer (Hawskley, Lancing, UK). Using an appropriately sized cuff, two BP readings were taken from the right arm with the patient in a seated position after resting for 5 min. Readings were taken from the top of the meniscus and measurement was recorded to the nearest 2 mmHg. Diastolic BP was recorded at the disappearance of sound (Korotkoff phase V). Data presented here are based on the mean of two measurements. Hypertension was defined as a systolic BP of 140 mmHg or more, or a diastolic BP of 90 mmHg or more, and/or the current use of BP lowering drugs. Patients were considered to be treated for hypertension if they were currently taking BP lowering drugs as assessed from clinical records by local investigators. Control was defined as having a systolic BP of less than 130 mmHg and a diastolic BP of less than 85 mmHg.

A single-timed 24-h urine collection was done to calculate albumin excretion rate after excluding proteinuria due to urinary tract infection. Urinary albumin was measured in a single laboratory by an immunoturbidimetric method (Sanofi Diagnostics Pasteur, Minneapolis, Minn., USA) [28]. Albumin excretion rate was categorised as normoalbuminuria at 20 μg/min or less, microalbuminuria between 20 and 200 μg/min and macroalbuminuria at 200 μg/min or more. At baseline, albumin excretion rates were measured once, whereas at follow-up these were measured twice, with the mean taken as data. If only one measurement was available then the result of just that one collection was used, but this was only the case in 11% (170 out of 1594) of the total number of patients.

Statistical analysis. The statistical packages SAS (SAS, Cary, N.C., USA) and STATA (STATA 6.0, Tex., USA) were used to carry out all statistical analyses. Chi-square and Student's *t* tests were used to test for differences in baseline risk factors between those included and those lost at

follow-up. Mc-Nemar and paired *t* tests were used to analyse differences in risk factors between the baseline and follow-up sample. The crude proportions of patients with hypertension, those who were on treatment and who were controlled were calculated both at baseline and at follow-up. These proportions were presented by 10-year age bands (using the baseline age) and by albuminuric status. Trends with age (age bands) in hypertension parameters were tested for using chi-square tests for trend. The 95% confidence intervals were calculated for the proportions (of the total) and the chi-square test or Mc-Nemar tests (if denominators were exactly similar) were used to test for differences in the proportions between baseline and follow-up. To test if changes over time in the proportions of hypertensives, treated and controlled for hypertension were independent of age, further conditional or logistic regression models were conducted, fitting time (as a dummy variable baseline or follow-up) and age (age at baseline or follow-up) for the subjects who were included at both timepoints. Likelihood ratio tests were used to test differences between models on hypertension, treatment or control, fitting time alone and models with both time and age. Similarly, the effects of centre on changes in hypertension, treatment and control over time were tested with likelihood ratio tests, to compare logistic regression models fitting time and centre (fitted as a dummy variable) with models fitting time alone. In addition, possible risk factors related to control of BP were analysed by using chi-square tests for categorical variables or *t* tests for continuous variables. A *p* value of less than 0.05 was considered to be statistically significant.

Results

The mean age at baseline was 33 years (age ranged from 14.9–60.7 years) and the mean duration of diabetes was 15 years (SD=9) (Table 2).The baseline characteristics of those included in this analysis (*n*=1866) and those lost to follow-up (*n*=1384) were mostly similar, except for a slightly higher proportion of current smokers (chi-square *p*=0.002) and a higher frequency of retinopathy (chi-square *p*=0.02), albuminuria (chi-square *p*=0.01), hypertension (chi-square *p*=0.001) and cardiovascular disease (chi-square *p*=0.001) in those who were lost at follow-up (Table 2). Patients who were lost at follow-up reported slightly more use of BP lowering drugs and were less well-controlled than those included in the study, but these findings were not statistically significant.

[Table 2. will appear here. See end of document.]

Sample characteristics changed between baseline and follow-up. By the time of follow-up, patients were on average 7 years older (mean age: 40 years, range from 22.6–67.6 years) and subsequently had a longer duration of diabetes (Table 2). In addition, there was a higher proportion

of patients with cardiovascular disease (McNemar p=0.001) and retinopathy at follow-up (McNemar p=0.001). All other risk factors were similar between baseline and follow-up.

