

Trends in hypertension control among the older population of Spain from 2000-2001 to 2008-2010: the role of frequency and intensity of drug treatment.

Short title: Trends in hypertension treatment and control

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ABSTRACT-

Background: The use of antihypertensive medication and hypertension control have significantly increased over recent decades in some developed countries, but the impact of improved drug treatment on blood pressure (BP) control in the population is unknown.

Methods and Results: Data were taken from two surveys representative of the population aged ≥ 60 years in Spain conducted with the same methodology in 2000-2001 and in 2008-2010. BP was measured six times. The first BP reading was discarded, and the average of the remaining 3 to 5 BP readings was taken for analysis. Hypertension prevalence was 68.7% in 2000-2001 and 66.0% in 2008-2010. Between both time periods there was an improvement in hypertension awareness (63.6% through 67.7%), drug treatment among those aware (84.5% through 87.5%), and BP control among treated hypertensives (30.3% through 42.9%). Overall, BP control among all hypertensives increased from 16.3% to 25.4%. After adjustment for age, sex, education, hypertension duration, smoking, alcohol consumption, body mass index, sedentary behavior, diabetes, cardiovascular disease, and visits to the physician through logistic regression, about 7% of the improvement in BP control among all hypertensives was explained by higher hypertension awareness, and 36.2% was explained by a higher treatment rate. Among the treated hypertensives, 22.6% of the progress in BP control was due to the increase in the number of BP medications used in each patient.

Conclusions: BP control among the older hypertensive population in Spain has improved from 2000-2001 to 2008-2010 due to a higher treatment rate and more intense antihypertensive drug treatment.

Key Words: hypertension; treatment; population studies; epidemiology; aging

Hypertension is an important public health challenge because it is highly prevalent in many developed and developing countries.^{1,2} As a result, high blood pressure (BP) is the leading risk factor for global disease burden, accounting for 7.6 million premature deaths and 7% of disability-adjusted life years worldwide.³ Moreover, in spite of proved benefits of treating hypertension and availability of abundant guidelines for managing hypertension,⁴⁻⁷ BP control in the population is only moderate.^{2,4,5,7}

Several studies have shown that in some countries the prevalence of hypertension has been generally stable and that a significant improvement in hypertension management has occurred over the last few decades.⁸⁻¹⁵ However, some studies have found no recent progress in BP control,^{16,17} and it has been questioned whether a favourable trend is actually occurring in the population.¹⁸ Discrepancies in results among studies might be partly due to the use of different settings and procedures for BP measurement. Appropriate trend analyses require that: (i) BP measurement is accurate, including minimizing the office or white-coat effect,^{19,20} and (ii) the results of clinic-based studies are considered separately from those of population-based research. In fact, participation in clinic-based studies is probably associated with health status and service accessibility, which are in turn related to the likelihood of being diagnosed with hypertension, of receiving drug treatment and achieving BP control. Thus, clinical surveys mainly serve to monitor the effectiveness of BP control in the clinic, and population-based studies are required to assess BP control in the general population.

Although the use of antihypertensive medication and BP control have significantly increased in some countries over recent decades,^{9,11-14,21} to our knowledge no attempts have been made to assess the independent impact of healthcare variables that influence BP control (awareness, treatment, and number of medications) on the changes in BP control over time.

We have used two comparable national population-based surveys in Spain, that included a series of BP measurements taken in relaxed conditions at subjects' home,^{22,23} to get a reliable picture of the clinical epidemiology of hypertension during the first decade of the XXI century. Specifically, we have estimated the independent contribution of awareness, drug treatment, and number of BP medications to the observed trends in the control of hypertension. Due to data availability, we have focused on the older adult population, where hypertension is very frequent but BP control is difficult to achieve.^{4-7,24}

Methods

Study design and participants

We have analyzed data from two studies conducted with the same methodology. The first one was carried out in 2000-2001 among 4009 individuals representative of the non-institutionalized population aged ≥ 60 years in Spain.²² The second study was conducted between 2008 and 2010 on a representative sample of 12948 people aged ≥ 18 years,^{23,25} which included 3488 individuals aged ≥ 60 years. Response rate among these older individuals was 70% and 60% in the first and second study, respectively. In both studies, subjects were selected through census-based multistage cluster random sampling. The information was collected by trained observers, through personal interview using structured questionnaires followed by physical examination (BP and anthropometric variables) at subjects' home.

Participants gave written consent and both studies were approved by the clinical research ethics committees of the Hospital Universitario "La Paz" in Madrid and the Hospital "Clínica" in Barcelona.

Study variables

Study participants reported their age, sex, level of education, hypertension duration (time since hypertension diagnosis by a physician), tobacco and alcohol consumption, sedentary behavior, history of diagnosed diabetes and cardiovascular disease (coronary heart disease and stroke), and use of healthcare services (annual number of any visit to the physician). Sedentary behavior was estimated with a standard questionnaire that asks about the number of hours spent watching television, seated in transportation, reading, listening to the music or using the computer, over a typical week, and was defined arbitrarily as ≥ 37 hours per week (percentile 65th in the 2000-1 survey and 70th in the 2008-10 survey).

In both surveys, BP was measured by trained observers using standardized procedures,^{19,26} with validated automatic devices (Omron 706/711 in 2000-2001 and Omron M6 in 2008-2010) and cuffs of three sizes according to arm circumference. In each survey, two sets of BP readings were obtained separated by a minimum of 90 minutes. In each set, BP was measured three times at 1-2 minute intervals, after resting 3-5 minutes in a seated position. The first BP reading was discarded, and the average of the remaining 3 to 5 BP readings was taken for analysis (mean number of BP readings was 4.69 in 2000 and 4.96 in 2010).

