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Socio-economic status influences blood pressure control despite equal access to care

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Objective. Denmark has a health care system with free and equal access to care irrespective of age and socio-economic status (SES). We conducted a cross-sectional study to investigate a possible association between SES and blood pressure (BP) control of hypertensive patients treated in general practice.

Methods. We enrolled 184 general practices and 5260 hypertensive patients. The general practitioners reported information about BP and diagnosis of diabetes. Information about education, income, antihypertensive drug treatment and other co-morbidity was retrieved from relevant registers from Statistics Denmark. The outcome measure was BP control defined as BP <140/90 mmHg in general and <130/80 mmHg in diabetics.

Results. Patients <65 years and with an educational level of 10–12 years had increased odds ratio (OR) of BP control compared to patients with an educational level <10 years. Patients ⩾65 years had increased OR of BP control if they were married/cohabiting as compared to being single, whereas education and income had no impact in this age group. Diabetics had significantly reduced odds of BP control irrespective of age, educational or income level.

Conclusions. Despite equal access to care for all patients, SES had significant impact on BP control in this survey. Diabetes and cardiovascular disease also had a substantial influence irrespective of age, educational and income level.

Keywords. Socio-economic status, hypertension, primary care, education, access to care.

Introduction

How socio-economic status (SES) influences blood pressure (BP) control is not clear.[1,2] Studies of hospital populations have shown an association between low SES and higher prevalence of hypertension, poorer BP control and higher mortality rate.[3–7] However, the association between SES and BP control in patients treated in general practice has not been studied. Investigating SES inequalities in patients often originates from health care systems based on a health insurance policy, limiting access to care for patients with lower SES.[3–5,7–9] Denmark has a health care system with free and equal access to care. Studying and finding socio-economic inequalities in this health care system with equal access to care could eliminate 'access to care' as an important cause of social inequality. In Denmark, diagnosis and treatment of hypertension are primarily carried out in general practice and hypertension accounts for 15% of all contacts.[10] Only 29.1–54% of treated hypertensive patients in Denmark achieve BP control.[11,12] Based on the hypothesis that SES influences BP control despite free access to care, we conducted a cross-sectional study with the aim of examining the association between SES and optimal BP control in hypertensive patients treated in general practice in Denmark.

Materials and methods

Study design

From November 2007 to January 2008, we enrolled 184 general practices. The GPs included 5413 patients with hypertension and registered information about each patient's BP and diagnosis of diabetes when relevant.[12] A patient questionnaire included information about lifestyle factors. Information about antihypertensive drug treatment, other co-morbidity [cardiovascular diseases (CVDs) and chronic kidney diseases] and socio-economic factors (education, cohabitation status and income) were retrieved from relevant registers provided by Statistics Denmark.

Danish health care

The health care system in Denmark is tax funded, providing free access to general practice, outpatient clinics and hospital care for all inhabitants irrespective of age, SES and geographical residence. Reimbursement increases with patient's expenses for prescription medication.[13]

Audit Project Odense

Patients were enrolled during an audit on hypertension carried out by Audit Project Odense (APO). APO is a quality development concept for general practice which is widely used.[14,15] During consultations, the GPs registered information about patient characteristics and treatment on an APO registration chart. Data were collected consecutively over a predefined period and provided a basis for evaluation of treatment and work patterns within the GPs' practices.

Guidelines for hypertension

The GPs were provided with national guidelines for BP measurement and instructed to follow them. Patients' office BP was measured at least twice with patients sitting down after 5 minutes of rest and using a cuff properly adapted to the arm size.[16] A maximum of 5-mmHg difference between measurements was accepted. The mean of the last two BP measurements was registered. Treatment goals were BP <140/90 mmHg in general (including patients with CVD) and <130/80 mmHg for diabetics and patients with chronic kidney disease.[17]

Data sources and measurements

Patient questionnaire. The patient questionnaire included information about smoking status (never, current or former smoker, with an indication of the year when stopped), alcohol intake (0, 1–8, 9–20, 20–50 or >50 U/week), weight (kilogram) and height (metre).[12]

Statistics Denmark. All inhabitants in Denmark are identified by a unique civil registration number, which allows individual linkage across national registers. Socio-economic information was retrieved for 2007. The Danish Register of Medical Product Statistics contains all prescriptions since 1995, with patient identifier, date and drug (ATC-code, name, package size, formulation and quantity). We retrieved all information on prescriptions for each patient from 1995 to 2008. From the Danish National Patient Registry, we obtained information on admissions, outpatient services and emergency room contacts with Danish hospitals classified according to the International Classification of Diseases (ICD-10) for the period 1994–2007.