Proportion of hypertensive patients. The (crude) proportion of hypertensive patients (systolic BP ≥140 mmHg or diastolic BP ≥90 mmHg or current use of anti-hypertensive drugs) increased from 22% (412/1866) at baseline to 34% (631/1866) at follow-up (McNemar p=0.001, Table 2). Of those who were hypertensive at baseline, 73% were still hypertensive at follow-up. As expected the proportion of hypertensive patients increased with age, for both men and women (chi-square test for trend p=0.001, Table 3). To show whether this increase over time was greater than expected from the ageing of the cohort, the data is presented by baseline age bands (Table 3). An increase in hypertension prevalence was found across all age groups. However, further modelling with conditional logistic regression models showed that there was no increase in hypertension over time when adjusted for age (Likelihood ratio-test p=0.51). Further adjustment for centre did not alter these results. Hence, after adjusting for age, the proportion of hypertensive patients was similar between baseline and follow-up.

[Table 3. will appear here. See end of document.]

Treatment of hypertension. Of those with hypertension, the crude proportion who were treated with BP lowering drugs increased from 40% (163/409) at baseline to 69% (434/628) at follow-up (chi-square p<0.0001) (Table 2). Of those on BP lowering drugs at baseline, 93% were reported to be still on drugs at follow-up. The proportions treated at baseline and at follow-up varied with age (chi-square test for trend p=0.01, Table 3). Treatment significantly improved comparing baseline and follow-up assessments across all age-bands (chi-square p<0.001). Further modelling with logistic regression analysis showed that the increase in treatment with BP lowering drugs over time remained significant, after adjustment for the ageing effect (likelihood ratio-test p<0.0001). Adjustment for centre did not change these findings.

Control of hypertension. Control of hypertension (defined as a systolic BP <130 and diastolic BP <85 mmHg) increased from baseline 32% (51/161) to follow-up 41% (176/434), in hypertensive patients who were on treatment, but was borderline significant (chi-square p=0.048) (Table 2). Of those controlled at baseline, only 59% were controlled at follow-up. A trend with age in control of hypertension was found (chi-square test for trend p=0.02). There were improvements in control of hypertension between baseline and follow-up by age-bands, but these were not statistically significant (Table 3). Further modelling with logistic regression analysis showed that there was no significant increase in the control of hypertension over time (likelihood ratio-test p=0.09) after allowing for the ageing effect. Adjustment for centre did not alter these results.

Factors associated with poor control of hypertension at follow-up. Baseline risk factors related to control of hypertension at follow-up (n=176 controlled, 258 not controlled) in treated hypertensive patients were analysed. There were no differences in sex, smoking status, albuminuria status, concentrations of glycated haemoglobin, fasting triglycerides and HDL-cholesterol between those controlled and those not-controlled. Those not controlled were more likely to have had complications at baseline, including retinopathy (78% vs 67%, chi-square p=0.07) and cardiovascular complications (19% vs 11%, chi-square p=0.03) compared to well controlled patients. They were also older (baseline age 39 vs 35 years, p<0.0001), had longer duration of diabetes (21 vs 18 years, t test p=0.001), and had higher systolic and diastolic BP (137/84 vs 124/78 mmHg, t test p<0.0001), BMI (24.8 vs 23.9 kg/m^2, t test p=0.005), WHR (0.87 vs 0.85, t test p=0.05), total cholesterol (5.8 vs 5.5 mmol/l, t test p=0.003) and LDL-cholesterol (3.8 vs 3.4 mmol/l, t test p=0.002).

Management of hypertension in albuminuric patients. Unadjusted proportions of the frequency, treatment and control of hypertension are shown by albuminuria status (Table 4). The proportion of hypertensive patients, those treated and controlled increased with albuminuric status. From baseline to follow-up, there was an increase in the proportion of hypertensive patients across all albuminuric groups, which was not statistically significant after adjusting for age. The proportion of those with microalbuminuria and macroalbuminuria treated for their hypertension increased from baseline to follow-up, from 35% to 76% (chi-square p<0.0001) and from 64% to 95% (chi-square p<0.0001), respectively. For control of hypertension in albuminuric patients who were hypertensive and who were treated with BP lowering drugs, non-significant increases were shown from 35% to 47% (chi-square p=0.18) in those with microalbuminuria and from 22% to 36% (chi-squared p=0.06) in those with macroalbuminuria.