Hypertension was defined as systolic BP (SBP) ≥ 140 mmHg and/or diastolic BP (DBP) ≥ 90 mmHg and/or on current antihypertensive drug treatment. Hypertension awareness was deemed as an affirmative answer to the question: "Have you ever been told by the doctor that you had hypertension?" Treatment was defined as reported current use of prescribed hypertension drug therapy. Finally, BP control was defined as pharmacological treatment of hypertension associated with SBP < 140 mmHg and DBP < 90 mmHg, which were the BP goals at the time of the surveys analyzed.

Weight and height were measured in each subject under standardized conditions.²⁵ Body mass index (BMI) was calculated as weight in kg divided by squared height in m. Obesity was defined as $BMI \geq 30 \text{ kg/m}^2$.

Medication use was collected by a face-to-face interview and verified against drug packaging during the home visit in both surveys. Antihypertensive medications were classified according to international guidelines.²⁶

Statistical analysis

Of the 4009 study participants in 2000-2001 and 3488 in 2008-2010, 429 and 214, respectively, were excluded due to lack of data on BP or demographic variables. Thus, 3580 individuals in 2000 and 3273 in 2010 were available for analysis. We calculated the prevalence of hypertension as well as of awareness, treatment, and control in each survey, and their relative change between surveys ($[(\text{proportion in 2010}) - (\text{proportion in 2000})] \times 100 / (\text{proportion in 2000})$), stratified by sociodemographic and clinical characteristics. The analyses took account of the complex sampling design; thus, individual observations were weighted to reconstruct the Spanish population, and the variances were corrected to obtain appropriate confidence intervals. The chi-square test was used to compare proportions and the Student *t*-test to compare means.

In order to analyze the factors contributing to the time trend in hypertension control, we first created a new variable called “time of survey” (T), which takes value 0 if 2000-2001 and value 1 if 2008-2010. Second, databases from the 2000-2001 and 2008-2010 surveys were merged, and only hypertensive patients were selected. Third, two multiple logistic regression models were built, in which the outcome or dependent variable was: (i) control of BP (yes/no) among all hypertensive patients, and (ii) control of BP (yes/no) among treated

hypertensive patients. Year 2000-1 was used as the reference category. Main independent variables were T, sociodemographic characteristics, cardiovascular risk factors, and use of healthcare services, which might be relevant for hypertension control⁴⁻⁷ and were selected *a priori*. The sociodemographic characteristics included age, sex, and educational level, while the cardiovascular risk factors included hypertension duration, BMI, sedentary behavior, smoking, alcohol consumption, diabetes, and cardiovascular disease (CVD). The odds ratio (OR) of T measures whether BP control has improved between both surveys after adjusting for those characteristics. Healthcare variables influencing BP control (awareness, drug treatment, and number of BP medications) were added sequentially to the models. Specifically, the first model, run on 4076 hypertensives (88.2% of all the hypertensive patients), was additionally adjusted for hypertension awareness and antihypertensive drug treatment; and the second model, run on 2264 treated hypertensives (87.1% of the treated hypertensive patients), was additionally adjusted for the number of BP medications since all patients were aware and treated. The change in the OR of T measures the independent contribution of each of these healthcare variables to the change in hypertension control between the two surveys, and was calculated using the formula: $[\text{OR}_{(\text{fully adjusted except for the specific healthcare variable})} - \text{OR}_{(\text{fully adjusted model})}] \times 100 / [\text{OR}_{(\text{fully adjusted except for the specific healthcare variable})} - 1]$.²⁷ Variables were modelled as categorical (dichotomic) except age, hypertension duration, BMI, and number of BP medications (continuous). The analyses were conducted in the total study sample and separately by sex. Statistical significance was set at 2-sided $p < 0.05$. Analyses were performed with the SPSS package v. 21.0.

Results

Change in hypertension prevalence

The prevalence of hypertension decreased from 68.7% in 2000-2001 to 66.0% in 2008-2010 (**Table 1**). This reduction occurred specifically among individuals under age 80, women, with lower education, and absence of diabetes or obesity.

Change in hypertension awareness, treatment, and control

Awareness of hypertension and drug treatment among the aware hypertensives increased slightly between 2000-2001 and 2008-2010 (63.6% through 67.7%, and 84.5% through 87.5%, respectively) (**Table 2**). Thus, drug treatment among all hypertensive patients increased from 53.7% in 2000-2001 to 59.2% in 2008-2010. Moreover, a substantial improvement in BP control was found among treated hypertensives (30.3% through 42.9%). The improvement in awareness and drug treatment was greater in persons aged ≥ 70 years, men, with lower education, with diabetes or obesity, and without sedentary behavior. However, the improvement in BP control among treated hypertensives was more frequent among patients under age 80, men, with higher education, without obesity, or sedentary behavior (**Table 2**).

Overall, BP control among all hypertensive patients increased from 16.3% in 2000-2001 to 25.4% in 2008-2010, an improvement that was higher in patients under age 80, men, with higher education, diabetes, without obesity or sedentary behavior, and in those on less than 3 drugs (**Table 3**).

Factors contributing to change in blood pressure control

Table 4 shows the time changes in variables which could potentially influence the change in BP control among hypertensive patients. Mean age was somewhat lower in 2008-2010 than

in 2000-2001 (69.9 and 72.1 years, respectively). The percentage of hypertensives with \leq primary education fell from 87.7% to 60.0%. Both mean SBP and mean DBP decreased significantly (2.9 mmHg and 1.7 mmHg, respectively). Moreover, sedentary behavior became less frequent, and a significant reduction was seen in the frequency of previous CVD. The percentage of current smokers increased slightly (among women) as well as the percentage of current alcohol drinkers. Lastly, the number of antihypertensive drugs increased between 2000-2001 and 2008-2010 (1.4 to 1.8), and the percentage on combination therapy increased from 40.9% to 48.6% relying heavily on those on 3 or more medications (9.6% to 15.6%).

