Variation in reported prevalences of hypertension in The Netherlands: the impact of methodological variables

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Abstract
Study objective – To estimate the prevalence of hypertension in The Netherlands and to quantify the influence of methodological variables on the reported prevalences.

Design – A pooled analysis was performed based on reported age specific prevalences of hypertension. A logistic model was used to estimate the probability of hypertension.

Main results – The age standardised prevalence of hypertension varies more than fivefold between studies carried out in The Netherlands. The probability of having hypertension was lower if blood pressure was measured at more than one point in time (Odds ratio 0·44 (OR) (95% confidence interval (95% CI) 0·38, 0·51) for men and 0·47 (0·41, 0·54) for women, and if the study was carried out more recently (OR 0·92 (0·91, 0·93) per year). The probability was higher if the study was carried out in a general practice (OR 1·14 (1·03, 1·27) for men and 1·52 (1·36, 1·69) for women). The inclusion of treated people as hypertensive yields contradictory results for men and women.

Conclusions – The strong variation in prevalence is explained by methodology and by a period effect indicating a decrease of the prevalence of hypertension over time. Whether this decrease is true or causal by confounding due to unknown or unreported methodological variation over time is unknown. For future studies, a standardised method could reduce the influence of methodological variables and thereby the variation in reported prevalences.

Hypertension is an important risk factor for cardiovascular disease, the major killer in low mortality countries of the developed world. Moreover, blood pressure is modifiable, and treatment to lower it reduces the risk of cardiovascular disease in hypertensive patients. Hence, hypertension is an important target for health policy, confronting the policy maker with two types of questions:

• How many people are hypertensive, and is there an indication that these numbers are changing over time?
• What will be the expected effects of preventive interventions, and how should these be monitored?

Both questions seem straightforward and easy to answer: measure the blood pressure over several points in time, estimate the modifiable fraction, and calculate the population attributable risk and the potential impact fraction. There have been a number of surveys which included blood pressure measurement, so prevalence data seem readily available. But are they really? Blood pressure measurement does not ask for sophisticated equipment, but to yield reliable results a very stringent standardised method has to be adopted since there are several factors that can influence a blood pressure measurement. The reported prevalence of hypertension varies tremendously between and within countries. In the Dutch studies presented here, we found the same fivefold variation, even after adjustment for age. These differences might be explained by different characteristics of the studied populations, but this raises the question of what these (unknown) characteristics might be to cause such tremendous variation. Different methods, leading to varying degrees of over-estimation of hypertension, seems a more probable hypothesis. The present study aims to make sense of all studies published since 1970 about hypertension in The Netherlands. We tried to correct for methodological variation, to arrive at a best possible estimate of the prevalence of hypertension, and at an estimate of changes in this prevalence over time.

Methods
Criteria for selection of studies
All data published since 1970 about the prevalence of hypertension in The Netherlands were collected. Few are published in peer reviewed papers, most were identified through the snowball method (checking references in all detected publications) and expert advice. We found 13 studies reporting the prevalence of hypertension in The Netherlands. To be included in this analysis, age specific prevalences should be reported for at least two age groups for both men and women. This excluded two studies. Of the remaining 11 studies, three were identified in publications in scientific journals, four in reports from various registers, and four in PhD theses.

Data analysis
The data were analysed using a logistic model with the presence or absence of hypertension.
as the dependent variable. All analyses were performed for men and women separately. In the first analysis, age and study were chosen as independent variables. For age the median age of each age group was used. The number of people in each age and sex group were used as weights. If aggregated sample sizes only were available, we assumed that the distribution by age and sex was equal to that of the Dutch population in that period.

In the second analysis, age, chosen cut off point, number of points in time at which blood pressure was measured, calendar year, whether or not treated people were considered as hypertensive, and whether or not the study was performed in general practice were chosen as independent variables. The estimated coefficients were then used to estimate the prevalence of hypertension in The Netherlands. Hypertension was defined as a diastolic cut off point of 95 mmHg, measuring blood pressure at three points in time and by including treated people as hypertensive.

