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ORIGINAL ARTICLE

Prevalence and determinants of undertreatment of hypertension in the Netherlands

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The objective of this study was to determine the prevalence, treatment, and control of hypertension, and the determinants of undertreatment in the Dutch population. The study design was cross-sectional. A population-based survey on cardiovascular disease risk factors in the Netherlands from 1996 to 2002 was the setting of the study. A total of 10 820 men and women, aged 30–59 years, were included in the study. The main outcome measures of the study were: Prevalence of hypertension, treatment, and control of hypertension and determinants of undertreatment of hypertension. Hypertension was defined as: systolic blood pressure (SBP) ⩾140 mmHg and/or diastolic blood pressure (DBP) ⩾90 mmHg, and/or the use of antihypertensive medication. Treated and controlled hypertension was defined as SBP <140 mmHg and DBP <90 mmHg. Multivariate logistic regression was used to assess the determinants of undertreatment. The prevalence of hypertension in men was 21.4% and in women 14.9%, and 17.9% of the hypertensive men and 38.5% of the hypertensive women were receiving antihypertensive medication. Of the untreated hypertensives, 21.9% of the men and 13.6% of the women were eligible for treatment with antihypertensive medication according to Dutch guidelines. Female gender and the use of cholesterol-lowering medication were associated with an increased chance of being treated. Subjects who were physically active, on a low salt diet, and current smokers had an increased chance of being untreated. Taking cholesterol-lowering medication and no asthma or allergy were factors associated with better control of blood pressure. In conclusion, a considerable proportion of hypertensives were untreated and uncontrolled. Therefore, the detection and control of hypertension in the Netherlands needs to improve. Several groups of hypertensives were identified that need additional care and attention.
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Keywords: antihypertensive treatment; population-based survey; prevalence; detection and control; undertreatment

Introduction

Hypertension is a major public health hazard because of its high prevalence[1] and its strong positive association with cardiovascular diseases.[2–6] Also, the overall beneficial effect of treatment of hypertension has been demonstrated.[7–9] Therefore, the detection and adequate treatment of hypertension is important to reduce the incidence of cardiovascular diseases. Knowledge of factors that are associated with undertreatment of hypertension may help to identify subgroups that need additional care and attention. Previously, it was reported that the prevalence of hypertension (systolic blood pressure (SBP) ⩾140 mmHg and/or diastolic blood pressure (DBP) ⩾90 mmHg and/or use of antihypertensive medication) in the Netherlands in the period 1993–1997 was approximately 20.2% of the population in the age-group from 40 to 59 years.[10] Studies from other countries suggest that the proportion of hypertensives treated and/or controlled has been stable in recent years or has even decreased.[11,12]

Therefore, we performed the present study to assess the prevalence and determinants of undertreatment of hypertension in the Netherlands during 1996–2002.

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Methods

Data

Data were obtained from population-based surveys on cardiovascular disease risk factors conducted in The Netherlands. The Monitoring Project on Cardiovascular Disease Risk Factors (MPCDRF) study was carried out from 1987 to 1992 in men and women aged 20–59 years. Each year, a new random sample was collected in basic health services in Amsterdam, the capital in the west with about 700 000 inhabitants, Doetinchem, a small town with circa 40 000 inhabitants in a rural area in the east, and Maastricht in the south with roughly 100 000 inhabitants at that time.

The overall response rate in Amsterdam, Maastricht, and Doetinchem was 45, 58, and 62%, respectively. The average response rate for men was 50% and for women 57%. This project was continued from 1993 to 1997 as the "Monitoring risk factors and health in The Netherlands" (MORGEN) project. In Amsterdam and Maastricht, new random samples were collected for those aged 20–59 years, whereas in Doetinchem the study population consisted of individuals who had participated in the previous study. So, patients in Doetinchem were re-examined after 5 years. The response rate in Amsterdam was 30% for men and 37% for women, in Maastricht it was 42 and 49%, and in Doetinchem it was 57 and 60%, respectively. From 1998 to 2002, data were only collected from the Doetinchem cohort, which was the second re-examination of the participants of the MPCDRF (aged 30–69 years). The overall response rate was 68% for men and 63% for women.

