Blood Pressure

ISSN: 0803-7051 (Print) 1651-1999 (Online) Journal homepage: informahealthcare.com/journals/iblo20

The Swedish Primary Care Cardiovascular Database (SPCCD): 74 751 hypertensive primary care patients

Jan Hasselström, Ramin Zarrinkoub, Charlotte Holmquist, Per Hjerpe, Charlotta Ljungman, Miriam Qvarnström, Björn Wettermark, Karin Manhem, Thomas Kahan & Kristina Bengtsson Boström

To cite this article: Jan Hasselström, Ramin Zarrinkoub, Charlotte Holmquist, Per Hjerpe, Charlotta Ljungman, Miriam Qvarnström, Björn Wettermark, Karin Manhem, Thomas Kahan & Kristina Bengtsson Boström (2014) The Swedish Primary Care Cardiovascular Database (SPCCD): 74 751 hypertensive primary care patients, Blood Pressure, 23:2, 116-125, DOI: 10.3109/08037051.2013.814829

To link to this article: https://doi.org/10.3109/08037051.2013.814829

Published online: 06 Aug 2013.

Submit your article to this journal

Article views: 1023

View related articles

View Crossmark data

Citing articles: 5 View citing articles

Full Terms & Conditions of access and use can be found at
https://informahealthcare.com/action/journalInformation?journalCode=iblo20

Blood Pressure, 2014; 23: 116–125

informa
healthcare

ORIGINAL ARTICLE

The Swedish Primary Care Cardiovascular Database (SPCCD): 74 751 hypertensive primary care patients

JAN HASSELSTRÖM[1,2], RAMIN ZARRINKOUB[1,2,3], CHARLOTTE HOLMQUIST[2], PER HJERPE[4], CHARLOTTA LJUNGMAN[5], MIRIAM QVARNSTRÖM[6], BJÖRN WETTERMARK[1,6], KARIN MANHEM[5], THOMAS KAHAN[7] & KRISTINA BENGTSSON BOSTRÖM[4]

[1]*Stockholm County Drug and Therapeutics Committee,* [2]*Karolinska Institutet, Department of Neurobiology, Care Sciences and Society, Centre for Family Medicine and* [3]*Public Healthcare Services Committee Administration, Stockholm County Council, Stockholm,* [4]*R&D Centre Skaraborg Primary Care, Skövde,* [5]*Institute of Medicine, Department of Molecular and Clinical Medicine/Cardiology, Sahlgrenska University Hospital, Sahlgrenska Academy, University of Gothenburg, Göteborg,* [6]*Karolinska Institutet, Department of Medicine, Karolinska University Hospital, Centre for Pharmacoepidemiology and Clinical Epidemiology Unit, and* [7]*Karolinska Institutet, Department of Clinical Sciences, Danderyd Hospital, Division of Cardiovascular Medicine, Stockholm, Sweden*

Abstract

Objective. To describe the Swedish Primary Care Cardiovascular Database, SPCCD. *Design.* Longitudinal data from electronic medical records, linked to national registers. *Setting.* 48 primary healthcare centres in urban (south-western Stockholm) and rural (Skaraborg) regions in Sweden. *Subjects.* Patients diagnosed with hypertension 2001–2008. *Main outcome measures.* Blood pressure (BP) and impact of retrieval of data on BP levels, clinical characteristics, co-morbidity and pharmacological treatment. *Results.* The SPCCD contains 74 751 individuals, 56% women. Completeness of data ranged from $>99\%$ for drug prescriptions to 34% for smoking habits. BP was recorded in 98% of patients during 2001–2008 and in 63% in 2008. Mean BP based on the last recorded value in 2008 was $142 \pm 17/80 \pm 13$ mmHg. Digit preference in BP measurements differed between the two regions, $p < 0.001$. Antihypertensive drugs were prescribed in primary healthcare to 88% of the patients in 2008; however, when all prescribers were included 96% purchased their drugs. Cardiovascular co-morbidity and diabetes mellitus were present in 28% and 22%, respectively. *Conclusion.* This large and representative database shows that there is room for improvement of BP control in Sweden. The SPCCD will provide a rich source for further research of hypertension and its complications.

Key Words: *Blood pressure, comorbidity, drug therapy, hypertension, primary healthcare, registries*

Introduction

Hypertension is a common condition and a major global cause of premature death (1). The estimated prevalence is 27% in Sweden (2), and the rates are similar in other countries (3,4). Blood pressure (BP) reduction by antihypertensive drugs substantially reduces the risk of non-fatal and fatal cardiovascular events (5,6). However, only a minority of hypertensive patients reaches target BP (3,7).

Most patients with hypertension are treated in primary healthcare (8), which is the basis of the healthcare system in many countries, including Sweden. Studies on prescription patterns and BP levels have used various methods for reporting BP values, e.g. extraction of self-reported data from questionnaires (8–11), single day measurement by primary care physicians (12) and selected data extracted from computerized medical records (13). However, these differences in methodology with possible selection bias make the results potentially unreliable and difficult to interpret and generalize.

Most medical records in Swedish primary healthcare are computerized, which enables unbiased extraction of data (14). Furthermore, linkage between

Correspondence: Jan Hasselström, Centre for Family and Community Medicine, Alfred Nobels Allé 12, S-141 83 Huddinge, Sweden. Tel: +46-524 88772. Fax: +46-52488706. E-mail: jan.hasselstrom@priv.sll.se

(Received 10 March 2013; accepted 28 May 2013)

ISSN 0803-7051 print/ISSN 1651-1999 online © 2014 Scandinavian Foundation for Cardiovascular Research
DOI: 10.3109/08037051.2013.814829

data from medical records and national registers provide opportunities to study how well patients are treated to target values, compliance to drug treatment, morbidity and mortality, and the role of socio-economy in the treatment of hypertension.

The aim of this report was to describe the methods of retrieval, data completeness, and the structure of the Swedish Primary Care Cardiovascular Database (SPCCD), a large primary healthcare database of patients with a recorded diagnosis of hypertension.

Material and methods

Study design and patients

The SPCCD is an observational database based on medical records from primary healthcare in a mixed urban area of the south-western part of Stockholm County, and the rural area of Skaraborg in south western Sweden, with populations in 2008 of approximately 336 000 and 256 000 subjects, respectively.