Logistic regression analyses show that the odds of BP control among all hypertensive patients was 1.75 times greater in 2008-2010 than in 2000-2001, and it was still 1.74 times higher after adjusting for socio-demographic variables, cardiovascular risk factors, and use of healthcare services (**Table 5**). That is, a real improvement in BP control has occurred between both time periods, regardless of those important BP-related variables. After additional adjustment for hypertension awareness, the OR was 1.69; in relative terms, a 6.8% lower than before adjustment. Thus, awareness of hypertension contributed, though to a moderate extent, to the increase in BP control over time. Lastly, additional adjustment for antihypertensive drug treatment used yielded an OR of 1.44. Thus, 36.2% of the improvement in BP control was explained by drug treatment beyond what is explained by awareness and the rest of variables (Table 5). Taken together, awareness and treatment explained 40.5% of the change observed in BP control. Separate models for men and women showed that the contribution of hypertension awareness and drug treatment to the improvement in BP control was higher among women (**Table 5**).

Among treated hypertensive patients, the OR of BP control was 1.62 after adjusting for sociodemographic and clinical variables (**Table 6**); additional adjusted for the number of BP medications led to an OR of 1.48. Thus, the increase in the number of BP medications between 2000-2001 and 2008-2010 explained 22.6% of the improvement in BP control, beyond what was accounted for sociodemographic and clinical variables. The influence of the number of antihypertensive drugs was somewhat higher among women (23.6% vs. 19.0% in men).

Discussion

To our knowledge, this is the first study to systematically examine the impact of hypertension awareness and treatment on the time trends in BP control among older hypertensive patients from the general population. Our results show that the degree of BP control in hypertensive individuals improved significantly from 2000-2001 to 2008-2010, and that a substantial part of the improvement was due to a greater treatment rate and to an increase in the number of BP medications used in each patient.

Comparison with other studies

Previous reports in many countries have shown a high prevalence of hypertension, particularly in older age groups, and generally stable or modest reductions in hypertension prevalence in the last few decades.^{2,8,9-14,16} In our study, both the prevalence and mean SBP and DBP fell over time, which is consistent with a recent pooled analysis showing a worldwide reduction in SBP since 1980.²⁸ The decrease in the prevalence of hypertension in Spain occurred selectively among women, probably related to the reduction in BMI recently observed in older women but not older men.²⁹

As in most other countries, awareness, treatment and control of hypertension have generally increased in hypertensive patients, though the success rates achieved varied by country and sociodemographic and clinical subgroups.^{9,11-15}

Control of hypertension among treated hypertensive patients improved by 13% in absolute terms (from 30% in 2000-2001 to 43% in 2008-2010). However, hypertension control is still far from the rates in a few other countries, like England (41% in 2003 and 50% in 2006 for treated hypertensive patients ≥ 65 years),⁹ the United States (47% in 2001-2 and 58% in 2007-8 for treated hypertensive patients older than 60) and especially, Canada, where the control rate among treated patients was 64% in 2009.^{12,13,16} Nevertheless, hypertension control among both those treated and all hypertensives in Spain was comparable to or even higher than in many other countries.^{10,11,14,15,30}

Explanations for changes in hypertension control

This study confirms the important role of drug treatment in BP control,⁴⁻⁷ and extends previous reports by quantifying the impact of increased awareness, treatment, and the number of BP medications. The higher contribution of awareness and treatment of hypertension to the improvement in BP control over time among women than men is consistent with their more favorable trend in SBP (absolute change -3.7 mmHg vs. -2.1 mmHg in men), sedentary behavior (-12% vs. -1%), diabetes (-3.6% vs. +2.1%), and combined therapy (+8.8% vs. +5.9%).

There is also evidence in some countries of a significant increase in the proportion of hypertensives taking multiple antihypertensive agents,^{9,21,31,32} in consonance with guidelines indicating that at least 2 antihypertensive agents are usually needed to achieve BP goals.⁴⁻⁷ However, no previous quantification of the impact of medication on time changes in BP

control has been made. Interestingly, the greater increase in polytherapy among hypertensive patients aged ≥ 60 years in the United States²¹ than in Spain during approximately the same time period (44.5% in 2000-2001 to 56.1% in 2009-2010 vs. 40.9% to 48.6%, respectively) was accompanied by a higher increase in BP control among treated patients in the United States (37.5% to 55.8%) than in Spain (30.3% to 42.9%).

Intensification of drug treatment has been associated with a reduction of cardiovascular risk in habitual clinical practice.³³ However, in Spain and the United States, physicians failed to increase medications in most uncontrolled hypertensive patients, especially in the elderly.^{34,35} Reluctance to initiate combination therapy in older patients was often because of safety concerns such as orthostatic hypotension.⁴⁻⁷ Also, as reported in the United States,³² we found that the proportion of treated uncontrolled patients taking 1 to 2 medications (a proxy for treatment inertia in our study) fell from 89.3% in 2000-2001 to 81.9% in 2008-2010, and the proportion on ≥ 3 medications (a proxy for apparent treatment-resistant hypertension) rose from 10.6% in 2000 to 18.1% in 2010 (data not presented).