All respondents completed a questionnaire that contained questions on demographic variables, cardiovascular risk factors, and current use of medication. After this, blood pressure, weight, and height were measured and blood was drawn for total and high-density lipoprotein cholesterol determination. The design of this study has been described in detail elsewhere.[10,12] A nonresponse survey was conducted in order to assess possible selection bias. Of all nonrespondents ($n=1620$), 61% agreed to participate, 23% could not be reached, and 16% refused to participate. The results suggested that no selection bias with respect to educational level has occurred, as educational level is a main determinant of nonresponse and is associated with blood pressure.[13,14] Therefore, no substantial differences are expected in blood pressure between respondents and nonrespondents.[10]

A random zero sphygmomanometer was used to measure blood pressure with the subject in a sitting position using a cuff of proper size for arm circumference. After the first measurement, the heart rate was measured for 30 s followed after 5 min by a second blood pressure measurement.

We selected patients group aged 30–59 years, because persons aged 20–29 were not included in the re-examination of the Doetinchem cohort (1998–2002), and in Amsterdam and Maastricht (1996–1997) there were no persons aged 60–69 years included.

Definitions

Hypertension was defined according to the WHO-ISH criteria as SBP $\geqslant$140 mmHg and/or DBP $\geqslant$90 mmHg, and/or the use of antihypertensive medication (irrespective of the level of blood pressure). Participants with hypertension were further classified as: treated and adequately controlled, treated but uncontrolled, and untreated. Uncontrolled persons were treated but had their SBP $\geqslant$140 mmHg and/or DBP $\geqslant$90 mmHg. For the analysis of undertreatment, we used Dutch guidelines of 2000 for the treatment of hypertension.[15] If SBP $\geqslant$180 mmHg and DBP $\geqslant$100 mmHg, treatment is always necessary. When the 10-year cardiovascular risk (estimated with the multifactorial Framingham risk equation) exceeds 20%, hypertension should also be pharmacologically treated. Persons aged 40–59 years with a cardiovascular disease, people with diabetes aged 50–59 years, people with diabetes and smoking aged 40–49 years, and smoking males aged 50–59 years with SBP between 140 and 180 mmHg and/or DBP between 90 and 100 mmHg should be treated because their 10-year cardiovascular risk exceeds 20%. Among treated hypertensives, blood pressure is considered controlled if SBP $<$140 mmHg and DBP $<$90 mmHg.

For the analysis of the determinants or treatment and control, besides a cutoff value of 140/90 mmHg, also a higher SBP cutoff ($\geqslant$160 mmHg) and/or DBP cutoff ($\geqslant$95 mmHg) was chosen, in order to minimise misclassification of subjects as untreated or uncontrolled hypertensives on the basis of two blood pressure measurements on the same day.

Correction for within-person variability

Repeated measurements of blood pressure and total cholesterol were available from a sample of the population screened from 1987 to 1992.[9] Among 924 subjects who were examined in 1989 and 1990, in each year two blood pressure measurements (in duplicate) and a total cholesterol determination were performed. These measurements were used to calculate blood pressure, serum total cholesterol, and HDL-cholesterol levels adjusted for within-person variability.

The adjustment for SBP and DBP was performed separately for persons untreated for hypertension with no other risk factor present, respondents who were untreated for hypertension with one or more risk factors, and drug-treated persons after stratification by gender and 10-year age category.[16] This adjustment was performed within these strata because each stratum can be considered a separate subpopulation with a specific distribution of blood

pressure values. By this approach, each blood pressure value was corrected towards the mean of the stratum to which that individual belonged. This will correct for the possibility to classify a person with normal blood pressure as hypertensive. For total cholesterol values, this correction was performed after stratification for gender and 10-year age category.[16]

Statistical analysis

The prevalence of treatment and undertreatment of hypertension was estimated and standardised to the age and gender distribution of the general population in 1999. Multivariate logistic regression analysis was used to assess the association between demographic variables, cardiovascular disease risk factors, medication use as independent variables, and treatment and control of hypertension as dependent variables. The χ^2 statistics for trend was used for the time trends.