Twenty-four public primary healthcare centres (out of 25) in Skaraborg and 24 primary healthcare centres in south-western Stockholm were included. All used the computerized patient record system Profdoc Journal III (PDIII, Profdoc AB, Uppsala, Sweden). The primary healthcare centres had an almost total coverage of patients attending primary healthcare within the areas. They were group practices with 2.5–20 primary care physicians, of whom 50–70% were specialists in family medicine; the rest comprised physicians under training and locum physicians. Due to continuous quality improvement activities for several years, agreement had been reached on how diagnoses and quality parameters should be registered. In 2008, an average of 85% of all consultations had a medical diagnosis recorded according to the Swedish primary care version of the International Classification of Diseases (ICD-10) (15). A validation of the diagnoses in Skaraborg 2010 showed that the diagnosis of hypertension had a sensitivity of 83% (16).

The SPCCD included all patients 30 years or older with a recorded diagnosis of hypertension in any of the primary healthcare centres between 1 January 2001 and 31 December 2008. Hypertension was diagnosed according to the prevailing recommendations at the time for diagnosis as a brachial artery BP of ≥ 140 and/or ≥ 90 mmHg in the a seated or supine position after 5 min of rest on at least three occasions, or ongoing antihypertensive treatment, and was based on the clinical decision of the physician (17,18). Body mass index was calculated as body weight to the nearest 0.1 kg divided by the square of height in meter (measured to the nearest cm), as based on last recorded values. A diagnosis of diabetes mellitus in primary healthcare was based on the prevailing definitions at the time of diagnosis (19,20) or ongoing antidiabetic drug therapy. All other diagnoses of cardiovascular disease according to ICD-10 were recorded as stated in the primary healthcare medical records, and were based on the clinical decision of the primary care physician (Table I). Hospital-based diagnoses

Table I. Variables in the Swedish Primary Care Cardiovascular Database (SPCCD).

Variables	Description
Patients	Anonymous identification number, age, sex
Contacts with caregivers	Dates and type of contact, caregiver (physicians, registered nurses)
Clinical data	Body weight and height, all recorded systolic and diastolic blood pressures and structured recorded data on smoking habits
Blood and urine laboratory analyses	Fasting total cholesterol, LDL-cholesterol, HDL-cholesterol, triglycerides and glucose, creatinine, HbA1c and microalbuminuria
Diagnoses in primary care (ICD-10 codes)	Hypertension (I10, I13P and I15), atrial fibrillation/flutter (I48), congestive heart failure (I50), diabetes mellitus (E10-11, E14), ischaemic heart disease (I20–25), ischaemic and haemorrhagic stroke (I60–69), transient ischaemic attack (G45)
Prescribed drugs (ATC codes)	Angiotensin-converting enzyme inhibitors C09A, C09B; angiotensin receptor blockers C09C, C09D; beta adrenergic receptor blockers C07; calcium channel blockers C08; diuretics, C03 (including thiazides, loop diuretics and spironolactone)
All prescriptions dispensed for all drugs July 2005–December 2009	ATC code, date and amount of drugs, prescriber and healthcare provider
All hospitalizations; all consultations in hospital-based outpatient care	Date of admission, discharge and consultation up to eight recorded ICD-10 diagnoses per occasion for in-hospital (1997–2009) and out-patient (2001–2009) care
Date and cause of death	Date of death, cause of death (main and contributing), ICD-10 codes
Level of education, in 2005 and 2009	Low (9 years or less of schooling, elementary); Medium, two levels (10–12 years, secondary school); High, three levels (>12 years, post-gymnasium education)
Country of birth; residence of patients	Sweden, other Nordic countries, the EU27 or countries in the rest of the world. Place of residence per year from 2004 (municipality)

LDL, low-density lipoprotein; HDL, high-density lipoprotein; HbA1c; glycosylated haemoglobin; ICD-10, International Classification of Diseases, version 10; ATC, anatomic therapeutic chemical classification system; EU27, Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, The Netherlands, UK.

were included from the National Patient Register, see below.

Data management and record linkages

Information on patient contacts with care-givers, clinical and laboratory data, diagnoses, and prescribed medications (as described in Table I) was extracted by a designated purpose-built software in close resemblance of that described by Kristianson et al. (14). Data was subsequently merged into the SPCCD database and stored on a virtual server at the University of Gothenburg, running Windows Server 2008 R2 (Microsoft Corp., Redmond, WA, USA).

In Skaraborg and south-western Stockholm, all laboratories of the primary healthcare centres were certified by the Swedish Board for Accreditation and Conformity Assessment (SWEDAC, Borås, Sweden), assuring adherence to the ISO 15189 standard. Of note, glucose was analysed in blood until 2004, and thereafter in plasma. The formula plasma glucose = 1.11 × blood glucose can be used for conversion (21). Serum and plasma creatinine were analysed with the Jaffé reaction until 2005, and thereafter with an enzymatic method. HbA1c was determined by the prevailing method in Sweden at this time (Mono-S), which means that HbA1c levels are nearly 1% unit lower than by other methods used worldwide (22). Results concerning laboratory analyses given in the present report are the last recorded values.

The SPCCD links data information from five national population-based registers to each patient by using the unique personal identity number assigned to each Swedish resident (23) (Figure 1). The Prescribed Drug Register contains complete data on all dispensed drugs in the country with unique identifiers of patients for >99% of all prescriptions since 2005 (24); the National Patient Register with all hospitalizations and outpatient consultations in hospitals (25); the Cause of Death Register; the Census Registers contain information on residence and immigration and migration in Sweden (26); and the National Education Register, which provides information on the highest formal education attained by each individual (27).

Statistical analyses

Data are presented as mean values ± SD or with 95% confidence intervals, where appropriate. Calculations were performed in SAS, version 9.3 (SAS System for Windows, SAS Institute Inc, Cary, NC, USA). Statistical differences between groups were evaluated by the Student's *t*-test or with the χ^2 test, as appropriate. A probability of $p < 0.05$ was considered statistically significant.

The Regional Ethical Review Board in Gothenburg approved the study, and written consent to data extraction from all directors of the primary healthcare centres was obtained.