[Table 4. will appear here. See end of document.]

Number and type of BP lowering drugs used among those on treatment. A larger proportion of all diabetic patients were treated with BP lowering drugs at follow-up (23%, 435/1866) compared to baseline (17%, 310/1866) (Mc-Nemar p<0.0001). The use of ACE-inhibitors increased from baseline (57%) to follow-up (82%) (chi-square p<0.0001) (Table 5). At baseline, 81% were on one drug, whereas at follow-up, this proportion had decreased to 67%. More patients were treated with multiple drugs in 1997 to 1999 (33%) than at baseline (19%) (chi-squared p<0.0001). An ACE-inhibitor and a calcium antagonist was the predominantly used combination among those receiving two BP lowering drugs at both time-points and increased from 1989–1990 to 1997–1999. Similar patterns in the use of BP lowering drugs were shown for patients with albuminuria. About 77% of those treated for hypertension, but not controlled, were taking one drug at follow-up.

[Table 5. will appear here. See end of document.]

Discussion

We have shown in this EURODIAB PCS cohort of Type I diabetic patients that hypertension treatment has improved over a 7-year follow-up period. However, the number of patients treated and well controlled is still not optimal, especially in patients with both hypertension and albuminuria. Poor control at follow-up is related to a more atherogenic risk profile and a higher frequency of complications at baseline. There is still a long way to go before target BP levels, according to new and more stringent guidelines, will be reached. We have also shown an increase in the use of ACE-inhibitors, a decrease in the use of monotherapy and an increase in the use of multiple drugs from baseline to follow-up.

Clinical trials with BP lowering drugs. Convincing evidence exists of the beneficial effects of reducing BP in Type II diabetic patients, summarised in several reviews [7, 8]. Lower target levels (<130/80 mmHg) were indicated [29, 30, 31] and greater risk reductions were reported in diabetic patients than in non-diabetic subjects [32, 33] Different anti-hypertensive treatments have been examined, including ACE inhibitors [31, 34, 35, 36], diuretics or beta-blockers [32, 36, 37, 38] and CCB's [33, 35, 36, 37, 38] which all have been shown to be beneficial compared to placebo or conventional treatments. To achieve lower BP goals in diabetic patients with hypertension, the use of ACE inhibitors (or angiotensin II receptor blockers if ACE inhibitors cannot be tolerated) as first-line therapy and the use of multiple agents has been shown to be advantageous [29, 30]. The benefits of angiotensin II receptor blockers [9, 10, 11] on nephropathy has been shown in Type II diabetes. To date, there are no BP lowering trials reporting on microvascular and macrovascular events in Type I diabetes, even though reductions in the progression of retinopathy [12] and nephropathy [13, 14] were reported with the use of ACE inhibitors in normotensive subjects.

Hypertension management guidelines. Several national and international guidelines have been published on the management of hypertension in diabetes. These guidelines, which include recommendations for specific populations such as diabetic patients, could have contributed to the improvement of the hypertension treatment over time. On the other hand, the complexity of the guidelines and the absence of proper guidelines for Type I diabetes could have discouraged physicians from applying them, leading to suboptimal management of hypertension. Most guidelines, but not all, recommend a systolic BP target of less than 130 mmHg and a diastolic BP

target of less than 85 mmHg and recommend earlier intervention in Type I diabetic patients, especially in those with albuminuria.

Observational studies on hypertension treatment and control. Substantial evidence from European and American studies has confirmed improvements in treatment and control of hypertension but still with suboptimal BP levels in non-diabetic subjects, from cross-sectional [39, 40, 41, 42, 43, 44, 45, 46] and prospective studies [15, 16, 17, 18, 19, 20, 47, 48, 49, 50].

In the EUROASPIRE I and II studies (1995–1996 to 1999–2000) in patients with coronary heart disease, the proportion of hypertensive patients was high at both timepoints (55% vs 54%), but the proportion of patients on BP lowering drugs achieving a target of <140/90 mmHg was low and did not change over time (44% vs 45%). In the same study, there was a slight increase in the use of BP lowering drugs (84% to 89%), and an increase in the use of beta-blockers (54% to 66%) and ACE inhibitors (from 30% to 43%) [17].