Results

Prevalence of hypertension, treatment, and control of hypertension

After exclusion of pregnant women ($n=125$) and subjects with missing blood pressure data ($n=12$), 10 820 subjects remained available for analysis. Using the WHO-ISH guidelines,[11] 20.1% (2176/10 820) of the study population was classified as hypertensive (Table 1). Of the hypertensives, 70% (1530/2176) were not receiving any medication, while among those treated 54% (347/646) had blood pressure levels $\geqslant$140/90 mmHg.

Table 2 lists the prevalence of hypertension by age and gender. Among men, 21.4% had hypertension, only 17.9% were treated, and in 67.6% of those treated blood pressure was not controlled. According to the current Dutch guidelines, 21.9% of the untreated hypertensive men were eligible for treatment. Among women, 14.9% had hypertension,

Table 1 Prevalence of hypertension according to the WHO-ISH classification, adjusted for within-person variability

WHO-ISH grade	*SBP (mmHg)*	*DBP (mmHg)*	*Total study population (n (% of total population))*	*Treated (n (% of total population))*	*Untreated (%) (n (% of total population))*
Normotensive					
Optimal	<120	<80	4247 (39.3)	32 (0.3)	4215 (40.0)
Normal	120–129	80–84	2713 (25.1)	93 (0.9)	2620 (24.2)
High normal	130–139	85–89	1983 (18.3)	174 (1.6)	1809 (16.7)
Hypertensive					
Grade 1	140–159	90–99	1509 (13.9)	257 (2.4)	1252 (11.6)
Grade 2	160–179	100–109	311 (2.9)	77 (0.7)	234 (2.2)
Grade 3	$\geqslant$180	$\geqslant$110	57 (0.5)	13 (0.1)	44 (0.4)
ALL			10820 (100)	646 (6.0)	1530 (14.2)[a]

[a]Only the sum of the percentages of grade 1, 2, and 3.
All percentages refer to the total study population.

Table 2 Prevalence of hypertension ($\geqslant$140/90 mmHg), treated and undertreated hypertension in men and women by 10-year category and adjusted for within-person variability

	Respondents	*Hypertension (n (% of population))*	*Patients treated (n (% of hypertensive))*	*Patients treated but uncontrolled[a] (n (% of those treated))*	*Patients untreated (n (% of hypertensive))*	*Patients untreated but should be treated[b] (n (% of those untreated))*
Men						
30–59[c]	5004	1201 (21.4)	285 (17.9)	181 (67.6)	916 (82.1)	271 (21.9)
30–39	1237	130 (10.5)	11 (8.5)	8 (72.7)	119 (91.5)	14 (11.8)
40–49	1958	419 (21.4)	75 (17.9)	50 (67.7)	344 (82.1)	65 (16.3)
50–59	1809	652 (36.0)	199 (30.5)	123 (61.8)	453 (69.5)	192 (42.4)
Women						
30–59[c]	5816	975 (14.9)	361 (38.5)	166 (51.9)	614 (61.5)	94 (13.6)
30–39	1593	59 (3.7)	24 (40.7)	16 (66.7)	35 (59.3)	4 (11.4)
40–49	2306	312 (13.5)	119 (38.1)	46 (38.7)	193 (61.9)	26 (13.5)
50–59	1917	604 (31.5)	218 (36.1)	104 (47.7)	386 (63.9)	64 (16.6)

[a]DBP $\geqslant$140 mmHg and/or SBP $\geqslant$90 mmHg.
[b]Untreated should be treated refers to the subjects not treated for hypertension, who should be treated according to the CBO consensus Hypertension because their risk for developing a cardiovascular disease is more then 20% based on their age, gender, blood pressure, smoking status, and presence of diabetes, or cardiovascular diseases.
[c]Weighed by the age and gender distribution of the general Dutch population in 1999.