Overall, we were able to identify factors that accounted for less than 50% of the improvement in BP control in Spain over the last decade. The remainder, however, should still be elucidated. We have no data on trends in the salt content in food or sodium excreted in urine over time, but as in other countries,³⁶ high levels are observed currently in Spain.³⁷ Moreover, the diet of hypertensive patients in Spain, including older individuals, has a low accordance with the DASH and Mediterranean dietary pattern, including sodium intake,³⁷ which may be counterbalancing efforts in drug treatment. Also, we did not study the potential effect of trends in advice and adherence to healthy lifestyle on BP control.

Methodological aspects

Although the response rate in the Spanish surveys was somewhat lower than in the NHANES surveys in the United States,³⁸ it was among the highest of the examination surveys conducted in Europe.^{9,39} Moreover, the sex, age, and educational level structure of the national surveys closely resemble the sociodemographic distribution of the Spanish population.^{22,25}

As regards variable measurement, six BP readings were made by trained lay personnel at subjects' household, and the first measurement was excluded for analysis; all this contributes to reducing the alerting reaction. Also, the increase in BP control in Spain in the last decade was consistent with that reported in a series of primary-care surveys across the country.³¹ In addition, medication packages were checked at subjects' home, which contributes to the accuracy of data in drug treatment. Unfortunately, medication dose and adherence were not assessed.

We made an additional sensitivity analysis using the recently proposed clinic BP goal of 150/90 mmHg for older people.⁴⁰ As expected, BP control among treated hypertensives was much better when using the 150/90 threshold in both time periods (49.7% in 2000 and 63.9% in 2010). Also, the percent contribution of the number of BP medications to the improvement in BP control between 2000 and 2010 was 15.9% (vs. 22.6% using the 140/90 threshold). Thus, proportions of hypertension control and contribution of the number of BP medications were sensitive to the BP threshold, though the message of progress in BP control and the importance of more intense use of drug treatment remain.

Proportions of prevalence and management of hypertension were presented stratified by age and clinical characteristics rather than adjusted, nevertheless age-adjusted proportions remained very similar (data not shown).

Given that the number of missing data for univariate and multivariable analyses was not high (<10% and <15%, respectively), and that there were no significant differences between persons with missing data and those without for most important variables (data not shown), we think bias due to excluded cases should not be relevant. However, there still may be bias due to unmeasured factors. Regarding the multivariable analyses, we adjusted for BP-related lifestyles and other important cardiovascular risk factors, thus isolating to some extent the independent effect of drug treatment on changes in BP control. Finally, the extrapolation to other countries with higher or lower values of the variables studied should be done with caution. Nevertheless, there is no reason to doubt that the same factors are influencing trends in different countries, though the relative contribution of each one could vary.

Conclusions and implications

Among older adults in Spain, BP control has increased during the last decade, and it was partly due to higher treatment rates and more intense drug treatment. However, despite progress, in 2008-2010 about one-third of hypertensive patients were still unaware of their hypertensive status, 40% were untreated, and more than half of treated patients were uncontrolled; as a result, only one in four patients achieved BP targets. Our results remark the importance of renewed efforts aiming at even higher and more intense use of drug treatments for achieving hypertension control in the general older population.

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Disclosures. None.

References

1.-Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. *Lancet*. 2005;365:217-223.

2.-Pereira M, Lunet N, Azevedo A, Barros H. Differences in prevalence, awareness, treatment and control of hypertension between developing and developed countries. *J Hypertens*. 2009;27:963-975.

3.- Lawes CM, Vander Hoorn S, Rodgers A; International Society of Hypertension. Global burden of blood-pressure-related disease, 2001. *Lancet*.2008;371:1513-1518.

4.-Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL Jr, Jones DW, Materson BJ, Oparil S, Wright JT Jr, Roccella EJ; Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. JNC 7 complete version. *Hypertension*. 2003;42:1206–1252.

5.-Mancia G, De Backer G, Dominiczak A, Cifkova R, Fagard R, Germano G, Grassi G, Heagerty AM, Kjeldsen SE, Laurent S, Narkiewicz K, Ruilope L, Rynkiewicz A, Schmieder RE, Boudier HA;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). *J Hypertens*. 2007;25:1105-1187.

6.-Hypertension: clinical management of primary hypertension in adults. Available at: <http://guidance.nice.org.uk/cg127>. Accessed January 2013.

7.-Mancia G, Fagard R, Narkiewicz K, Redón J, Zanchetti A, Böhm M, Christiaens T, Cifkova R, De Backer G, Dominiczak A, Galderisi M, Grobbee DE, Jaarsma T, Kirchhof P, Kjeldsen SE, Laurent S, Manolis AJ, Nilsson PM, Ruilope LM, Schmieder RE, Sirnes PA,

Sleight P, Viigimaa M, Waeber B, Zannad F; Task Force Members. 2013 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). *J Hypertens*. 2013;31:1281-1357.

8.-Pereira M, Carreira H, Vales C, Rocha V, Azevedo A, Lunet N. Trends in hypertension prevalence (1990-2005) and mean blood pressure (1975-2005) in Portugal: a systematic review. *Blood Press* 2012;21;220-226.

9.-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.

10.-Kastarinen M, Antikainen R, Peltonen M, Laatikainen T, Barengo MC, Jula A, Salomaa V, Jousilahti P, Nissinen A, Vartiainen E, Tuomilehto J. Prevalence, awareness and treatment of hypertension in Finland during 1982-2007. *J Hypertens*. 2009;27:1552-1559.