In the United States, using data from the National Health and Nutrition Examination Survey (NHANES) more than 7000 non-diabetic subjects, increases in the treatment and control of hypertensive patients but with suboptimal levels of management, were shown from 1976–1980 (NHANES II) to 1991–1994 (NHANES III phase 2) [16]. With the same definition of hypertension, the proportion of hypertensive patients treated with blood pressure lowering drugs increased from 31% to 53%, which is similar to our data (increases from 40% to 69%). Control of hypertension (<140/90 mmHg) increased, as a proportion of the hypertensive patients (from 10% to 27%) which is similar to our data (from 12% to 28%) [15, 16]. For control of hypertension using treated hypertensive patients as the denominator, an increase was seen from 32% to 55% (NHANES phase 1 1988–1991), corresponding with our data (32% to 41%) [49].

In Type I diabetes, the Pittsburgh (USA) Epidemiology of Diabetes Complications Study, showed an increase in control of hypertension from 38% in 1986–1988 to 49.5% in 1996–1998 in those treated and aware of hypertension [23].

Possible explanations for poor hypertension control. Multiple factors could explain suboptimal levels of treatment and control of hypertension but both the patient and physician are important. From the patients' perspective, male sex [39, 46], obesity [39, 40], alcohol [18] and patient education [51] have been suggested to explain poor control. In our study, we also found that increased age, duration of diabetes, BP levels, lipid concentrations and the presence of more complications, as well as obesity at baseline partly explained the reasons for poor control at follow-up. In addition, costs and side-effects of drugs, the complexity of the regimen including multiple drugs and dosages,

lack of patients' adherence to medication and lifestyle modifications could contribute to poor control.

From the physicians' point of view, inappropriate or ineffective treatments, lack of acceptance or knowledge of hypertension treatment guidelines, costs and side-effects, and dosing schedules of drugs have been suggested to play a role in poor management [52, 53, 54]. As a result physicians have been shown to initiate treatment at higher BP thresholds than existing guidelines, are less attentive to controlling BP because they are satisfied with the existing BP, seldom intensify drug therapy for BP above target levels and are more likely to treat or control increased diastolic BP than systolic BP [53, 54, 55].

Limitations of the EURODIAB PCS. The EURODIAB PCS provides a useful European-wide summary as the same standardised methods for BP measurements and albumin excretion rate assessments were used in each centre. However, there are some limitations. This is a clinic-based, and not a population-based study, and is therefore not fully representative. The definition of hypertension used in most studies is a problem because a person treated with BP lowering drugs is considered to be hypertensive, which could lead to an overestimation of the proportion of hypertensives. The apparent increase in the proportion of hypertensives over time is explained by the age, as well as a higher proportion of patients being treated. By examining this sample of Type I diabetic patients in 1989 to 1990 the physicians would have been alerted to put patients on treatment for their hypertension therefore influencing the measurements in 1997 to 1999. As BP was measured on a single occasion, it could also have led to overestimations in the proportion of hypertensives, although two recordings were taken. Underestimations in our results were possibly caused by those patients lost at follow-up who had a higher frequency of complications (retinopathy, cardiovascular disease and hypertension) compared with the baseline sample.

The compliance with BP lowering treatment, the actual indication for taking the BP lowering drugs and non-pharmacological lifestyle interventions could not be assessed in this study. Despite the standardization of methods, there are possible differences between countries in the management of hypertension, however, the results did not change after adjustment for centre.

In conclusion, despite the publication of various guidelines, optimal levels of treatment and BP control have not been achieved in hypertensive Type I diabetic patients over a 7-year period. There is more scope for improvement. Factors that are limiting the widespread use of multiple drug therapy to reduce raised BP levels need to be examined.