38.5% were treated, of whom 51.9% were uncontrolled. About 14% of the untreated hypertensive women were eligible for treatment. The prevalence of hypertension increased with age for both men and women. In each age category, the treatment with antihypertensive medication was more prevalent in women compared to men. Among the 2176 subjects with hypertension, a total of 365 subjects were eligible for treatment but untreated and of those treated ($n=646$) 347 persons had their blood pressure not controlled.

Time trends in the treatment and control of hypertension

The prevalence of hypertension decreased significantly from 1996 to 2002 in Doetinchem (trend test P-value $=0.04$). An increasing trend was observed for the percentage of treated hypertensives (trend test P-value $=0.02$).

The percentage of controlled persons fluctuated during the period, with the worst situation between 1998 and 1999 (Table 3). During this period, the percentage of hypertensives who were eligible for treatment but untreated was highest. The proportion of treated hypertensives with uncontrolled blood pressure and the proportion of untreated hypertensives who were eligible for treatment was lowest from 2000 to 2002. However, none of these differences were statistically significant.

Determinants of untreated and treated but uncontrolled hypertension

Determinants of undertreatment, defined as eligible for treatment but not receiving antihypertensive medication, are reported in Figure 1a. Subjects who used cholesterol lowering medication and subjects screened during the years 1998 and 1999 were less likely to be untreated (Odds ratio <1). Males, current smokers, subjects on a low salt diet, and physically active hypertensives were more likely to be untreated (Odds ratio >1).

Determinants of treated but uncontrolled hypertension are reported in Figure 1b. The use of cholesterol-lowering medication was significantly associated with a lower probability of uncontrolled hypertension (Odds ratio <1) and having asthma or allergy with a higher probability of uncontrolled hypertension.

We also performed an analysis with a higher SBP cutoff ($\geqslant 160$ mmHg) and/or DBP cutoff ($\geqslant 95$ mmHg). The association between determinants and treatment status was similar compared to the analysis with lower blood pressure cutoffs. Although the following factors showed the same trend, they were no longer significant: year of screening (1998–1999 *vs* 1996–1997 OR $=0.43$, 95% CI $=0.16$–1.16) and being physically active (OR $=1.96$, 95% CI $=0.96$–3.99). The place of residence became significant (Maastricht *vs* Doetinchem OR $=0.28$, 95% CI $=0.08$–0.78; Amsterdam *vs* Doetinchem OR $=0.25$, 95% CI $=0.09$–0.84). The association between determinants and uncontrolled blood pressure was also similar compared to the analysis with a lower blood pressure cutoff level. However, year of screening (2000–2002 *vs* 1996–1997 OR $=0.20$, 95% CI $=0.05$–0.82) and older age were significantly associated (OR $=0.93$, 95% CI $=0.86$–0.99). Asthma or allergy was no longer significant (OR $=1.69$, 95% CI $=0.62$–4.57).

Discussion

Approximately 21% of the men and 15% of the women aged 30–59 years were hypertensive. Approximately 18% of the hypertensive men and 39% of the hypertensive women were receiving antihy-

Table 3 Prevalence of hypertension ($\geqslant 140/90$ mmHg), treated and undertreated hypertension for different time periods, weighted by age and gender distribution of the general Dutch population in 1999 and adjusted for within-person variability

	Respondents	*Hypertension (n (% of population))*	*Patients treated (n (% of hypertensive))*	*Patients treated but uncontrolled[a] (n (% of those treated))*	*Patients untreated (n (% of hypertensive))*	*Patients untreated but should be treated[b] (n (% of those untreated))*
1996–1997						
Amsterdam	2421	389 (15.8)	133 (32.3)	58 (54.2)	256 (67.6)	62 (14.5)
Maastricht	2089	440 (16.7)	157 (38.0)	82 (62.8)	283 (62.0)	68 (25.3)
Doetinchem	2518	427 (21.4)	91 (20.7)	63 (65.2)	336 (79.3)	77 (23.0)
1998–1999						
Doetinchem	1446	349 (21.3)	94 (27.2)	55 (67.6)	255 (72.8)	78 (23.0)
2000–2002						
Doetinchem	2346	571 (20.6)	171 (28.5)	89 (56.3)	400 (71.5)	80 (14.9)