Results

Patient characteristics

The SPCCD comprise a total of 74 751 individuals with a diagnosis of hypertension recorded between 2001 and 2008 (Figure 2). The mean age of those alive in 2008 was 69.6 ± 13.4 years (67.8 ± 12.9 years in men and 71.0 ± 13.7 years in women). The distribution by age at study start is shown in Figure 3.

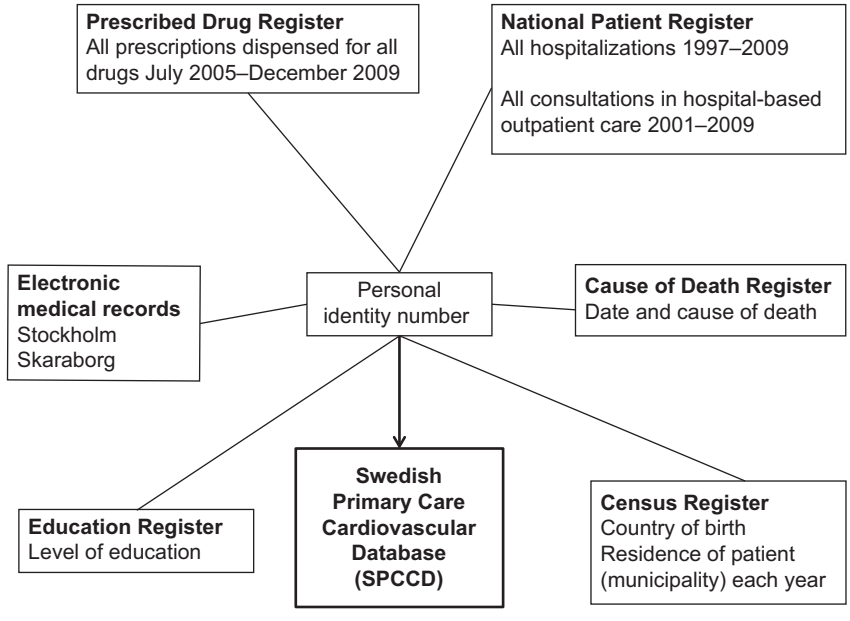

Figure 1. Sources contributing with data in Swedish Primary Care Cardiovascular Database.

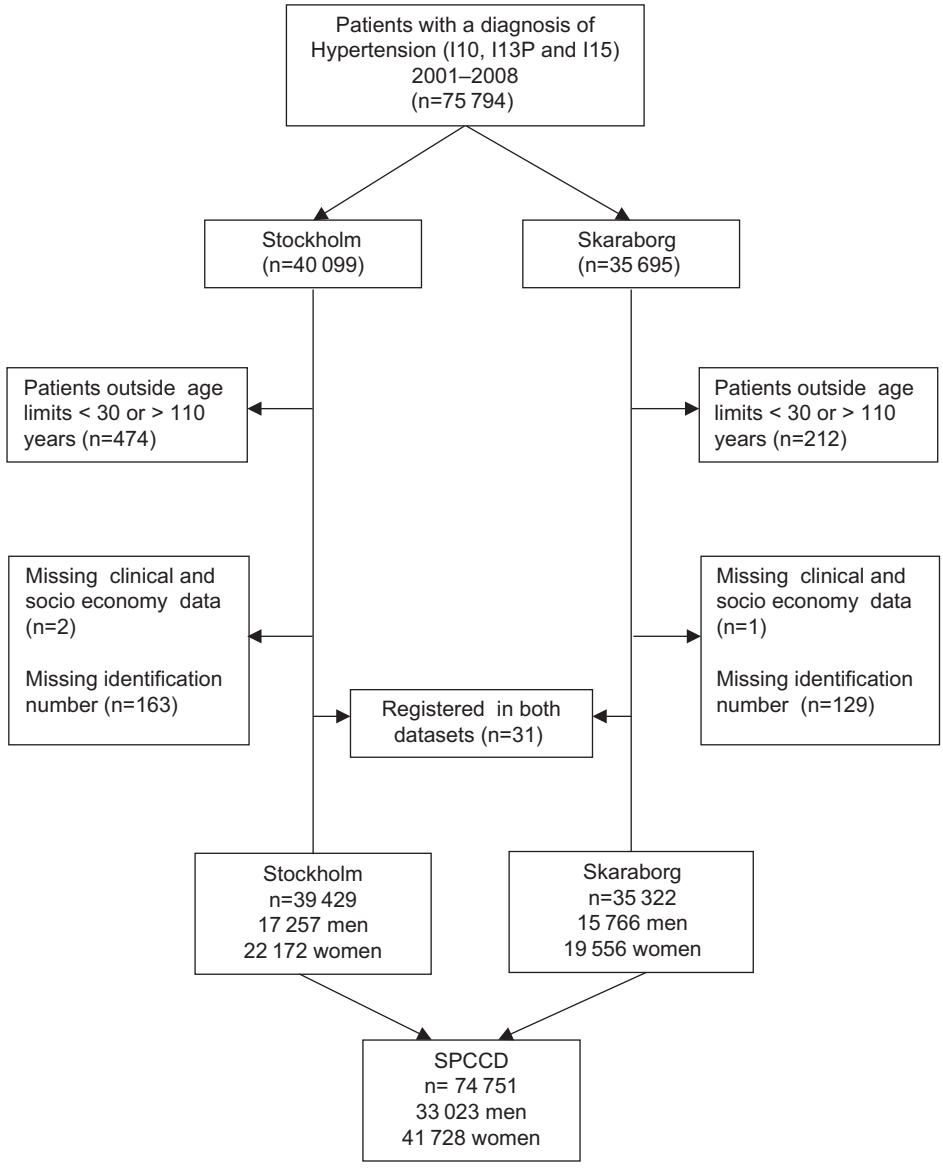

Figure 2. Flowchart over patients included in the Swedish Primary Care Cardiovascular Database (SPCCD). In Stockholm 1609 patients and in Skaraborg 1204 patients attended more than one primary healthcare centre.