Participants. A total of 7111 hypertensive patients were invited to participate during a BP follow-up with their GP and 5413 patients accepted participation. Some 153 patients only had a home BP measurement registered and were excluded. The study population therefore comprises 5260 patients with an office BP.

Variables. Outcome measure was optimal BP control defined as BP <140/90 mmHg in general and <130/80 mmHg in diabetics. Body mass index (BMI) was classified as normal (<25 kg/m^2), excess weight (25 ⩽ BMI < 30) and obesity (⩾30 kg/m^2).

Socio-economic variables. Education was categorized according to the length of highest attained educational level: <10 years (primary and lower secondary school), 10–12 years (vocational education and upper secondary school), >12 years (short, medium and long-term higher education).[18–20] We used the variable equivalent disposable income for a single family member, which comprises all income (wages, salaries, all types of benefits and pensions) after taxation for the entire household and then adjusted for number of persons in the household. Disposable income was categorized as low (first quartile), medium (second and third quartile) and high (fourth quartile).[21] Labour market status was categorized as working, not on the workforce, early retirement pension and retirement pension.[22] Cohabitant status was categorized as married/cohabitating or single (divorced, widowed and never married).

Co-morbidity. As co-morbidity, we included CVDs, diabetes or chronic kidney disease since there are special recommendations for hypertension treatment of these three groups. From the Danish National Patient Registry, we extracted primary and secondary diagnoses from the last 13 years within the following diseases: ischaemic heart diseases, cerebral diseases, peripheral vascular diseases and chronic kidney diseases. CVD included ischaemic heart diseases, cerebral and peripheral vascular diseases.

Antihypertensive medication. Antihypertensive drug treatment included the following: diuretics, angiotensin-converting enzymes inhibitors (ACE-Is), angiotensin receptor blockers, calcium channel blockers and beta-blockers. A patient was defined as being treated with one or more of the antihypertensive drug classes, if he/she had tablets available on the day they consulted their GP for BP follow-up and thereby were included in the study. An example: redemption of 100 tablets was assumed to cover 120 days because we allowed for minor non-adherence. Combination drugs were split into each drug class.

Statistical analysis

Due to age-specific differences in income and education, we stratified all analyses into two age groups: <65 years and ⩾65 years. The age 65 years was chosen as it is the normal retirement age in Denmark.[18,19] Differences in baseline characteristics stratified on educational and income levels were investigated using linear, logistic or multinomial logistic regression adjusted for age and sex. A *P*-value <0.05 was considered significant. Educational level <10 years and low-income level were used as baseline, respectively. All regression analyses were adjusted for cluster effect at practice level using robust cluster estimation. Odds ratio (OR) is presented with 95% confidence intervals (CIs). We analysed the association between optimal BP control and various covariates in three different logistic regression models. Model 1 analysed the association between optimal BP control and each covariate, adjusted for age and sex. Model 2 analysed the association between optimal BP control and educational level or disposable income adjusted for age, sex, cohabitation status, co-morbidity and antihypertensive drug treatment. Model 3 further adjusted for lifestyles factors like BMI, smoking and alcohol habits. The models were compared using Akaike information criterion (AIC) to identify the preferred model, i.e. the model explaining most of the variation in the outcome variable. We assumed that labour market status and income were both on the causal pathway from education to optimal BP control (Fig. 1) and thus did not include education and income in the same model. Labour market status was not analysed separately due to the age stratification below and above 65 years, which separates the working population from the patients on retirement pension. Rank order correlation (Kendall's tau) was used to measure correlation between the following covariates: (i) education and income, (ii) education and lifestyle factors and (iii) income and lifestyle factors. Interaction terms between education and lifestyle factors (BMI, smoking, alcohol) and between income level and lifestyle factors were tested, as was the interaction between diabetes and BMI. Missing values were considered missing at random. STATA release 11.0 (StataCorp, College Station, TX) was used for all statistical analyses.

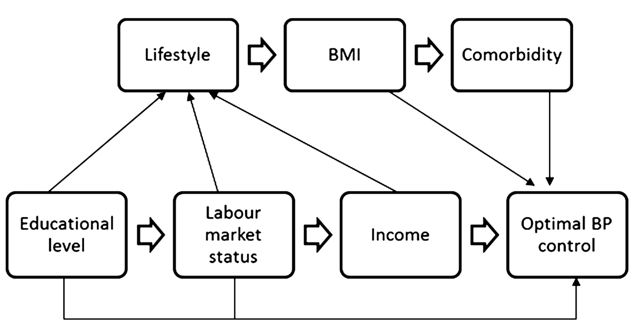

FIGURE 1 *A simplified model for possible pathways between socio-economic factors and optimal BP control*

Ethics

Patients gave consent to participate in the study by answering the questionnaire. The study was approved by the Danish Data Protection Agency. The study did not need approval by the Regional Ethics Committee.