11.-Cífková R, Skodová Z, Bruthans J, Holub J, Adámková V, Jozífová M, Galovcová M, Wohlfahrt P, Krajčoviechová A, Petržílková Z, Lánská V. Longitudinal trends in cardiovascular mortality and blood pressure levels, prevalence, awareness, treatment, and control of hypertension in the Czech population from 1985 to 2007/2008. *J Hypertens*. 2010;28:2196-2203.

12.-Egan BM, Zhao AND, Axon RN. US trends in prevalence, awareness, treatment, and control of hypertension, 1988-2008. *JAMA*. 2010;303:2043-2050.

13.-McAlister FA, Wilkins K, Joffres M, Leenen FH, Fodor G, Gee M, Tremblay MS, Walker R, Johansen H, Campbell N. Changes in the rates of awareness, treatment and control of hypertension in Canada over the past two decades. *CMAJ*. 2011;183:1007-1013.

- 14.-Xi B, Liang Y, Reilly KH, Wang Q, Hu AND, Tang W. Trends in prevalence, awareness, treatment, and control of hypertension among Chinese adults 1991–2009. *Int J Cardiol.* 2012;158:326-329.
- 15.-Tocci G, Rosei EA, Ambrosioni E, Borghi C, Ferri C, Ferrucci A. Blood pressure control in Italy: analysis of clinical data from 2005-2011 surveys on hypertension. *J Hypertens.* 2012;30:1065-1074.
- 16.-Guo F, He D, Zhang W, Walton RG. Trends in prevalence, awareness, management, and control of hypertension among United States adults, 1999 to 2010. *J Am Coll Cardiol.* 2012;60:599-606.
- 17.-Carrington MJ, Jennings GL, Stewart S. Pressure points in primary care: blood pressure and management of hypertension in 532 050 patients from 2005 to 2010. *J Hypertens.* 2013;31:1265-1271.
- 18.-Mancia G. Blood pressure control in the hypertensive population. Is the trend favourable? *J Hypertens.* 2013;31:1094-1095.
- 19.-Pickering TG, Hall JE, Appel LJ, Falkner BE, Graves J, Hill MN, Jones DW, Kurtz T, Sheps SG, Roccella EJ; Recommendations for Blood Pressure Measurement in Humans and Experimental Animals. Part 1: Blood Pressure Measurement in Humans A Statement for Professionals From the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. *Hypertension.* 2005;45:142-161.
- 20.-Myers MG, Godwin M, Dawes M, Kiss A, Tobe SW, Grant FC, Kaczorowski J. Conventional versus automated measurement of blood pressure in primary care patients with systolic hypertension: randomised parallel design controlled trial. *BMJ.* 2011;342:d286.

- 21.-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.
- 22.-Banegas JR, Rodríguez-Artalejo F, Ruilope LM, Graciani A, Luque M, de la Cruz-Troca JJ, García-Robles R, Tamargo J, Rey-Calero J. Hypertension magnitude and management in the elderly population of Spain. *J Hypertens.* 2002; 20:2157-2164.
- 23.-Banegas JR, Graciani A, de la Cruz-Troca JJ, León-Muñoz LM, Guallar-Castillón P, Coca A, Ruilope LM, Rodríguez-Artalejo F. Achievement of cardiometabolic goals in aware hypertensive patients in Spain: a nationwide population-based study. *Hypertension.* 2012;60:898-905.
- 24.-Grodzichi T, Messerli FH. Hypertension in the elderly. In:Mancia G, Chalmers J, Julius S, Saruta T, Weber M, Ferrari A, Wilkinson I (eds.) *Manual of Hypertension.* London: Churchill Livingstone; 2002, pp. 543-553.
- 25.- Rodríguez-Artalejo F, Graciani A, Guallar-Castillón P, León-Muñoz LM, Zuluaga MC, López-García E, Gutiérrez-Fisac JL, Taboada JM, Aguilera MT, Regidor E, Villar-Álvarez F, Banegas JR. Rationale and methods of the Study on Nutrition and Cardiovascular Risk in Spain (ENRICA). *Rev Esp Cardiol.* 2011;64:876-882.
- 26.-Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VI). *Arch Intern Med.* 1997; 157:2413–2446.
- 27.-MacKinnon DP, Krull JL, Lockwood CM. Equivalence of the mediation, confounding and suppression effect. *Prev Sci.* 2000;1:173-181.

28.-Danaei G, Finucane MM, Lin JK, Singh GM, Paciorek CJ, Cowan MJ, Farzadfar F, Stevens GA, Lim SS, Riley LM, Ezzati M; Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group (Blood Pressure). National, regional, and global trends in systolic blood pressure since 1980: systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5.4 million participants. *Lancet*. 2011;377:568-577.

29.-Gutiérrez-Fisac JL, León-Muñoz LM, Regidor E, Banegas J, Rodríguez-Artalejo F. Trends in obesity and abdominal obesity in the older adult population of Spain (2000-2010). *Obes Facts*. 2013;6:1-8.

30.- Bielecka-Dabrowa A, Aronow WS, Rysz J, Banach M. The rise and fall of hypertension: lessons learned from Eastern Europe. *Curr Cardiovasc Risk Rep*. 2011;5:174-179.

31.-Llisterri JL, Rodriguez-Roca GC, Escobar C, Alonso-Moreno FJ, Prieto MA, Barrios V, González-Alsina D, Divisón JA, Pallarés V, Beato P; Working Group of Arterial Hypertension of the Spanish Society of Primary Care Physicians Group HTASEMERGEN; PRESCAP 2010 investigators. Treatment and blood pressure control in Spain during 2002-2010. *J Hypertens*. 2012;30:2425-2431.