Most patients were between 55 and 75 years old and there was a pronounced dominance of women from 60 years and older. Both men and women were older in Skaraborg, compared with Stockholm (69.2 ± 12.7 and 72.5 ± 13.2 vs 66.5 ± 13.0 and 69.7 ± 14.0 years, respectively, $p < 0.001$ for both). Data on cardiovascular risk factors showed no substantial differences between the regions (Table II). Blood glucose values (not adjusted for diabetes status) differed between sexes. Creatinine levels were higher in men than in women. Among those where information on smoking habits was available ($n = 25\,435$), 18% were reported as smokers, which was more common in Stockholm than in Skaraborg (27.1 vs 13.8%, $p < 0.001$). Cardiovascular co-morbidity and diabetes mellitus were present in 28 and 22%, respectively. Information on country of birth and socio-economic data are presented in Tables III and IV, respectively.

Blood pressure

A BP recording at some time during 2001–2008 was present in 73 050 individuals (Table V) and 46 937 patients had a value recorded in 2008. Between 2001 and 2008 BP was recorded in each patient on average 2.8 ± 2.8 times per patient and year, and in 2008 alone 3.0 ± 2.8 (median 2.0) times per patient. The BP based on the last recorded BP for each calendar year in the entire study population ($n = 73\,050$) was 151 ± 21/83 ± 13 mmHg. The BP based on the last recorded BP in 2008 ($n = 46\,937$) was 142 ± 17/80 ± 13 mmHg. The BP in 2008 was on average 1.4 ± 0.3/4.0 ± 0.3 mmHg higher in Stockholm than in Skaraborg ($p < 0.001$ for both).

To evaluate the reliability of the last recorded BP, we also assessed the difference between the last recorded BP 2008 (i.e.142 ± 17/80 ± 13 mmHg) and

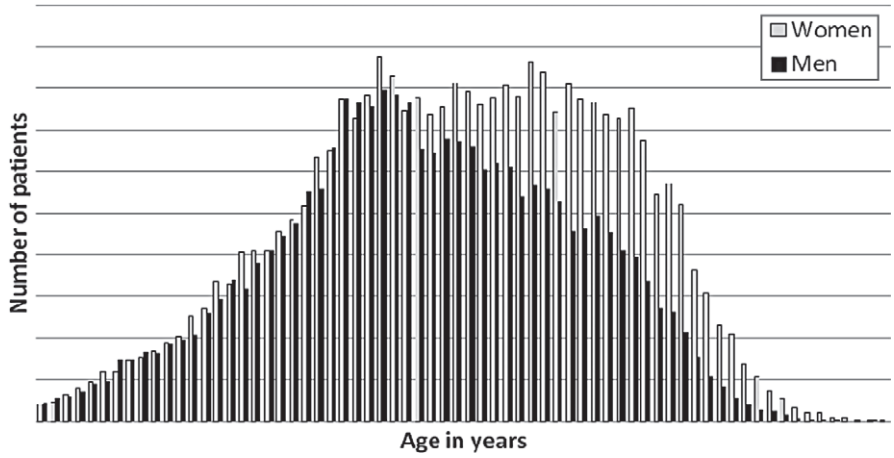

Figure 3. Age distribution according to sex of the patients in the Swedish Primary Care Cardiovascular Database. The patients presented are those with recorded blood pressures in 2008; the age is given for 2001. The mean blood pressure for men ($n = 32\,184$) was 143/81 ± 18/11 mmHg and for women ($n = 40\,845$) 144/80 ± 19/11 mmHg. The last recorded blood pressure in age groups 30–49 years ($n = 11\,529$), 50–70 years ($n = 38\,704$), and >70 years ($n = 22\,796$) were 140/86 ± 17/10, 143/81 ± 17/10 and 146/77 ± 21/11 mmHg, respectively.

the mean value of the three last recordings in the same patient within the preceding 12 months during 2007–2008, which was 144 ± 18/81 ± 13 mmHg. The difference was 2.1 ± 11/0.91 ± 8.0 mmHg, with significantly ($p < 0.001$) lower mean values for both systolic and diastolic BP. Furthermore, there was a digit preference in the reporting of BP values (Figure 4). Digit preference was more pronounced for both systolic and diastolic BP in Stockholm than in Skaraborg ($p < 0.001$).

Drug treatment

In 2008, 88% of the patients were prescribed antihypertensive drug therapy in primary healthcare. On average, each patient received 1.9 ± 0.9 (median 2.0) drugs per patients (Table V). When all dispensed drugs from prescriptions issued by primary healthcare and by other prescriber categories were included, 96% of the patients ($n = 49\,509$) purchased antihypertensive drugs in 2008.

Discussion

This study reports a unique large primary healthcare database, SPCCD, comprising close to 75 000 patients. It includes all patients diagnosed with hypertension in primary healthcare in two large regions, containing both rural and urban areas, regardless of socio-economy and with no selection bias of patients or physicians due to voluntary participation or economic incentive structures. Data were extracted from electronic records, not from self-reported questionnaires, and subsequently linked to several nationwide registers of high quality and complete coverage. Thus, the results are likely to reflect hypertensive patients attending Swedish primary healthcare. Furthermore, the SPCCD provides excellent opportunities to study several aspects of hypertension and cardiovascular disease in primary healthcare with high accuracy.

A key issue in clinical databases is the completeness and quality of data. Some clinical information and data are not collected and documented in a systematic and well-structured way in clinical practice, as demonstrated by the information in the SPCCD on smoking habits and body height and weight. This may be a potential limitation to the usefulness of data for specific research questions. Furthermore, BP measurements may not be performed in a standardized way or may be recorded during different circumstances, such as at yearly control visits for hypertension or at unscheduled visits due to acute illnesses or in other situations clearly not suitable for therapeutic control. Also, some patients may be well controlled over several years whereas others are newly diagnosed and not yet on appropriate drug therapy. To examine this potentially confounding influence, we extracted BP data from SPCCD in two different ways. The value of last recorded BP measurement in 2008 was lower than the mean of the three most recent recordings within the preceding year in the same patient. Thus, the use of the last recorded value appears valid and would, if anything, overestimate the number of patients who reach target BP values. This might reflect a temporal decline in BP in newly diagnosed patients or treatment adjustment to reach target levels of BP. Our results are in line with observations of increased antihypertensive drug treatment and better BP control with time (28–31). Further analyses of temporal changes in BP and on the variability of BP in association with morbidity and mortality are currently in progress.