Results

Baseline characteristics stratified on education and income

Table 1 presents the baseline characteristics. Of the 5260 patients included, 44.3% were males. Overall mean age was 65.9 years (CI: 65.6–66.2). For patients <65 years and with an educational level <10 years, a lower proportion were working and a lower proportion were married/cohabiting compared to patients with an educational level of 10–12 years. When stratifying on income level, a higher proportion of patients <65 years with a low-income level were diabetics, a higher proportion were on early retirement pension and a higher proportion were single.

There were far fewer patients with low educational and low-income level in the age group <65 years (10.2% with low income and 29.3% with education <10 years) compared to patients <65 years (37.0% with low income and 46.0% with education <10 years).

Optimal BP control

The overall proportion of patients achieving optimal BP control was 29.1% (CI: 27.9–30.3) (Table 2). The proportion of patients <65 years with optimal controlled BP was 31.7% (CI: 29.8–33.6) with no difference between sex (P = 0.080, age adjusted), while 27.1% (CI: 25.5–28.7) of patients ⩾65 years achieved optimal BP control with no difference between sex (P = 0.446, age adjusted) (Table 2). Since there were no sex differences, the results in the following are not presented separately for each sex.

Education and income

Patients <65 years of age had significantly higher odds (OR: 1.23, CI: 1.01–1.52) of achieving optimal BP control if their educational level was 10–12 years compared with a level <10 years adjusted for all covariates (Table 3). However, the association between educational level and optimal BP control is attenuated from Model 1 to 3. This is due to the confounding

Table 1 *Baseline characteristic of 5260 hypertensive patients stratified by age, income and educational level*

	Age <65 years							Age ⩾65 years						
	All	Educational level			Income			All	Educational level			Income		
	n = 2313	<10	10–12	>12	Low	Medium	High	n = 2947	<10	10–12	>12	Low	Medium	High
Number, %		29.3	47.7	22.9	10.2	51.8	38.0	–	46.0	36.5	17.6	37.0	48.5	14.5
Male, %	46.3	39.5	50.2[a]	46.3[a]	43.6	43.6	50.6	42.8	33.5	52.3[a]	51.1[a]	34.8	45.5[a]	54.1[a]
Age, mean	55.7	56.3	55.5	55.6	55.9	55.4	56.2	73.8	74.0	72.6	73.0	75.6	73.1[a]	71.7[a]
BP														
Systolic BP, mean	140.9	140.6	141.3	140.6	142.7	140.7	140.8	144.9	144.9	144.8	144.4	145.1	144.8	144.7
Diastolic BP, mean	85.4	84.7	85.4	86.2[a]	84.1	85.1	86.1[a]	80.7	80.0	81.4[a]	81.5	79.8	81.0	82.0
Labour market status, %														
Working	70.5	57.0	72.3[a]	84.7[a]	30.6	64.1[a]	88.6[a]	4.7	2.7	5.1	10.3[a]	–	3.6[a]	20.3[a]
Retirement pension	–	–	–	–	–	–	–	92.0	94.8	89.8	87.0[a]	98.8	91.7[a]	75.6[a]
Early retirement pension	15.0	19.0	15.4	8.9[a]	28.2	17.7[a]	8.0[a]	2.7	1.7	4.4[a]	2.2	0.06	4.2[a]	2.6
Not on the workforce	14.5	24.0	12.3[a]	6.4[a]	41.2	18.2[a]	3.4[a]	0.6	0.8	0.7	0.0	0.05	0.6[a]	1.4
Cohabitation status, %														
Single	24.3	27.1	22.7[a]	23.9	53.8	27.2[a]	12.5[a]	39.5	42.8	33.4	35.1	51.6	33.9[a]	27.4[a]
Married/cohabiting	75.7	72.9	77.3[a]	76.1	46.2	72.8[a]	87.5[a]	60.5	57.2	66.6	64.9	48.4	66.1[a]	72.6[a]
Co-morbidity														
No diabetes or CVD	76.3	71.1	76.4[a]	83.4[a]	70.1	73.8	81.2[a]	64.0	62.0	63.7[a]	68.4[a]	61.7	64.6	67.7[a]
Diabetes[b], %	13.6	17.1	13.2[a]	9.0[a]	20.1	15.4	9.5[a]	17.0	18.0	17.4	15.8[a]	18.6	16.5[a]	14.8[a]
CVD[c], %	10.1	11.8	10.4	7.7[a]	9.8	10.8	9.3[a]	19.0	19.9	19.0	15.8[a]	19.6	18.9	17.4
Kidney disease, %	0.04	–	–	–	0	0	0.11	0.4	0.2	0.8	0.2	0.3	0.5	0.5