### Results

In table 1 some characteristics of the selected studies are described, along with the reported prevalences in each of the studies. Almost all studies define hypertension as a systolic blood pressure above 160 mmHg or a diastolic blood pressure above 95 mmHg, or both. The reported prevalences vary considerably, even between studies that used comparable methods, as for instance EPOZ and RIVM. In the first analysis we quantified the extent of the differences between studies, adjusted for age. We estimated that the age adjusted prevalence in COPH was seven times higher in men and five times higher in women than PreTensi. The EPOZ study reported prevalences that were four and five times higher than those reported in the CB heart project for men and women respectively. Lelystad on the other hand, reported prevalences for men that were about the same as those from the CB heart project, but were four times higher for women.
Table 2  Influence of different variables on the prevalence of hypertension in The Netherlands

<table>
<thead>
<tr>
<th>Variable</th>
<th>Odd ratio (95% CI)</th>
</tr>
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<tbody>
<tr>
<td>Age (per year)</td>
<td>Men</td>
</tr>
<tr>
<td></td>
<td>Women</td>
</tr>
<tr>
<td>Age off (per mmHg DBP over 95)</td>
<td>1.06 (1.06, 1.06)</td>
</tr>
<tr>
<td>Measurement at 2 points in time</td>
<td>0.85 (0.83, 0.86)</td>
</tr>
<tr>
<td>Measurement at 3 points in time</td>
<td>0.44 (0.38, 0.51)</td>
</tr>
<tr>
<td>Calendar year (per year)</td>
<td>0.92 (0.92, 0.93)</td>
</tr>
<tr>
<td>Treated people included as hypertensive</td>
<td>0.85 (0.78, 0.92)</td>
</tr>
<tr>
<td>Study carried out in general practice (compared with surveys)</td>
<td>1.14 (1.03, 1.27)</td>
</tr>
</tbody>
</table>

To explain some of the differences between studies, table 2 shows the estimated influence of various methodological variables on the reported prevalence, adjusted for each of the other variables. The prevalence increases with age, and increases more strongly in women than in men. A 10 mmHg higher cut off point in diastolic blood pressure resulted in an 80% lower prevalence for men and a 65% lower prevalence for women. Where blood pressure was measured at more than one point in time, the prevalence was approximately half the value for one point of measurement. This may be expected given the reliability of blood pressure measurement. Studies carried out in general practice reported higher prevalences, especially in women. This higher prevalence may be due to the fact that these populations are a selection of sick people, who visit the general practitioner because they have symptoms. The inclusion of treated people in the definition of hypertension resulted in a higher prevalence for women but a lower prevalence for men. Assuming that treatment will be successful in lowering blood pressure, a higher prevalence is expected when treated people are considered as hypertensive, as was found in women. This outcome for men from the logistic model is therefore probably caused by unknown confounders.

The estimated coefficients from the logistic model were then used to calculate the prevalence of hypertension in The Netherlands adjusted for calendar year (figure 1 for men and figure 2 for women). For both men and women the model gives the best possible estimates of the age specific prevalence of hypertension, given the large variation between studies. At younger ages the prevalence of hypertension in men is higher than the prevalence in women. At older ages however, this is reversed to a higher prevalence for women. This cross over takes place at 50 years of age, the period of menopause. Such a cross over is also found in other populations at about the same age.

Discussion

This study aimed to achieve the best possible estimate of the prevalence of hypertension in The Netherlands and to identify possible time trends. When there is considerable heterogeneity between studies, pooling data to a single estimate is considered unsound. However, it seems the only way to overcome the considerable shortcomings of each individual study and to reach an acceptable estimate of the prevalence of hypertension in The Netherlands. The results from the pooled analysis we carried out need to be interpreted with caution, but they are remarkably consistent with what is known about hypertension: the increase with age; the well known sex differences, with women having a lower tension before and a higher tension after the menopause than men; the increasing specificity when measuring at more than one point in time; and the selection effect in the population that visit the general practitioner. This consistency supports the face validity of this pooling exercise.

The signalled trend in time seems less credible because of its magnitude: a 71% decrease in prevalence over 15 years. This may be because older studies used different measurement methods or that prescribing behaviour of doctors has changed over time, or that there are unknown confounding factors. We did not have sufficient data to investigate whether any of these factors could explain the strong trend in time. However, assessing trends based on studies in which blood pressure measurements are taken at only one moment in time is certainly not acceptable. The signal of any true
trend will be smothered by the noise of random variability. For the moment it seems that the prevalence of hypertension has fallen over time in The Netherlands. To investigate further the real nature of this trend, a standardised method for measuring blood pressure seems to be necessary. This should at least include several points of measurements in time, one standard cut off point, whether or not treated people are included as hypertensive and the type of blood pressure meter that is used. If such a standardised method is not used, policy makers should at least be aware of the extreme variation in prevalence estimates, since this might influence the weighing of alternative policy options, the estimated avoidable mortality that policy makers aim to achieve, or the evaluation of health policy interventions aiming at reducing hypertension.

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