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Table 1. Summary of guidelines on the management of hypertension in diabetes

		Intervention threshold		Target blood pressure	
		Systolic BP (mmHg)	Diastolic BP (mmHg)	Systolic BP (mmHg)	Diastolic BP (mmHg)
Consensus guidelines: European IDDM Policy Group [56]	1993			≤140	≤85
National High Blood Pressure Education Working Group [57]	1994	140	90	<130	<85
St. Vincent Declaration [58]					
Age <40 years or end-organ damage	1995	140	90	≤140	≤85
Age ≥ 40 years and no end-organ damage		160	95	≤140	≤85
American Diabetes Association [59]	1996	140	90	<130	<85
Joint National Committee VI [16]	1997	130	85	≤130	≤85
With proteinuria >1 g/24 hours				≤125	≤75
Italian Hypertension guidelines (SIIA) (www.siia.it/linee) [60, 61]	1999	140	90	<130	<85
British Hypertension Society [62]	1999	140	90	<140	<80
European Diabetes Policy Group: Type 1 diabetes with proteinuria [63]	1999	135	85	<130	<80
Desktop guide: European NIDDM Policy Group [64]	1999			<140	<85
World Health Organisation/ International Society for Hypertension [65]	1999	140	90	<130	<85
Dutch hypertension guidelines (CBO) (http://www.cbo.nl/richtlijnen)	2000	140	90	<140	<90
French Hypertension recommendations: ANAES [66]	2000	140	80	<140	<80

		Intervention threshold		Target blood pressure	
		Systolic BP (mmHg)	Diastolic BP (mmHg)	Systolic BP (mmHg)	Diastolic BP (mmHg)
Finnish Hypertension guidelines (www.duodecim.fi/kh)	2001	140	90	<140	<80
German Hypertension guidelines (AWMF) (http://www.uni-dusseldorf.de, arterielle hypertonie leitlinien)	2002	140	90	<135	<85
With proteinuria >1 g/day				<125	<75
American Diabetes Association [67]	2002	140	90	<130	<80

Table 2. Baseline and follow-up characteristics of subjects included and lost at follow-up

	1989–1990 cohort (*n*=1866)	Lost at follow-up (*n*=1384)	1997–1999 cohort (*n*=1866)
	Baseline risk factors	Baseline risk factors	Follow-up risk factors
	Means ± SD	Means ± SD	Means ± SD
Age (years)	33±10	33±11	40±10
Duration of diabetes (years)	15±9	15±10	22±9
Systolic BP (mm Hg)	120±17	123±19	121±19
Diastolic BP (mm Hg)	75±11	76±12	74±12
BMI (kg/m^2)	23.6±2.8	23.4±3.0	24.6±3.3
WHR	0.84±0.10	0.85±0.12	0.89±0.15
HbA_{1c} (%)[a]	8.3±1.9	8.7±2.0	8.3±1.4
Cholesterol (mmol/l)	5.3±1.1	5.4±1.2	5.3±1.2
LDL-cholesterol (mmol/l)	3.3±0.9	3.5±1.1	3.2±1.0
Fasting triglyceride (mmol/l)[e]	1.0±1.6	1.1±1.7	1.1±1.7
	% (95%CI)	% (95%CI)	% (95%CI)
Men	52	51	52
Current smokers	30	36	29
Albuminuria	30	32	28
Retinopathy	45	48	73
Cardiovascular disease	8	12	11
Hypertensives[b]	22 (20–24)	27 (25–29)	34 (32–36)
Treated with BP lowering drugs[d]	40 (35–45)	45 (40–50)	69 (65–73)
Controlled[c, d]	12 (9–16)	10 (7–14)	28 (24–32)
Controlled[c, e]	32 (25–39)	23 (17–30)	41 (36–45)

[a]Corrected HbA1c values according to DCCT method
[b]Hypertension: defined as a SBP≥140 mmHg or DBP≥90 mmHg or the use of blood pressure lowering drugs
[c]Control is defined as BP<130/85 mmHg
[d]Proportion of hypertensives
[e]Geometric mean (log-transformation)