All numbers presented in columns are percent (%), unless otherwise indicated as mean values in column 1.
[a]Indicates a *P*-values <0.05 using linear, logistic or multinomial logistic regression for the differences in baseline characteristics with, respectively, educational level <10 years or low income level as baseline.
[b]Diagnosis of diabetes with or without CVD (202 diabetics had a CVD).
[c]CVD without diagnosis of diabetes.

effect of antihypertensive drug treatment and lifestyles factors on the association between optimal BP control and educational level (Table 3). The OR of optimal BP control increased among patients with high income, when adjusting only for age and sex. However, the association between income and BP control was attenuated, when adjusting for further covariates.

For patients ⩾65 years of age, education and income showed no significant association with BP control, but being married/cohabiting increased the OR of control to 1.21 (CI: 1.00–1.46, Model 3) for models adjusted for education and an OR of 1.22 (CI: 1.00–1.48, Model 3) for models adjusted for income.

Co-morbidity

Irrespective of age, diagnosis of diabetes strongly reduced the odds of optimal BP control in all analyses (Table 3). CVD increased the odds of optimal BP control irrespective of age, education and income (Table 3). Chronic kidney disease was not included in the analysis since only 12 patients were registered with the disease.

Correlation and interactions terms

The rank order correlation (r) between educational level and income was $r = 0.34$ (low to moderate), between educational level and BMI $r = -0.10$ and between income and BMI $r = -0.04$. No interaction terms were significant at a 5% level for either age group. For patients <65 years, the AIC values from comparing the educational models decreased from Model 1 (AIC = 2851) to Model 2 (AIC = 2658) and Model 3 (AIC = 2564). For income models, the same was seen (AIC = 2885, 2691, 2596, respectively). This indicated that a logistic model adjusting for all covariates (civil status, co-morbidity, antihypertensive drug treatment and lifestyles factors) should be the preferred and best fitted model. A similar model comparison applies for patients ⩾65 years.

Discussion

We found that higher SES was associated with optimal BP control for hypertensive patients treated in primary care. The socio-economic gradient differed with age. Firstly, for the age group <65 years, educational level was positively associated with optimal BP control, whereas cohabiting status had little influence. Secondly, for patients ⩾65 years being married/cohabiting, the odds increased for optimal BP control compared to patients being single, while education and income had little impact for this age group. Thirdly, CVD was strongly associated with optimal BP control,

TABLE 2 *Optimal BP control according to socio-economic factors, co-morbidity, antihypertensive drug treatment and lifestyle factors*