[a]SBP $\geqslant 140$ mmHg and/or DBP $\geqslant 90$ mmHg.
[b]Untreated should be treated refers to the subjects not treated for hypertension, who should be treated according to the CBO consensus Hypertension because their risk for developing a cardiovascular disease is more then 20% based on their age, gender, blood pressure, smoking status, and presence of diabetes, or cardiovascular diseases.

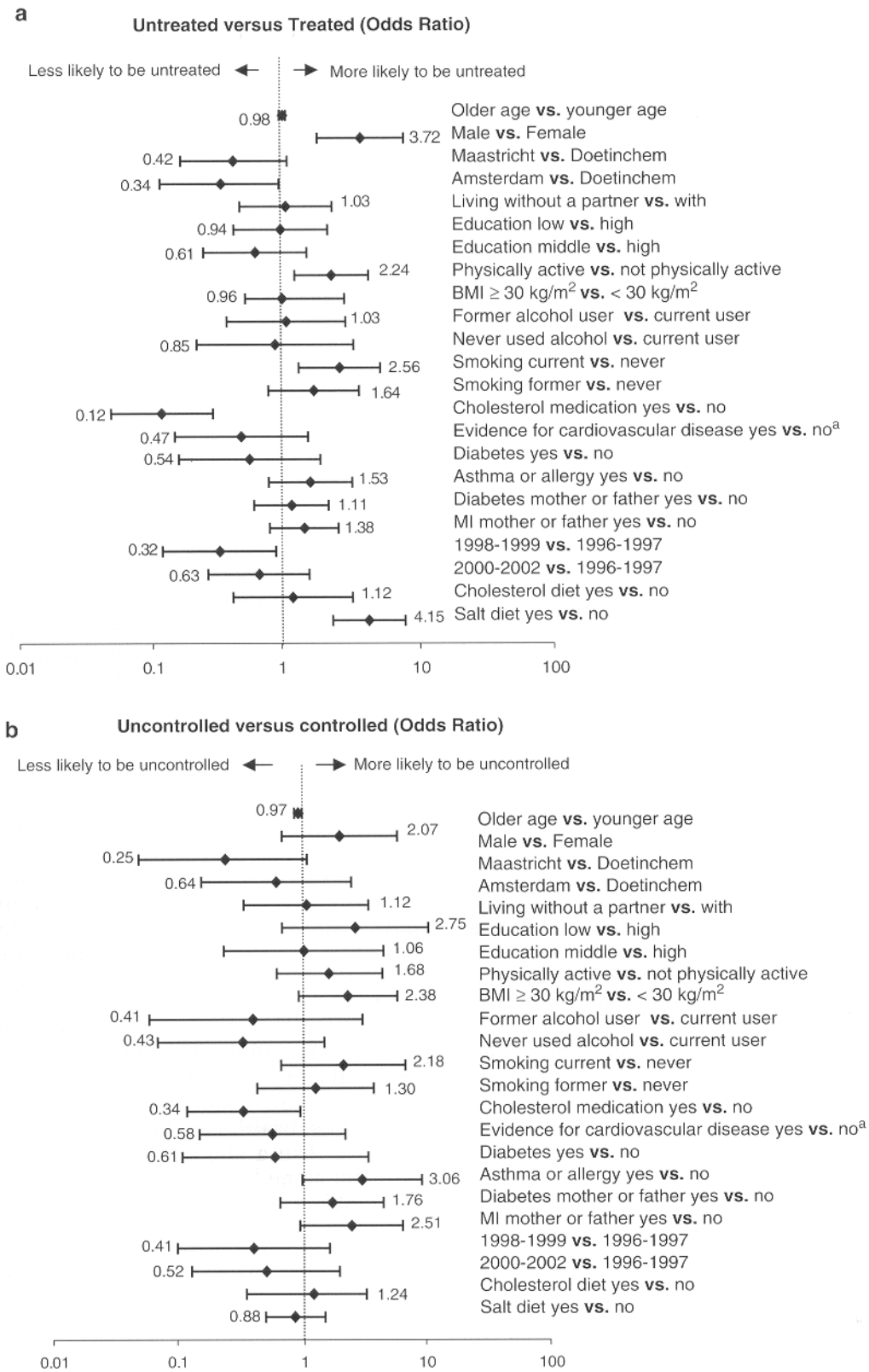

Figure 1 (a) Determinants of untreated and uncontrolled hypertension according to CBO consensus Hypertension. All odds ratio are adjusted for demographic variables, cardiovascular risk factors, and medication use.
[a]Evidence for cardiovascular disease = myocardial infarction, cerebrovascular disease, coronary artery bypass, PTCA, and/or heart catherisation.

pertensive medication. According to the Dutch guidelines, only 21.9% of the untreated hypertensive men and 13.6% of the untreated hypertensive women were eligible for pharmacological treatment. Of the treated persons, 67.6% of the men and 51.9% of the women had uncontrolled blood pressure levels despite pharmacological treatment. A possible explanation for the differences found in men and women could be the higher rate of patient–physician contact of women and the higher compliance of women in our study population. Unfortunately, we did not have information on these variables and were therefore unable to investigate these factors. The prevalence of hypertension decreased and the prevalence of treatment increased between 1996 and 2002 in Doetinchem.

The prevalence of hypertension in the Netherlands is similar compared to other Western-European studies. In England, the prevalence is approximately 24% in men and 22% for women (aged 30–59 years);[17] in France, it is 16% for men and 9% for women (aged 18-50);[18] and in Germany 39% for men and 25% for women (aged 25–64 years).