Table 3. Frequency of hypertensives and management of hypertension by age groups

		1989–1990				1997–1999			
	Age at baseline	*n*	Men	Women	Total	*n*	Men	Women	Total
			969	897	1866		969	897	1866
Hypertensives[a]	≤25	471	12.6%	10.8%	11.7% (9–15)	471	20.9%	15.5%	18.3% (15–22)
	25–35	727	18.3%	13.7%	16.2% (14–19)	727	31.4%	21.9%	27.1% (24–30)
	35–45	431	33.0%	25.0%	29.0% (25–34)	431	48.4%	41.2%	44.8% (40–50)
	45–55	202	49.0%	46.2%	47.5% (40–55)	202	64.6%	63.2%	63.9% (57–70)
	>55	35	33.3%	78.6%	51.4% (34–69)	35	66.7%	85.7%	74.3% (57–88)
Treated hypertensives[b]	≤25	55	27.6%	37.5%	32.1% (20–46)	86	52.0%	82.9%	64.7% (54–75)
	25–35	118	31.5%	28.9%	30.5% (22–40)	197	67.2%	68.1%	67.5% (60–74)
	35–45	125	50.0%	35.2%	43.6% (35–53)	193	77.9%	66.3%	72.5% (66–79)
	45–55	96	51.1%	55.1%	53.1% (43–63)	129	68.9%	78.8%	74.0% (65–81)
	>55	18	14.3%	36.4%	27.8% (10–53)	26	35.7%	58.3%	46.2% (27–67)
Controlled (treated hypertensives)[c, d]	≤ 25	17	25.0%	77.8%	52.9% (28–77)	55	57.7%	58.6%	58.2% (44–71)
	25–35	36	30.4%	53.9%	38.9% (23–57)	133	44.1%	51.0%	46.6% (38–55)
	35–45	53	23.5%	26.3%	24.5% (14–38)	140	30.9%	42.4%	35.7% (28–44)
	45–55	50	25.0%	34.6%	30.0% (18–45)	94	33.3%	30.8%	31.9% (23–42)
	>55	5	0%	0%	0%	12	0%	28.6%	16.7% (2–48)

% (95%CI)

[a]Hypertension: defined as a SBP≥140 mmHg or DBP≥90 mmHg or the use of blood pressure lowering drugs

[b]As a percentage of those with hypertension

[c]Control is defined as BP<130/85 mmHg

[d]As a percentage of treated hypertensives

Table 4. Change in prevalence, treatment and control of hypertension by albuminuric status, between 1989–1990 and 1997–1999

		1989–90				1997–99			
	Albuminuria	*n*	Men	Women	Total	*n*	Men	Women	Total
Hypertensives[a]		925		869	1794	925		869	1794
	Normo	1260	14.4%	16.0%	15.2% (13–17)	1260	24.3%	23.4%	23.8% (21–26)
	Micro	398	29.5%	28.2%	28.9% (24–34)	398	48.7%	42.5%	46.0% (41–51)
	Macro	136	72.3%	52.8%	64.7% (56–73)	136	94.0%	83.0%	89.7% (83–94)
Treated hypertensives[b]	Normo	192	27.3%	35.3%	31.6% (25–39)	300	47.0%	63.1%	55.0% (49–61)
	Micro	115	35.4%	34.7%	35.1% (26–45)	183	73.4%	79.5%	75.8% (69–82)
	Macro	88	65.0%	60.7%	63.6% (53–74)	122	94.9%	95.5%	95.1% (90–98)
Controlled (treated hypertensives)[c, d]	Normo	60	33.3%	40.0%	37.3% (25–51)	164	41.4%	36.2%	38.4% (31–46)
	Micro	40	26.1%	47.1%	35.0% (21–52)	138	43.8%	51.7%	47.1% (39–56)
	Macro	56	21.1%	23.5%	21.8% (12–35)	116	31.1%	45.2%	36.2% (27–46)

% (95%CI)

[a]Hypertension: defined as a SBP≥140 mmHg or DBP≥90 mmHg or the use of blood pressure lowering drugs

[b]As a percentage of those with hypertension

[c]Control is defined as BP<130/85 mmHg

[d]As a percentage of treated hypertensives

Table 5. Distribution of blood pressure lowering drugs in 1989/90 and 1997/99

	1989–1990 (*n*=310)	1997–1999 (*n*=435)
ACE inhibitor	57% (*n*=178)	82% (*n*=355)
CCB	22% (*n*=67)	25% (*n*=109)
Beta Blocker	17% (*n*=54)	11% (*n*=48)
Diuretic	9% (*n*=27)	15% (*n*=69)
Alpha Blocker	4% (*n*=11)	6% (*n*=24)
Other	4% (*n*=11)	6% (*n*=27)