	Proportion of patients with optimal BP control[a]			OR for optimal BP control, adjusted for age and sex	
	All subjects (%)	<65 years (%)	⩾65 years (%)	<65 years, OR (95% CI)	⩾ 65 years, OR (95% CI)
Optimal BP control	29.1	31.7	27.1	–	–
Highest attained education (years)					
<10	27.9	28.6	27.5	1	1
10–12	30.2	33.7	26.4	**1.28 (1.04–1.58)**	0.96 (0.80–1.15)
>12	30.0	32.3	27.6	1.20 (0.94–1.52)	1.02 (0.82–1.26)
Income					
Low (1st quartile)	27.7	26.9	27.9	1	1
Medium (2nd + 3rd quartile)	28.4	30.9	26.4	1.20 (0.88–1.65)	0.94 (0.79–1.11)
High (4th quartile)	31.9	34.1	27.2	**1.43 (1.04–1.96)**	0.99 (0.76–1.29)
Labour market status					
Working	31.6	32.4	21.6	1	1
Retirement from 67 years	27.4		27.4	–	1.35 (0.91–2.01)
Early retirement from 60 years	26.8	27.6	23.1	0.82 (0.62–1.10)	1.07 (0.49–2.34)
Not on the workforce	33.3	33.1	36.8	1.03 (0.80–1.32)	2.08 (0.75–5.80)
Cohabitation status					
Single	30.1	30.3	25.6	1	1
Married/cohabiting	27.1	32.2	28.1	1.11 (0.90–1.36)	**1.20 (1.01–1.43)**
Co-morbidity					
No diabetes or CVD	31.3	33.8	28.9	1	1
Diabetes[b], %	10.9	10.8	11.0	**0.24 (0.17–0.36)**	**0.30 (0.21–0.45)**
CVD[c], %	37.8	43.6	35.4	**1.57 (1.14–2.17)**	**1.36 (1.10–1.68)**
Antihypertensive treatment, %					
0 Drug	23.5	26.6	20.1	0.80 (0.58–1.12)	**0.64 (0.43–0.94)**
1 Drug	29.4	30.6	28.3	1	**1**
2 Drugs	29.9	34.2	26.6	1.20 (0.99–1.46)	0.91 (0.75–1.10)
3 Drugs	30.3	33.0	28.8	1.18 (0.92–1.51)	1.02 (0.82–1.27)
⩾4 Drugs	25.1	24.1	25.6	0.76 (0.45–1.27)	0.87 (0.60–1.26)
BMI, %					
BMI <25	30.8	34.3	28.8	1	1
BMI 25–30	30.0	31.4	28.8	0.92 (0.73–1.15)	1.01 (0.84–1.21)
BMI ⩾30	24.7	29.1	19.6	0.81 (0.65–1.02)	0.60 (0.47–0.77)
Smoking, %					
Non-smoker	29.7	32.2	27.5	1	1
Former smoker	28.3	32.1	26.1	1.05 (0.86–1.28)	0.95 (0.79–1.14)
Smoker	29.7	30.4	28.9	0.94 (0.76–1.16)	1.09 (0.86–1.39)
Alcohol, %					
0 U/week	28.4	32.1	25.6	1	1
1–7 U/week	30.7	33.6	28.5	1.13 (0.89–1.43)	1.17 (0.94–1.45)
8–20 U/week	26.9	28.7	25.3	0.93 (0.70–1.22)	1.01 (0.80–1.28)
>20 U/week	28.0	29.4	26.1	1.00 (0.69–1.47)	1.07 (0.69–1.65)

[a]Optimal BP control: BP <140/90 mmHg and BP <130/80 mmHg for diabetics.
[b]Diagnosis of diabetes with or without CVD (202 diabetics had a CVD).
[c]CVD without diagnosis of diabetes.

whereas diabetes was negatively associated, irrespective of age, education and income.

Strengths and weaknesses

We used information from Statistics Denmark, which is a valid data source on socio-economic factors and diagnoses from hospitalizations.[21,23] Data on a large Danish population of hypertensive patients from general practice were sampled through a data collection tool, which GPs were accustomed to use.[12,14] This optimized the consistency in the registration data and BP measurements. We were furthermore able to include information on lifestyle factors like BMI, smoking status and alcohol consumption with register information. Another strength of our study was the careful design of analytical models. We tested for relevant correlations and decided not to include education and income in the same analytical models because we believe that income level is on the causal pathway between education and optimal BP control (Fig. 1).

The sampling methods with enrolment of patients during 4–8 weeks may have given rise to some sampling bias. Patients seeing their doctor often had a higher chance of being included in the study. Since patients with low SES visit their doctor more seldom than patients with higher SES,[24] patients with high SES could be over-represented in this study population. Sampling bias might therefore have caused the