[19] The percentage of treated hypertensives in West-Europe is around 60% and the percentage of uncontrolled hypertensives around 20%. Recently, Wolf-Maier *et al*[20] published that the prevalence of hypertension was 44 % in six European countries and that only 8% of the hypertensive persons had their blood pressure controlled (aged 35–64 years). However, because of differences in study design, such as age range, years of screening, and method for blood pressure measurement it is difficult to compare the results. In most studies, treatment and control of hypertension is better in women than in men.[19]

The results from the multivariate analysis show that females, being not physically active, not having been screened at the beginning of the follow-up, low intake of salt, and use of cholesterol-lowering medication are significantly positively associated with the treatment of hypertension. Also, in other European studies, females and non-smoking are positively associated with the treatment of hypertension, while results for age and evidence for cardiovascular diseases are not the same.[21–23] This is probably caused by the difference in age range. In our study, subjects who are physically active or having a low salt diet are less likely to receive treatment. This might have occurred because these subjects were borderline hypertensive and were advised by their doctors to be more active in order to reduce their blood pressure or eat a low salt diet. The use of cholesterol-lowering medication and having asthma or allergy are factors associated with a better control of blood pressure. A possible explanation is that patients who already use medication besides blood pressure-lowering drugs have a higher compliance. In other European studies, female gender and evidence for cardiovascular disease are associated with a better control of blood pressure.[21–23] The results of our study are similar, although the differences in study designs makes it difficult to compare the results.