Table II. Clinical characteristics of individuals in the Swedish Primary Care Cardiovascular Database (SPCCD), 2001–2008.

	All SPCCD			Stockholm		Skaraborg	
	Women	Men	All	Women	Men	Women	Men
n (2001–2008)	41 728	33 023	74 751	22 172	17 257	39 429	19 556
n (with BP recordings 2008)	26 452	20 485	46 937	13 655	10 190	12 797	10 295
Mean ± SD of values							
Age, years	71.0 ± 13.7	67.8 ± 12.9	69.6 ± 13.4	69.7 ± 14.0	66.5 ± 13.0	72.5 ± 13.2	69.2 ± 12.7
BMI, kg/m^2	29.0 ± 5.6	28.8 ± 4.6	28.9 ± 5.2	29.5 ± 5.8	29.1 ± 4.9	28.8 ± 5.5	28.7 ± 4.5
Tot-cholesterol, mmol/l	5.5 ± 1.1	5.1 ± 1.0	5.4 ± 1.1	5.6 ± 1.1	5.2 ± 1.1	5.5 ± 1.1	5.1 ± 1.0
HDL cholesterol, mmol/l	1.6 ± 0.4	1.3 ± 0.4	1.4 ± 0.4	1.5 ± 0.4	1.3 ± 0.4	1.6 ± 0.4	1.3 ± 0.4
LDL cholesterol, mmol/l	3.2 ± 0.9	3.1 ± 0.9	3.2 ± 0.9	3.3 ± 0.9	3.1 ± 0.9	3.2 ± 0.9	3.0 ± 0.9
Triglycerides, mmol/l	1.5 ± 0.8	1.7 ± 1.0	1.6 ± 0.9	1.5 ± 0.8	1.7 ± 1.1	1.5 ± 0.7	1.6 ± 0.9
P-glucose, mmol/l	6.2 ± 2.1	6.5 ± 2.3	6.4 ± 2.2	6.2 ± 2.3	6.7 ± 2.7	6.2 ± 1.8	6.5 ± 2.0
Creatinine, mmol/l	75.5 ± 29.9	91.9 ± 37.7	82.7 ± 34.5	73.5 ± 27.8	90.5 ± 36.9	77.7 ± 32.0	93.5 ± 38.4
Co-morbidity, *n* (%)							
Atrial fibrillation	2857 (6.8%)	2926 (8.9%)	5783 (7.7%)	1350 (6.1%)	1424 (8.3%)	1507 (6.8%)	1502 (8.7%)
IHD	5353 (12.8%)	5606 (17.0%)	10 959 (14.7%)	2666 (12.0%)	2644 (15.3%)	2687 (12.1%)	2962 (17.2%)
CHF	3200 (7.7%)	2412 (7.3%)	5612 (7.5%)	1469 (6.6%)	1063 (6.2%)	1731 (7.8%)	1349 (7.8%)
Cerebrovascular disease	2387 (5.7%)	2693 (8.2%)	5080 (6.8%)	1042 (4.7%)	1234 (7.2%)	1345 (6.1%)	1459 (8.5%)
Diabetes mellitus	7934 (19.0%)	8406 (25.5%)	16 340 (21.9%)	4186 (18.9%)	4538 (26.3%)	3748 (16.9%)	3868 (22.4%)
No CVD or diabetes mellitus[a]	25 965 (62.2%)	17 380 (52.6%)	43 345 (58.0%)	14 260 (64.3%)	9382 (54.4%)	11 705 (52.8%)	7998 (46.3%)

Data are based on last recorded values for each patient and are mean values ± standard deviations, unless stated otherwise. BP, blood pressure; BMI, body mass index; HDL, high-density lipoprotein; LDL, low-density lipoprotein; IHD, ischaemic heart disease; CHF, congestive heart failure; CVD, cardiovascular disease. Hypertension was diagnosed according to the prevailing recommendations at the time for diagnosis (17), from 1999 at blood pressure levels of ≥ 140 and/or ≥ 90 mmHg (18). A diagnosis of diabetes was based on WHO definitions from 1985 (19) and 1997 (20), or ongoing treatment. Diagnoses according to ICD-codes, as stated in the medical records were based on the clinical decision of the primary care physician. [a]Subjects with no diagnosis of atrial fibrillation, ischaemic heart disease, congestive heart failure, cerebrovascular disease or diabetes mellitus were considered to have no cardiovascular disease.

Table III. Country of birth in the study population.

	All SPCCD						Stockholm						Skaraborg					
	Women		Men		All		Women		Men		All		Women		Men		All	
Country of birth	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]
Sweden	33 506	80.3	26 938	81.6	60 444	80.9	15 565	70.2	12 365	71.7	27 930	70.9	17 941	91.8	14 573	92.4	32 514	92.1
Nordic countries outside Sweden	3660	8.8	2260	6.8	5920	7.9	2731	12.3	1590	9.2	4321	11.0	929	4.8	670	4.2	1599	4.5
Europe outside Nordic countries	2669	6.4	2115	6.4	4784	6.4	2154	9.7	1746	10.1	3900	9.9	515	2.6	369	2.3	884	2.5
Outside Europe	1884	4.5	1705	5.2	3589	4.8	1716	7.7	1552	9.0	3268	8.3	168	0.9	153	1.0	321	0.9
Total	41 719		33 018		74 737		22 166		17 253		39 419		19 553		15 765		35 318	

SPCCD, Swedish Primary Care Cardiovascular Database. [a]Calculated as percentage of total by column. Data were recorded for 74 737 of the 74 751 patients. Nordic countries: Denmark, Finland, Iceland, Norway and Sweden.

Table IV. Educational level in the study population.

Educational level	All SPCCD						Stockholm						Skaraborg					
	Women		Men		All		Women		Men		All		Women		Men		All	
	n	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]	*n*	%[a]
Low	8832	31.2	8652	36.7	17 484	33.7	4416	31.2	3870	30.3	8286	30.8	4416	31.2	4782	44.3	9198	36.9
Medium	12 598	44.6	10 310	43.7	22 908	44.2	6299	44.6	5958	46.6	12257	45.5	6299	44.6	4352	40.3	10651	42.7
High	6842	24.2	4626	19.6	11 468	22.1	3421	24.2	2960	23.1	6381	23.7	3421	24.2	1666	15.4	5087	20.4
Total	28 272		23 588		51 860		14 136		12 788		26 924		14 136		10 800		24 936	

SPCCD, Swedish Primary Care Cardiovascular Database. Data were recorded for 51 860 of the 74 751 patients. Educational level was defined as Low: up to upper secondary level; Medium: post secondary level up to non-university level; High: university degree. [a]Calculated as percentage of total by column.