TABLE 3 *OR for optimal BP control according to socio-economic factors*

		Education		Income	
	Model 1[a]	Model 2[b]	Model 3[c]	Model 2[b]	Model 3[c]
Patients <65 years					
Highest attained educational level (years)					
<10	1	1	1		
10–12	**1.28 (1.04–1.58)**	**1.24 (1.01–1.53)**	**1.23 (1.01–1.52)**		
>12	1.20 (0.94–1.52)	1.13 (0.89–1.45)	1.18 (0.91–1.52)		
Income					
Low (1st quartile)	1			1	1
Medium (2nd + 3rd quartile)	1.20 (0.88–1.65)			1.13 (0.81–1.58)	1.09 (0.77–1.53)
High (4th quartile)	**1.43 (1.04–1.96)**			1.28 (0.92–1.79)	1.29 (0.92–1.81)
Cohabitation status					
Single	1	1	1	1	1
Married/cohabiting	1.11 (0.90–1.36)	1.06 (0.86–1.32)	1.01 (0.81–1.25)	1.03 (0.82–1.29)	0.98 (0.78–1.22)
Co-morbidity					
No co-morbidity	1	1	1	1	1
Diabetes	**0.24 (0.17–0.36)**	**0.22 (0.15–0.34)**	**0.24 (0.15–0.36)**	**0.25 (0.17–0.37)**	**0.26 (0.17–0.39)**
CVD	**1.57 (1.14–2.17)**	**1.59 (1.15–2.20)**	**1.57 (1.13–2.18)**	**1.59 (1.14–2.21)**	**1.57 (1.13–2.19)**
Patients ⩾65 years					
Highest attained educational level (years)					
<10	1	1	1		
10–12	0.96 (0.80–1.15)	0.93 (0.78–1.12)	0.98 (0.81–1.18)		
>12	1.02 (0.82–1.26)	0.99 (0.80–1.23)	1.03 (0.82–1.29)		
Income					
Low (1st quartile)	1			1	1
Medium (2nd + 3rd quartile)	0.94 (0.79–1.11)			0.89 (0.74–1.06)	0.91 (0.75–1.10)
High (4th quartile)	0.99 (0.76–1.29)			0.91 (0.69–1.19)	0.91 (0.67–1.25)
Cohabitation status					
Single	1	1	1	1	1
Married/cohabiting	**1.20 (1.01–1.43)**	1.14 (0.95–1.37)	1.21 (1.00–1.47)	1.17 (0.98–1.40)	**1.22 (1.01–1.48)**
Co-morbidity					
No co-morbidity	1	1	1	1	1
Diabetes	**0.30 (0.21–0.45)**	**0.31 (0.21–0.45)**	**0.33 (0.22–0.50)**	**0.30 (0.20–0.44)**	**0.32 (0.21–0.48)**
CVD	**1.36 (1.10–1.68)**	**1.38 (1.11–1.73)**	**1.38 (1.10–1.74)**	**1.34 (1.08–1.66)**	**1.34 (1.08–1.68)**

[a]Model 1 is OR (95% CI) analysed separately, adjusted for age and sex.
[b]Model 2 is OR (95% CI) with educational level or income, adjusted for age, sex, cohabitation status, co-morbidity and number of antihypertensive drug used as baseline characteristics.
[c]Model 3 is OR (95% CI) for optimal BP control with educational level or income adjusted for age, sex, cohabitation status, co-morbidity, number of antihypertensive drug used, BMI, smoking and alcohol.

proportion of patients with low income or low educational level to be much smaller in the age group <65 years than in the age group ⩾65 years as seen in Table 1. And if sampling bias is the main cause of this difference, the association between education and BP control for the lower educated and the low-income group may have been underestimated in our study. However, the difference in educational and income levels between age groups observed in Table 1 is most likely due to the demographic development in the Danish population, where the younger patients have longer educations than the elderly, and the younger working population has higher income levels than the elderly on retirement pension.

However, the effect of educational level on BP control remained after adjustment for a number of factors. It is not clearly defined through which pathways educational level affects BP control. Higher education could lead to a better understanding of risks and the importance of treatment, but the impact of education might also be mediated through other socio-economic factors (Fig. 1) or through lifestyle.[25–27] Methodological studies have recommended that socio-economic factors like education, occupation and income are not used interchangeably.[21,26,28] In our analysis, these factors were studied independently and we found different effects of education and income on BP control and a pronounced difference in the patterns according to age.

It is worrying that low educational level is associated with lower OR of BP control in hypertensive patients <65 years, especially in a health care system with equal access to care. In patients ⩾65 years, educational level had no impact on BP control. Other factors such as physiology, co-morbidity, polypharmacy and performance status can be more important for BP control than educational level in the elderly. Furthermore, the age group ⩾65 years had a high mean age of 73.8 years. At this age, one would expect that the lower educated patients included in our study are the healthiest patients, who had survived long enough to be included. This could have eliminated a possible educational difference in BP control for this age group.

GPs should pay particular attention to patients' educational level and, in case of the elderly, the cohabiting status. This simple approach could strengthen the attention towards patients without optimal BP control and together with intensive BP follow-up and careful information to this vulnerable group of hypertensive patients, an increased focus would be on the patients needed it. An important aspect to consider in this context is the communication between the GP and the patient.[29] In the elderly, education and income level had no impact on the ability to achieve BP control, while being married or cohabiting increased the odds, which could be due to the fact that the married/cohabiting elderly patients often visit their GP together with their partner that might improve the understanding of the information given by the GP.