32.-Egan BM, Zhao Y, Axon RN, Brzezinski WA, Ferdinand KC. Uncontrolled and apparent treatment resistant hypertension in the United States, 1988 to 2008. *Circulation*. 2011;124:1046-1058.

33.-Corrao G, Nicotra F, Parodi A, Zambon A, Heiman F, Merlino L, Fortino I, Cesana G, Mancia G. Cardiovascular protection by initial and subsequent combination of antihypertensive drugs in daily life practice. *Hypertension*. 2011;58:566-572.

34.-Rodriguez-Roca GC, Llisterri JL, Prieto-Diaz MA, Alonso-Moreno FJ, Escobar-Cervantes C, Pallares-Carratala V, Valls-Roca F, Barrios V, Banegas JR, Alsina DS. Blood pressure control and management of very elderly patients with hypertension in primary care settings in Spain. *Hypertens Res.* 2014;37:166-171.

35.-Okonofua EC, Simpson KN, Jesri A, Rehman SU, Durkalski VL, Egan BM. Therapeutic inertia is an impediment to achieving the Healthy People 2010 blood pressure control goals. *Hypertension.* 2006;47:345-351.

36.-Meyer KA, Harnack LJ, Luepker RV, Zhou X, Jacobs DR, Steffen LM. Twenty-two-year population trends in sodium and potassium consumption: the Minnesota heart survey. *J Am Heart Assoc.* 2013;2:e000478.

37.-León-Muñoz LM, Guallar-Castillón P, Graciani A, López-García E, Mesas AE, Taboada JM, Banegas JR, Rodríguez-Artalejo F. Dietary habits of the hypertensive population of Spain: accordance with the DASH diet and the Mediterranean diet. *J Hypertens.* 2012;30:1373-1382.

38.-Centers for Disease Control and Prevention: National Health and Nutrition Examination Survey. NHANES Response rates and population total. www.cdc.gov/nchs/nhanes/response-rates-CPS-htm (accessed September, 2013).

39.-Aromaa A, Koponen P, Tafforeau J, Vermeire C; HIS/HES Core Group: Evaluation of health interview surveys and health examination surveys in the European Union. *Eur J Public Health.* 2003;13(3suppl):67-72.

40.-James PA, Oparil S, Carter BL, Cushman WC, Dennison-Himmelfarb C, Handler J, Lackland DT, LeFevre ML, MacKenzie TD, Ogedegbe O, Smith SC Jr, Svetkey LP, Taler SJ, Townsend RR, Wright JT Jr, Narva AS, Ortiz E. 2014 evidence-based guideline for the

management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). JAMA. 2014;311:507-520.

TABLE 1. Prevalence of Hypertension in Individuals Aged ≥ 60 years in Spain in 2000-2001 and 2008-2010.

	2000-01	2008-10	2000-01	2008-10	
	N	N	%	%	Relative change (%)
Total	2461/3580	2162/3273	68.7	66.0*	-3.9
Age					
60-69 years	1038/1609	1169/1879	64.5	62.2*	-3.6
70-79 years	956/1315	791/1122	72.7	70.5*	-3.0
≥ 80 years	467/656	202/272	71.2	74.3*	4.3
Sex					
Men	1059/1585	1012/1491	66.8	67.9*	1.6
Women	1402/1995	1148/1783	70.3	64.4*	-8.4
Education					
\leq Primary studies	2064/2979	1294/1932	69.3	67.0*	-3.3
\geq Secondary studies	291/453	863/1332	64.2	64.8*	0.9
Obesity					
No	1377/2103	1298/2132	65.5	60.9*	-7.0
Yes	910/1221	828/1092	74.5	75.8	1.7
Sedentary behavior					
No	1461/2184	1440/2198	66.9	65.5*	-2.1
Yes	852/1161	626/899	73.4	69.6*	-5.2
Diabetes mellitus					
No	1877/2818	1680/2638	66.6	63.7*	-4.4
Yes	555/717	487/626	77.4	77.8	0.5
Current smoking					
No	2217/3213	1918/2876	69.0	66.7*	-3.3
Yes	239/363	239/388	65.8	61.6*	-6.4
Current alcohol intake					
No	1570/2217	829/1247	70.8	66.5*	-6.1
Yes	890/1361	1294/1975	65.4	65.5	0.2
Previous CVD					
No	2227/3256	2096/3176	68.4	66.0*	-3.5
Yes	224/307	63/89	73.0	70.8*	-3.0
Annual visits to the physician					
≤ 1	448/738	420/752	60.7	55.9*	-7.9
≥ 2	1998/2822	1736/2505	70.8	69.3	-2.1

CVD: Cardiovascular disease. For definition of variables see Methods. Difference between number of subjects by risk factor strata and number of total individuals is due to missing data. Relative change: $[(\text{proportion in 2010}) - (\text{proportion in 2000})] \times 100 / (\text{proportion in 2000})$. * $p < 0.05$ between 2000-2001 and 2008-20010.

TABLE 2. Awareness, Drug Treatment, and Control of Hypertension in Hypertensive Patients Aged ≥ 60 years in Spain in 2000-2001 and 2008-2010.