Digit preference is another important feature of BP measurement. As already reported (32), our results suggest a digit preference for values ending with 5 and 10 mmHg, in agreement with findings by others (33,34). Digit preference was less pronounced in Skaraborg than in Stockholm. The Skaraborg Project (35), which inaugurated nurse-led structured care of patients with hypertension and strict measurements of BP to the nearest 2 mmHg, may in part explain this difference. Digit preference can influence the proportion of patients attaining target BP. Digit preference may also imply that care-givers underestimate the impact of BP and can reduce the likelihood for patients of being prescribed appropriate antihypertensive drug therapy (34). Thus, digit preference can influence clinical decision making improperly and should thus be avoided (28). Interestingly, in the current study the region with most propensities for digit preference had higher BP levels, which seems to contradict an underestimation of the impact of BP.

The current preliminary results suggest that BP control has improved during the last two decades. However, there are still subgroups of high risk patients where there is room for substantial improvement in BP control in Sweden, in support of previous observations (7,36). What is needed in regard of personal commitment of the primary care physician, educational activities, and the healthcare organization and policy-making boards to attain this is a matter of further ongoing studies using the SPCCD.

SPCCD contains data over a prolonged period (2001–2008) and is thus well suited to study temporal changes in BP control and drug utilization in individual patients, as well as in the population. One drawback of long-term data of this kind is that the movement of individuals in and out of the regions is difficult to assess, especially in urban areas where there is a greater choice of healthcare. Analyses of longitudinal data have to take this into account. The linkage to high-quality nationwide registries provide unique opportunities to study cardiovascular outcome and the impact of and socio-economic issues and education on related to compliance and adherence to prescribed drugs are possible. We are currently undertaking such studies.

In conclusion, the SPCCD is a large and representative database well suited for the study of cardiovascular disease in primary healthcare. We foresee that the SPCCD will provide a rich source of data for future research and hope that it will help to advance the knowledge on practice-based data and improve treatment and control of cardiovascular disease.

Table V. Completeness of data in different variables in 74 751 individuals in the Swedish Primary Care Cardiovascular Database (SPCCD).

	Registered, *n* (%)	Limits for exclusion	Data outside limits (*n*)	Data outside limits, % of all
Blood pressure values any time during 2001–2008	73 050[a] (97.7)	–	–	–
SBP (mmHg)	948 268	SBP < DBP, SBP < 40, SBP > 300	491	0.1
DBP (mmHg)	948 161	SBP < DBP, DBP < 20, DBP > 150	581	0.1
Weight last recorded (kg)	33 324 (44.6)	< 20, > 300	22	0.1
Height last recorded (cm)	25 939 (34.7)	< 100, > 250	26	0.1
BMI (kg/m^2)	26 763 (35.5)	< 10, > 60	25	0.0
Glucose, first mmol/l[b]	50 799 (68.0)	< 0.9, > 50	0	0
Glucose, last mmol/l[b]	50 982 (62.2)	< 0.9, > 50	0	0
Total cholesterol (mmol/l)[b]	60 410 (80.8)	< 1, > 30	1	0.0
LDL cholesterol (mmol/l)[b]	41 842 (56.0)	< 0.1, > 20	0	0
HDL cholesterol (mmol/l)[b]	45 172 (60.4)	< 0.1, > 10	0	0
Triglycerides (mmol/l)[b]	46 454 (62.1)	< 0.1, > 50	0	0
Creatinine (μmol/l)	71 044 (95.0)	< 20, > 2000	4	0.0
Data on smoking	25 435 (34.0)	–	–	–
Data on prescribed drugs	71 426 (95.9)	–	–	–
Data on dispensed drugs[c]	71 686 (95.9)	–	–	–
Data on date of death (until 31 July 2011)	11 213 (15.0)	–	–	–
Data on cause of death (until 31 July 2011)	8 591 (11.5)	–	–	–

SBP, systolic blood pressure; DBP diastolic blood pressure; BMI, body mass index either calculated from body weight and length in database (kg/m^2) or registered directly; LDL low-density cholesterol; HDL, high-density cholesterol. [a]No blood pressure values were recorded in the database for 905 patients in Stockholm and for 851 in Skaraborg. [b]Glucose and lipids are fasting values. [c]Including prescriptions from other care-givers than primary healthcare from 1 July 2005 to 31 December 2009.