We found that only 29.1% of all patients achieved optimal BP control. Previous studies from Denmark have shown that the proportion of hypertensive patients with controlled BP increased from 21% to 43% from 1998 to 2004.[11,30] Our observation of only 29.1% having achieved controlled BP may to some extent be due to a higher proportion of hypertensive diabetics in our study (Table 1).[11] BP targets for diabetics are <130/80 mmHg, which is more difficult to achieve. Table 2 illustrates this since only 10.9% of all diabetics had controlled BP. Nevertheless, it is in accordance with other studies that hypertensive diabetics had significantly reduced OR of BP control and this reduced OR persists in our study regardless of using a model with education or income level (Tables 2 and 3).[9,30–35] It is noteworthy that in the age group <65 years, a much lower proportion of diabetics were seen among those with a high educational and high income level and that this difference persisted in the age group >65 years, although attenuated (Table 1). Reasons for lack of optimal BP control in diabetics have in other studies been explained by poor access to regular medical care or lack of health insurance,[33,34] but in our study, other reasons should be considered. The BP target <130/80 mmHg is more difficult to reach than BP limits <140/90 mmHg in general, and in a recent study, we found that not all diabetics in our study population were treated with an ACE-I as recommended by guidelines, which could cause a lower degree of BP control.[12]

As opposed to diabetics, patients with a CVD had much higher odds of optimal BP control (Table 3). Patients with CVD are often more intensively treated with combinations of drugs, which could give a better BP control. Having had a cardiovascular event, e.g. myocardial infarction or apoplexy, could also increase a patient's compliance to treatment because of their awareness and experiences with a life-threatening disease closely related to hypertension.

Implication for practice and further research

Despite equal access to care, SES has a significant impact on BP control in hypertensive patients treated in general practice in Denmark. Future development of tools to incorporate SES in the daily clinical work in primary care should be given priority, when trying to improve care of hypertensive patients. It should also be emphasized to the GPs and the health care system in general that SES should not be ignored when setting strategies in the management of hypertension. Diabetics are still far from achieving optimal BP control and there is an urgent challenge in improving the inadequate treatment of diabetics.

Conclusions

SES has an impact on BP control for hypertensive patients treated in the Danish primary health care system. Free access to care does not eliminate this problem. Co-morbidities such as diabetes and CVD also have a substantial influence on BP control, irrespective of educational or income level.

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References

1 Lang T, de GR, Chatellier G, Hamici L, Diene E. Prevalence and therapeutic control of hypertension in 30,000 subjects in the workplace. *Hypertension* 2001; **38:** 449–54.
2 de Gaudemaris R, Lang T, Chatellier G *et al*. Socioeconomic inequalities in hypertension prevalence and care: the IHPAF Study. *Hypertension* 2002; **39:** 1119–25.
3 Mensah GA, Mokdad AH, Ford ES, Greenlund KJ, Croft JB. State of disparities in cardiovascular health in the United States. *Circulation* 2005; **111:** 1233–41.
4 Avendano M, Glymour MM, Banks J, Mackenbach JP. Health disadvantage in US adults aged 50 to 74 years: a comparison of the