Treatment considerations

At the moment, two different treatment guidelines are used in the Netherlands.[15,24] The CBO consensus is the most recent guideline and is the result of a consensus between various health-care professionals, whereas the NHG guideline is less recent and is an advice from the Dutch General Practitioners Association. The NHG guideline still uses blood pressure $\geqslant$160/95 mmHg as a definition for hypertension, and recommends treatment goals below 160 mmHg SBP and 90 mmHg DBP. This may explain the poor control of blood pressure since 1996 and improvement during the most recent years. Nonetheless, even in the most recent years, treatment and control rates of hypertension were far from optimal. Recently, the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood pressure even recommended starting antihypertensive drug treatment in patients with blood pressure $\geqslant$140/90 mmHg, irrespective of their cardiovascular risk factor profile.[25]

One possible explanation for the lack of control of blood pressure among treated hypertensives might be the lack of aggressiveness in treating persons. Another reason for not achieving the target blood pressure is poor patient compliance with the antihypertensive medication. According to several studies, about 50–60% of hypertensives adhere well to antihypertensive medication.[26,27] Lack of treatment among those eligible for drug treatment may be caused by a lack of detection of hypertension, physician noncompliance with treatment guidelines,[28–32] or reluctance of persons to receive drug treatment.[33,34]

Unfortunately, despite various intervention strategies of different aspects in the management of hypertension, only a few of these interventions have been effective in achieving improved control of blood pressure.[35] Multiple interventions at the level of patients, health-care providers are probably more effective than a single interaction by a health-care provider alone.[36]

The WHO reported in 1999 that there are worrying signs that the control rates had stabilised or even declined in some cases.[11] This study demonstrates that the prevalence of hypertension has decreased and that the number of hypertensives treated has increased between 1996 and 2002 in Doetinchem. It is, however, difficult to compare the results from Doetinchem with the general Dutch population. The results from the multivariate analysis show that hypertensives living in Doetinchem were less likely to be treated and to be controlled compared to hypertensives living in Amsterdam or Maastricht between 1996 and 1997. So, even in a small country

such as the Netherlands there are regional differences in treatment probability, which may be related to differences in lifestyle.

Strengths and limitations

A potential bias is that patients are classified as hypertensives based on measurements, which were obtained on a single occasion, although averaged over two readings. However, we adjusted for within-person variability in blood pressure and total cholesterol. Ignoring this variability would have to incorrect classification of persons with normal blood pressure as hypertensives and therefore, influence prevalence estimates. Also, a higher blood pressure ($\geqslant$95/160 mmHg) cutoff was used for the analysis of determinants of hypertension, since this could minimise the number of falsely assigned hypertensives. The results are, however, similar.

Another limitation is that we used self-reported data and did not include an examination of the subjects' medical records. The influence of misclassification is difficult to assess because over- and under-reporting of cardiovascular risk factors and diseases occur.[37] The use of information from self-reported medication has most likely, not influenced our prevalence estimates, because agreement between self-reported antihypertensive drug use in this survey and the pharmacy records of antihypertensive drug dispensings is excellent.[38]

The Doetinchem cohort was a re-examination. It is possible that persons who participate in the re-examination are more conscious of their health (eg better compliance with drugs, better lifestyle, more visits to a physician). If this is the case we underestimated the number treated and controlled hypertensives in the general population.

We decided to consider only subjects with risks of developing a cardiovascular disease within the next 10 years exceeding 20% as "untreated but should be treated". However, according to the CBO guidelines[13] when the cardiovascular risk is between 10 and 20%, drug treatment is cost-effective and may therefore be considered. So, the eligible group for treatment is most likely larger than that considered in this study. We did not include this group in our analysis because the guidelines leave this to the individual choice of the physician and patient.

Conclusions

Overall, the results suggest that approximately 14% of the Dutch population aged 30–59 years has hypertension (blood pressure $\geqslant$140/90 mmHg). The situation is better for women than for men. There remains a considerable proportion of hypertensives who are eligible for treatment but are untreated (18%) and treated patients whose blood pressure is not controlled (46%). Although treatment improved slightly during the study period in Doetinchem, control of hypertension in our study is far from optimal. Owing to the strong association between blood pressure and cardiovascular disease, it is necessary to improve treatment and control rates of hypertension in the Netherlands. To improve the management of hypertension, physicians may focus on the subgroups, that are identified in this study.

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