	Awareness			Treatment among those aware			Control among those treated		
	2000-01	2008-10	% change	2000-01	2008-10	% change	2000-01	2008-10	% change
N	1564	1461		1322	1278		401	549	
	%	%	% change	%	%	% change	%	%	% change
Total	63.6	67.7*	6.4	84.5	87.5*	3.6	30.3	42.9*	41.6
Age									
60-69 years	64.5	65.3	1.2	84.2	84.6	0.5	32.4	48.7*	50.3
70-79 years	65.6	71.3*	8.7	83.9	90.6*	8.0	29.3	38.6*	31.7
≥ 80 years	57.2	66.5*	16.3	86.9	91.0*	4.7	27.6	29.2	5.8
Sex									
Men	58.8	64.2*	9.2	81.0	85.8*	5.9	27.6	42.7*	54.7
Women	67.2	70.7*	5.2	86.8	88.8*	2.3	31.9	43.0*	34.8
Education									
\leq Primary studies	63.7	69.7*	9.4	84.3	88.7*	5.2	30.3	41.2*	36.0
\geq Secondary studies	59.8	64.5*	7.9	86.2	85.6	-0.7	29.3	45.8*	56.3
Obesity									
No	58.7	62.7*	6.8	82.0	85.2*	3.9	29.7	44.6*	50.2
Yes	68.8	74.9*	8.9	87.2	91.1*	4.5	31.6	40.8*	29.1
Sedentary behavior									
No	62.3	67.2*	7.9	84.8	87.9*	3.7	30.0	44.4*	48.0
Yes	65.1	69.3*	6.5	84.9	86.2	1.5	29.6	39.1*	32.1
Diabetes mellitus									
No	61.2	64.8*	5.9	83.3	85.8*	3.0	31.8	45.3*	42.5
Yes	71.7	77.5*	8.1	88.2	92.2*	4.5	26.2	37.5*	43.1
Current smoking									
No	64.6	68.6*	6.2	84.8	88.0*	3.8	30.3	43.4*	43.2
Yes	53.3	58.2*	9.2	82.0	83.5	1.8	30.5	38.3*	25.6
Current alcohol intake									
No	64.0	71.1*	11.1	86.9	90.2*	3.8	29.6	39.5*	33.4
Yes	62.8	65.6	4.5	80.5	85.6*	6.3	31.8	45.2*	42.1
Previous CVD									
No	62.8	65.6*	4.5	80.5	85.6*	6.3	30.2	42.9*	42.1
Yes	64.0	71.1*	-11.1	86.9	90.2*	3.8	31.8	40.9*	28.6
Annual visits to physician									
≤ 1	35.3	51.2*	45	73.4	73.5	0.1	31.0	42.8*	38.1
≥ 2	69.7	71.6	2.7	86.1	89.9*	4.4*	30.3	42.9*	41.6

CVD: cardiovascular disease. % change: [(proportion in 2010)–(proportion in 2000)] x 100 / (proportion in 2000).. *p<0.05 between 2000-01 and 2008-10.

TABLE 3. Control of Hypertension Among All Hypertensive Patients Aged ≥ 60 years in Spain in 2000-2001 and 2008-2010.

N	Year 2000-01	Year 2008-10	Relative change (%)
	%	%	
Total	16.3	25.4*	55.8
Age			
60-69 years	17.6	27.0*	53.4
70-79 years	16.1	24.9*	54.7
≥ 80 years	13.7	17.3	26.3
Sex			
Men	13.1	23.5*	79.4
Women	18.6	26.9*	44.6
Education			
\leq Primary studies	16.3	25.5*	56.4
\geq Secondary studies	15.1	25.3*	67.5
Obesity			
No	14.3	23.8*	66.4
Yes	18.9	27.8*	47.1
Sedentary behavior			
No	15.8	26.2*	65.8
Yes	16.3	23.4*	43.6
Diabetes mellitus			
No	16.2	25.2*	55.6
Yes	16.6	26.9*	62.0
Current smoking			
No	16.6	26.3*	58.4
Yes	13.3	18.5	39.1
Current alcohol intake			
No	16.4	25.2*	53.7
Yes	16.1	25.4*	57.8
Previous CVD			
No	15.3	24.1*	57.5
Yes	17.7	26.5*	49.7
Annual visits to the physician			
≤ 1 /year	8.0	16.2*	102.5
≥ 2 /year	18.2	27.6*	51.6
Number of BP medications			
None	0.4	0.3	-25.0
One	22.1	34.8*	57.5
Two	28.2	40.9*	45.0
Three or more	29.1	39.1*	34.5

CVD: cardiovascular disease. BP: blood pressure. Control: systolic blood pressure < 140 mmHg and diastolic blood pressure < 90 mmHg in all individuals with hypertension. Relative change: [(proportion in 2010)–(proportion in 2000)] x 100 / (proportion in 2000). * $p < 0.05$ between 2000-2001 and 2008-2010.

TABLE 4. Sociodemographic Characteristics, Cardiovascular Risk Factors and Treatment Among Hypertensive Patients Aged ≥ 60 years in Spain in 2000-2001 and 2008-2010.

Characteristics	Year 2000-2001 (N=2461)		Year 2008-2010 (N=2162)	
	Mean \pm SD or %	95% CI	Mean \pm SD or %	95% CI
Age (years)	72.1 \pm 7.7	71.8 to 72.4	69.9 \pm 6.7	69.6 to 70.2*
Men	43.9	41.0 to 45.0	46.9	44.8 to 49.0
Education (\leq primary studies)	87.7	86.4 to 89.0	60.0	57.9 to 62.1*
Blood pressure (systolic, mmHg)	150.9 \pm 18.0	150.2 to 151.6	148.0 \pm 18.2	147.2 to 148.7*
Duration of hypertension (years)	5 (5-7)	-	5 (4-8)	-
Body mass index (kg/m ²)	29.2 \pm 4.7	29.0 to 29.4	29.2 \pm 4.4	29.0 to 29.4
Sedentary behavior (≥ 37 h/week)	35.2	33.1 to 37.3	28.4	26.4 to 30.3*
Diabetes mellitus	23.2	21.4 to 25.0	22.3	20.5 to 24.1
Current tobacco smoking	9.7	8.5 to 10.9	11.1	9.8 to 12.4
Current alcohol intake	36.2	34.2 to 38.2	61.6	59.5 to 63.7*
Previous cardiovascular disease	9.1	8.0 to 10.2	2.9	2.2 to 3.6*
Annual visits to the physician (≥ 2 /year)	81.7	80.2 to 83.2	80.6	78.9 to 82.3
#BP medication among treated patients	1.4 \pm 0.9	1.3 to 1.4	1.8 \pm 1.0	1.7 to 1.8*
Combined therapy (≥ 2 drugs)	40.9	38.3 to 43.5	48.6	45.9 to 51.3*
Three or more drugs	9.6	8.0 to 11.2	15.6	13.6 to 17.5*