health of rich and poor Americans with that of Europeans. *Am J Public Health* 2009; **99:** 540–8.
5 Avendano M, Kunst AE, Huisman M *et al*. Socioeconomic status and ischaemic heart disease mortality in 10 western European populations during the 1990s. *Heart* 2006; **92:** 461–7.
6 Grotto I, Huerta M, Sharabi Y. Hypertension and socioeconomic status. *Curr Opin Cardiol* 2008; **23:** 335–9.
7 Kaplan MS, Huguet N, Feeny DH, McFarland BH. Self-reported hypertension prevalence and income among older adults in Canada and the United States. *Soc Sci Med* 2010; **70:** 844–9.
8 McWilliams JM. Health consequences of uninsurance among adults in the United States: recent evidence and implications. *Milbank Q* 2009; **87:** 443–94.
9 Ong KL, Cheung BM, Man YB, Lau CP, Lam KS. Prevalence, awareness, treatment, and control of hypertension among United States adults 1999-2004. *Hypertension* 2007; **49:** 69–75.
10 Munck A. [Audit on ‘‘Prevention in General Practice’’, Report. Total Results from 394 General Practitioners.] Audit Project Odense (APO). Odense, Denmark: Research Unit for General Practice in Odense, 2005.
11 Kronborg CN, Hallas J, Jacobsen IA. Prevalence, awareness, and control of arterial hypertension in Denmark. *J Am Soc Hypertens* 2009; **3:** 19–24.
12 Paulsen MS, Sondergaard J, Reuther L *et al*. Treatment of hypertension in general practice: a cross-sectional study of 5413 hypertensive patients. *Fam Pract* 2011; **28:** 599–607.
13 Moller PK. Pricing and reimbursement of drugs in Denmark. *Eur J Health Econ* 2003; **4:** 60–5.
14 Bjerrum L, Munck A, Gahrn-Hansen B *et al*. Health Alliance for Prudent Prescribing, Yield and use of Antimicrobial drugs in the treatment of Respiratory Tract Infections (HAPPY AUDIT). *BMC Fam Pract* 2010; **11:** 29.
15 Sondergaard J, Hansen DG, Aarslev P, Munck AP. A multifaceted intervention according to the Audit Project Odense method improved secondary prevention of ischemic heart disease: a randomised controlled trial. *Fam Pract* 2006; **23:** 198–202.
16 Bang LE. [Diagnostic Blood Pressure Measurement—Diurnal, Home and Office Measurements]. Copenhagen, Denmark: The Danish Hypertension Society, 2006.
17 The Danish Society of General Practitioners, Christensen B. [Prevention of Ischemic Cardiovascular Disease in General Practice, 2007 Disease in General Practice]. 3rd edn. Copenhagen, Denmark: The Danish Society of General Practitioners, 2007.
18 Rasmussen JN, Rasmussen S, Gislason GH *et al*. Mortality after acute myocardial infarction according to income and education. *J Epidemiol Community Health* 2006; **60:** 351–6.
19 Rasmussen JN, Rasmussen S, Gislason GH *et al*. Persistent socioeconomic differences in revascularization after acute myocardial infarction despite a universal health care system—a Danish study. *Cardiovasc Drugs Ther* 2007; **21:** 449–57.
20 Rasmussen JN, Gislason GH, Rasmussen S *et al*. Use of statins and beta-blockers after acute myocardial infarction according to income and education. *J Epidemiol Community Health* 2007; **61:** 1091–7.
21 Chaix B, Bean K, Leal C *et al*. Individual/neighborhood social factors and blood pressure in the RECORD Cohort Study: which risk factors explain the associations? *Hypertension* 2010; **55:** 769–75.
22 Madsen M, Davidsen M, Rasmussen S, Abildstrom SZ, Osler M. The validity of the diagnosis of acute myocardial infarction in routine statistics: a comparison of mortality and hospital discharge data with the Danish MONICA registry. *J Clin Epidemiol* 2003; **56:** 124–30.
23 Dalton SO, Steding-Jessen M, Gislum M *et al*. Social inequality and incidence of and survival from cancer in a population-based study in Denmark, 1994-2003: background, aims, material and methods. *Eur J Cancer* 2008; **44:** 1938–49.
24 Arendt JN, Jensen BT, Nexoe J, Muntzberg G, Sorensen J. [Low income and number of contacts with general practice]. *Ugeskr Laeger* 2010; **172:** 1591–7.
25 Chaix B, Ducimetiere P, Lang T *et al*. Residential environment and blood pressure in the PRIME Study: is the association mediated by body mass index and waist circumference? *J Hypertens* 2008; **26:** 1078–84.
26 Lahelma E, Martikainen P, Laaksonen M, Aittomaki A. Pathways between socioeconomic determinants of health. *J Epidemiol Community Health* 2004; **58:** 327–32.
27 Andersen I, Gamborg M, Osler M, Prescott E, Diderichsen F. Income as mediator of the effect of occupation on the risk of myocardial infarction: does the income measurement matter? *J Epidemiol Community Health* 2005; **59:** 1080–5.
28 Geyer S, Hemstrom O, Peter R, Vagero D. Education, income, and occupational class cannot be used interchangeably in social epidemiology. Empirical evidence against a common practice. *J Epidemiol Community Health* 2006; **60:** 804–10.
29 Naik AD, Kallen MA, Walder A, Street RL Jr. Improving hypertension control in diabetes mellitus: the effects of collaborative and proactive health communication. *Circulation* 2008; **117:** 1361–8.
30 Sehestedt T, Ibsen H, Jorgensen T. Awareness, treatment and control of hypertension in Denmark. The inter99 study. *Blood Press* 2007; **16:** 312–19.
31 Bebb C, Coupland C, Stewart J *et al*. Practice and patient characteristics related to blood pressure in patients with type 2 diabetes in primary care: a cross-sectional study. *Fam Pract* 2007; **24:** 547–54.
32 Hedblad B, Nerbrand C, Ekesbo R *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:** 224–30.
33 Nelson SA, Dresser GK, Vandervoort MK *et al*. Barriers to blood pressure control: a STITCH substudy. *J Clin Hypertens (Greenwich)* 2011; **13:** 73–80.
34 Borzecki AM, Berlowitz DR. Management of hypertension and diabetes: treatment goals, drug choices, current practice, and strategies for improving care. *Curr Hypertens Rep* 2005; **7:** 439–49.
35 Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Worldwide prevalence of hypertension: a systematic review. *J Hypertens* 2004; **22:** 11–9.