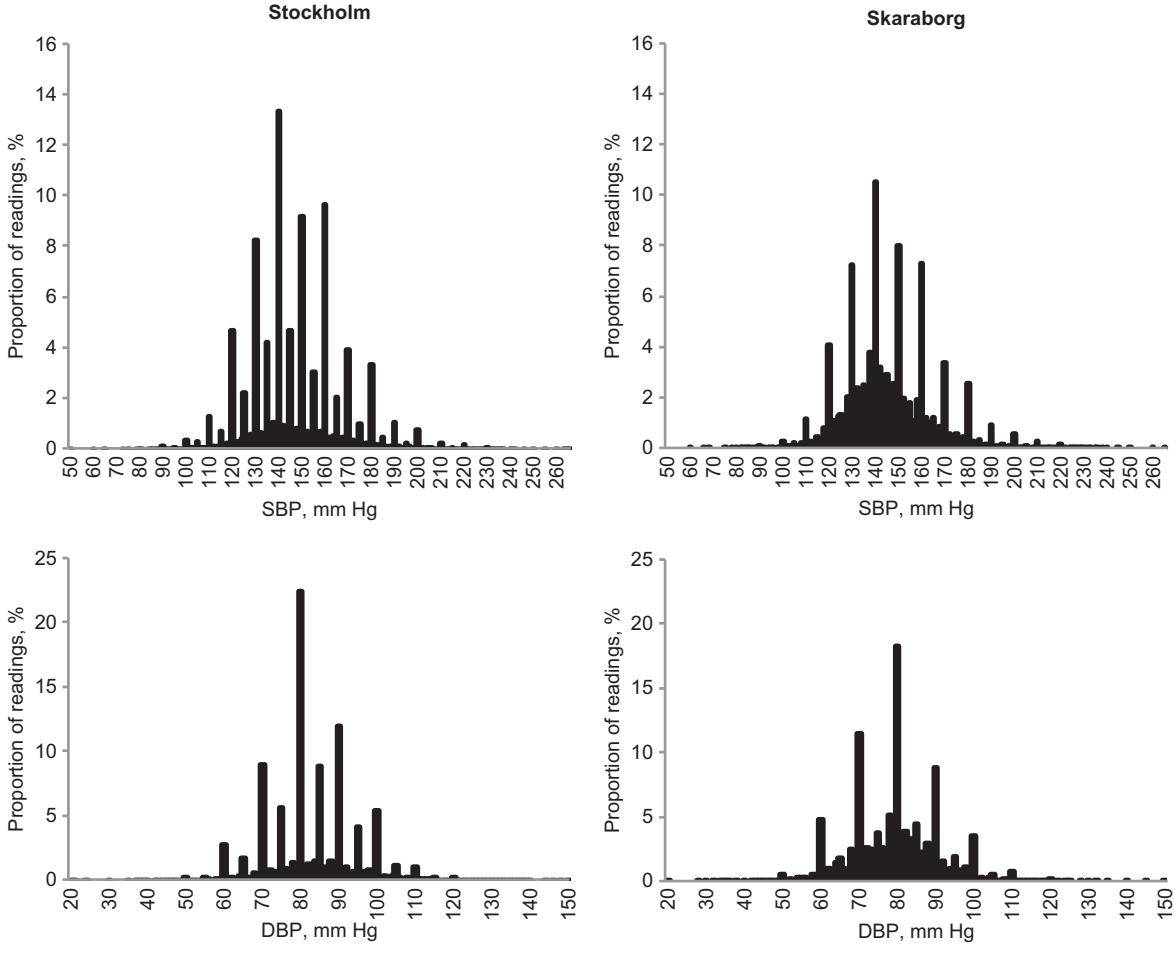

Figure 4. Digit preference of reported systolic (SBP) and diastolic (DBP) blood pressure measurements 2008 in Stockholm ($n = 80\,554$) and in Skaraborg ($n = 58\,590$).

Acknowledgements

The primary healthcare centres providing data for the studies are cordially thanked. In South West of Stockholm; Alby, Axelsberg, Bredäng, Fittja, Flemingsberg, Fruängen, Gröndal, Hallunda, Huddinge, Liljeholmen, Liseberg, Luna, Segeltorp, Carema i Skogås, Skärholmen, Storvreten, Stuvsta, Sätra, Telgeakuten, Trångsund, Tullinge, Tumba, Tveta, Älvsjö and in Skaraborg; Floby, Falköping (Oden and Mösseberg), Gullspång, Götene, Hjo, Karlsborg, Kvänum, Lidköping (Guldvingen and Ågårdsskogen), Mariestad (Eken and Linden), Nossebro, Skövde (Billingen, Hentorp, Norrmalm and Södra Ryd), Skara, Stenstorp, Tibro, Tidan, Tidaholm, Töreboda and Vara. We are also grateful for valuable technical support from Lennart Pettersson, system engineer, Linus Schiöler, PhD, and Bengt Sjöborg, BSc. Financial support was provided by the Swedish Heart Lung Foundation, Karolinska Institutet, the Health & Medical Care Committee of the Regional Executive Board of the Region Västra Götaland, the Swedish Society of Medicine (Lagerströms and Lysanders foundations), the Skaraborg Research and Development Council, and the Stockholm County Council (Stockholm County Drug and Therapeutics Committee, the Department of Drug Management and Informatics, and the EK-group of Centre for Family and Community Medicine). The SPCCD is endorsed by the Swedish Society for Hypertension, Stroke and Vascular Medicine.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