Hypertension duration is presented as median (P25-P75 interquartile range). For BP medication among treated patients, the appropriate N was 1322 in 2000 and 1278 in 2010. * $p < 0.05$ between 2000-2001 and 2008-2010.

Table 5. Impact of Hypertension Awareness and Treatment on Change in Blood Pressure Control from 2000-2001 to 2008-2010 Among Hypertensive Patients Aged ≥ 60 years in Spain, by Sex.

	Odds ratio (95% Confidence Interval)	P value	% of association explained by hypertension awareness and drug treatment*
Total			
Crude model	1.75 (1.52 to 2.01)	<0.001	
Models with progressive adjustment for:			
Sociodemographic variables	1.71(1.47 to 1.99)	<0.001	
Cardiovascular risk factors	1.72 (1.45 to 2.04)	<0.001	
Use of healthcare services	1.74 (1.47 to 2.06)	<0.001	
Hypertension awareness	1.69 (1.41 to 2.02)	<0.001	+6.8
Antihypertensive drug treatment	1.44 (1.19 to 1.74)	<0.001	+36.2
Men			
Crude model	2.12 (1.67 to 2.69)	<0.001	
Progressive adjustment for:			
Sociodemographic variables	1.90 (1.47 to 2.46)	<0.001	
Cardiovascular risk factors	1.91 (1.44 to 2.53)	<0.001	
Use of healthcare services	1.93 (1.45 to 2.55)	<0.001	
Hypertension awareness	1.92 (1.42 to 2.61)	<0.001	+1.1
Antihypertensive drug treatment	1.63 (1.18 to 2.26)	0.003	+31.5
Women			
Crude model	1.64 (1.37 to 1.97)	<0.001	
Progressive adjustment for:			
Sociodemographic variables	1.62 (1.32 to 1.96)	<0.001	
Cardiovascular risk factors	1.65 (1.33 to 2.04)	<0.001	
Use of healthcare services	1.67 (1.34 to 2.07)	<0.001	
Hypertension awareness	1.60 (1.27 to 2.01)	<0.001	+10.4
Antihypertensive drug treatment	1.38 (1.18 to 2.26)	0.008	+36.7

Logistic regression models were progressively adjusted for sociodemographic variables (age, sex, and education level), cardiovascular risk factors (hypertension duration, body mass index, sedentariness, diabetes, tobacco smoking, alcohol consumption, and cardiovascular disease), use of healthcare services (physicians annual visits), hypertension awareness, and antihypertensive drug treatment. Year 2000-2001 was used as the reference category (odds ratio=1). *Percent contribution of the specific healthcare variables (awareness and treatment) to the change in hypertension control between the two time periods, after adjustment for the rest of the above variables (for calculation, see the Methods section).

Table 6. Impact of the Number of Blood Pressure Medications on Change in Blood Pressure Control from 2000-2001 to 2008-2010 Among Treated Hypertensive Patients Aged ≥ 60 years in Spain, by Sex.

	Odds ratio (95% confidence interval)	P value	% of association explained by the number of BP medications*
Total			
Crude model	1.78 (1.52 to 2.08)	<0.001	
Models with progressive adjustment for:			
Sociodemographic variables	1.66 (1.40 to 1.97)	<0.001	
Cardiovascular risk factors	1.61 (1.33 to 1.94)	<0.001	
Use of healthcare services	1.62 (1.34 to 1.95)	<0.001	
Number of BP medications	1.48 (1.20 to 1.80)	<0.001	+22.6
Men			
Crude model	2.08 (1.60 to 2.71)	<0.001	
Progressive adjustment for:			
Sociodemographic variables	1.84 (1.38 to 2.45)	<0.001	
Cardiovascular risk factors	1.77 (1.29 to 2.43)	<0.001	
Use of healthcare services	1.79 (1.30 to 2.47)	<0.001	
Number of BP medications	1.64 (1.16 to 2.30)	0.001	+19.0
Women			
Crude model	1.67 (1.36 to 2.71)	<0.001	
Progressive adjustment for:			
Sociodemographic variables	1.57 (1.27 to 1.94)	<0.001	
Cardiovascular risk factors	1.55 (1.22 to 1.96)	<0.001	
Use of healthcare services	1.55 (1.22 to 1.97)	<0.001	
Number of BP medications	1.42 (1.19 to 1.94)	0.001	+23.6

BP indicates blood pressure. Logistic regression models were progressively adjusted for sociodemographic variables (age, sex, and education level), cardiovascular risk factors (hypertension duration, body mass index, sedentariness, diabetes, tobacco smoking, alcohol consumption, and cardiovascular disease), use of healthcare services (physicians annual visits), and number of BP medications. Year 2000-1 was used as the reference category (odds ratio=1). *Percent contribution of the number of BP medications to the change in hypertension control between the two time periods, after adjustment for the rest of the above variables (for calculation, see the Methods section).