1. Ezzati M, Lopez AD, Rodgers A, Vander Hoorn S, Murray CJ; Comparative Risk Assessment Collaborating Group. Selected major risk factors and global and regional burden of disease. Lancet. 2002;360:1347–1360.
2. Lindholm, LH, Agenäs I, Carlbeg B, Dahlgren H, de Faire U, Hedblad B, et al. Moderately elevated blood pressure. A systematic literature review. Volumes 1 & 2. Stockholm: The Swedish Council on Technology Assessment in Health Care 2004. SBU-rapport 170/1–2.
3. Wolf-Maier K, Cooper RS, Banegas JR, Giampaoli S, Hense HW, Joffres M, et al. Hypertension prevalence and blood pressure levels in 6 European countries, Canada, and the United States. JAMA. 2003;289:2363–2369.
4. Cutler JA, Sorlie PD, Wolz M, Thom T, Fields LE, Roccella EJ. Trends in hypertension prevalence, awareness, treatment, and control rates in United States adults between 1988–1994 and 1999–2004. Hypertension. 2008;52:818–827.
5. Psaty BM, Lumley T, Furberg CD, Schellenbaum G, Pahor M, Alderman MH, et al. Health outcomes associated with various antihypertensive therapies used as first-line agents: a network meta-analysis. JAMA. 2003;89:2534–2544.
6. Staessen JA, Wang JG, Thijs, L. Cardiovascular prevention and blood pressure reduction: A quantitative overview updated until 1 March 2003. J Hypertens. 2003;21: 1055–1076.
7. Weinehall L, Ohgren B, Persson M, Stegmayr B, Boman K, Hallmans G, et al. High remaining risk in poorly treated hypertension: The 'rule of halves' still exists. J Hypertens. 2002;20:2081–2088.
8. Hedblad B, Nerbrand C, Ekesbo R, Johansson L, Midlöv P, Brunkstedt I, et al. High blood pressure despite treatment: Results from a cross-sectional primary healthcare-based study in southern Sweden. Scand J Prim Health Care. 2006;24: 224–230.
9. Journath G, Hellénius ML, Petersson U, Theobald H, Nilsson PM; Hyper-Q Study Group Sweden. Sex differences in risk factor control of treated hypertensives: A national primary healthcare-based study in Sweden. Eur J Cardiovasc Prev Rehabil. 2008;15:258–262.
10. McInnis NH, Fodor G, Moy Lum-Kwong M, Leenen FH. Antihypertensive medication use and blood pressure control: A community-based cross-sectional survey (ON-BP). Am J Hypertens. 2008;21:1210–1215.
11. Westheim A, Klemetsrud T, Tretli S, Stokke HP, Olsen H. Blood pressure levels in treated hypertensive patients in general practice in Norway. Blood Press. 2001;10:37–42.
12. Rodriguez-Roca GC, Llisterri-Caro JL, Barrios-Alonso V, Alonso-Moreno FJ, Lou-Arnal S, Prieto-Diaz MA, et al. Cardiovascular risk and blood pressure control in a Spanish hypertensive population attended in a Primary Care setting. Data from the PRESCAP 2006 study. Blood Press. 2009;18: 117–125.
13. Laverty AA, Bottle A, Majeed A, Millett C. Blood pressure monitoring and control by cardiovascular disease status in UK primary care: 10 year retrospective cohort study 1998–2007. J Public Health (Oxf). 2011;33:302–309.
14. Kristianson KJ, Ljunggren H, Gustafsson LL. Data extraction from a semi-structured electronic medical record system for outpatients: A model to facilitate the access and use of data for quality control and research. Health Informatics J. 2009; 15:305–319.
15. The National Board of Health and Welfare, Classification of Diseases and Related Health Problems 1997 – PRIMARY CARE. Vol. 1. 1997, Stockholm: Socialstyrelsen (National Board of Health and Welfare).
16. Hjerpe P, Merlo J, Ohlsson H, Bengtsson Boström K, Lindblad U. Validity of registration of ICD codes and prescriptions in a research database in Swedish primary care: A cross-sectional study in Skaraborg primary care database. BMC Med Inform Decis Mak. 2010;10:23.
17. 1999 World Health Organization-International Society of Hypertension Guidelines for the Management of Hypertension. Guidelines Subcommittee. J Hypertens. 1999;17: 151–183.
18. Mansia G, De Backer G, Dominiczak A, Cifkova R, Fagard R, Germano G, et al. 2007 ESH-ESC Guidelines for the management of arterial hypertension: The task force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). Blood Press. 2007;16:135–232.
19. Diabetes mellitus. Report of a WHO Study Group. World Health Organ Tech Rep Ser. 1985;727:1–113.
20. Alberti KG and Zimmet, PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. Diabet Med. 1998;15: 539–553.
21. Stahl M, Brandslund I, Jørgensen LG, Hyltoft Petersen P, Borch-Johnsen K, de Fine Olivarius N. Can capillary whole blood glucose and venous plasma glucose measurements be used interchangeably in diagnosis of diabetes mellitus? Scand J Clin Lab Invest. 2002;62:159–166.

22. Weykamp C, John WG, Mosca, A. A review of the challenge in measuring hemoglobin A1c. J Diabetes Sci Technol. 2009;3:439–445.
23. Ludvigsson JF, Otterblad-Olausson P, Pettersson BU, Ekbom A. The Swedish personal identity number: Possibilities and pitfalls in healthcare and medical research. Eur J Epidemiol. 2009;24:659–667.
24. Wettermark B, Hammar N, Fored CM, Leimanis A, Otterblad Olausson P, Bergman U, et al. The new Swedish Prescribed Drug Register--opportunities for pharmacoepidemiological research and experience from the first six months. Pharmacoepidemiol Drug Saf. 2007;16:726–735.
25. Ludvigsson JF, Andersson E, Ekbom A, Feychting M, Kim JL, Reuterwall C, et al. External review and validation of the Swedish national inpatient register. BMC Public Health. 2011;11:450.
26. Rosen M. National Health Data Registers: A Nordic heritage to public health. Scand J Public Health. 2002;30:81–85.
27. Weitoft GR, Rosén M, Ericsson O, Ljung R. Education and drug use in Sweden – A nationwide register-based study. Pharmacoepidemiol Drug Saf. 2008;17:1020–1028.
28. Gu Q, Burt VL, Dillon CF, Yoon S. Trends in antihypertensive medication use and blood pressure control among United States adults with hypertension: The National Health and Nutrition Examination Survey, 2001 to 2010. Circulation. 2012;126:2105–2114.
29. Nilsson P, Andersson DK, Andersson PE, Schwan A, Ostlind B, Malmborg R, et al. Cardiovascular risk factors in treated hypertensives – A nation-wide, cross-sectional study in Sweden. J Intern Med. 1993;233:239–245.
30. Nilsson PM, Gudbjörnsdottir S, Eliasson B, Cederholm J; Steering Committee of the National Diabetes Register, Sweden. Hypertension in diabetes: Trends in clinical control in repeated large-scale national surveys from Sweden. J Hum Hypertens. 2003;17:37–44.
31. Falaschetti E, Chaudhury M, Mindell J, Poulter N. Continued improvement in hypertension management in England: Results from the Health Survey for England 2006. Hypertension. 2009;53:480–486.
32. Qvarnstrom M, Wettermark B, Ljungman C, Zarrinkoub R, Hasselström J, Manhem K, et al. Antihypertensive treatment and control in a large primary care population of 21 167 patients. J Hum Hypertens. 2011;25:484–491.
33. Carey IM, Nightingale CM, DeWilde S, Harris T, Whincup PH, Cook DG. Blood pressure recording bias during a period when the Quality and Outcomes Framework was introduced. J Hum Hypertens. 2009;23:764–770.
34. Nelson MR, Quinn S, Bowers-Ingram L, Nelson JM, Winzenberg TM. Cluster-randomized controlled trial of oscillometric vs. manual sphygmomanometer for blood pressure management in primary care (CRAB). Am J Hypertens. 2009;22:598–603.
35. Rastam L, Berglund G, Isacsson SO, Rydén L. The Skaraborg hypertension project. III. Influence on blood pressure of a medical care program for hypertension. Acta Med Scand. 1986;219:261–269.
36. Li C, Engström G, Hedblad B, Berglund G, Janzon L. Blood pressure control and risk of stroke: A population-based prospective cohort study. Stroke. 2005;36:725–730.