

ORIGINAL ARTICLE

Systolic vs diastolic blood pressure: community burden and impact on blood pressure staging

JR Banegas, JJ de la Cruz, F Rodríguez-Artalejo, A Graciani, P Guallar-Castillón and R Herruzo

Department of Preventive Medicine and Public Health. Universidad Autónoma de Madrid. Madrid, Spain

Systolic blood pressure (SBP) is a more frequent cardiovascular risk factor than diastolic blood pressure (DBP), and has a greater impact on blood pressure staging, though this can vary with age, sex and country. Therefore this paper compares SBP and DBP in terms of community burden and impact on blood pressure staging, among Spain's middle-aged population. Data were drawn from a cross-sectional study on a representative sample of the Spanish population aged 35–64 years. Blood pressure was determined under standardised conditions, and was classified as per WHO-ISH and JNC-VI criteria. Prevalence of SBP ≥ 140 mm Hg was 34.1%, and that of DBP ≥ 90 mm Hg, 30.9%. A total of 12% of subjects had isolated systolic hypertension (ISH) and 8.7% had isolated diastolic hypertension (IDH). Of treated hypertensives, 31% had their SBP controlled and 34% their DBP controlled. Of subjects not undergoing antihypertensive drug therapy, 60.8% had congruent

SBP and DBP levels, 22.5% were up-staged on the basis of their SBP, and 16.7% were up-staged on the basis of their DBP. SBP alone thus correctly classified JNC-VI staging in 83.3% of subjects vs 77.5% for DBP alone. It was solely among the population >50 years of age, in both sexes, that systolic proved more frequent than diastolic hypertension, ISH greater than IDH prevalence, SBP worse than DBP control, and the percentage of SBP higher than that of DBP up-staged subjects. SBP constitutes a greater community burden than does DBP, and has a greater impact on blood pressure staging in Spain's middle-aged population. However, the differential impact of SBP and DBP upon blood pressure burden and staging is favourable to SBP only among subjects >50 years old. These findings are in accordance with recent guidelines on hypertension management.

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Introduction

Hypertension burden and blood pressure staging are usually reported on the basis of both systolic blood pressure (SBP) and diastolic blood pressure (DBP),¹ following Joint National Committee VI (JNC-VI) and International Society of Hypertension (WHO-ISH) guidelines.^{2,3} However, different prevalences of systolic vs diastolic hypertension have been reported.^{4,5} Similarly, two recent studies have reported that SBP has a different impact than DBP on blood pressure staging.^{4,6} To our knowledge, the SBP and DBP staging impact has only been reported in the US.^{4,6,7} Nonetheless, the staging impact of SBP and DBP, as well as the community burden of elevated SBP and

DBP may vary across study populations and countries, or between age groups and sexes within a population.

Knowing whether there are differences in SBP and DBP community burden and staging impact could contribute to better management of arterial hypertension (AHT), since clinicians traditionally focus more on DBP than on SBP when detecting and treating patients with AHT,^{6,8,9} whereas JNC-VI and WHO-ISH guidelines assign relatively similar roles to SBP and DBP.^{2,3} Finally, more recent guidelines in the US highlight the importance of SBP as the major criterion for AHT staging and management, particularly in middle-aged and older people.¹⁰ Despite its importance, SBP and DBP community burden and staging impact tend to be little reported for populations or countries as a whole.

Therefore, this study compares separately SBP and DBP in terms of community burden and impact on blood pressure staging in Spain's middle-aged population.

Correspondence: JR Banegas, Departamento de Medicina Preventiva y Salud Pública, Facultad de Medicina, Universidad Autónoma de Madrid, Avda. Arzobispo Morcillo s/n. 28029 Madrid, Spain. E-mail: joseramon.banegas@uam.es
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Subjects and methods

Study population

Data were drawn from a study conducted on the general Spanish population aged 35–65 years, using methodology described elsewhere.¹¹ In brief, our representative general population sample was made up of 2021 individuals (mean age, 49 years; 57% women) selected through random multi-stage sampling stratified by age, sex and habitat of residence. The overall response rate to the survey was 73.3%. Blood pressure was determined with a mercury sphygmomanometer under standardised conditions,¹² and we used the average of the three readings taken. The study protocols were approved by an institutional review board. All participants gave their informed consent.

Hypertension prevalence and control

Community burden was approximated by the prevalence of the following: systolic hypertension (SBP ≥ 140 mm Hg for any DBP) and diastolic hypertension (DBP ≥ 90 mm Hg for any SBP); high-normal SBP (SBP 130–139 mm Hg) and high-normal DBP (DBP 85–89 mm Hg); isolated systolic hypertension (ISH) (SBP ≥ 140 mm Hg and DBP < 90 mm Hg) and isolated diastolic hypertension (IDH) (DBP ≥ 90 mm Hg and SBP < 140 mm Hg); and control of SBP (SBP < 140 mm Hg) and DBP (DBP < 90 mm Hg).^{2,3}

Blood pressure staging

To ascertain the impact of SBP and DBP on blood pressure staging, blood pressure levels were classified according to JNC-VI and WHO-ISH criteria^{2,3} and grouped into four categories, ie, normal (SBP < 130 and DBP < 85 mm Hg), high-normal (SBP 130–139 mm Hg or DBP 85–89 mm Hg), stage or grade 1 AHT (SBP 140–159 mm Hg or DBP 90–99 mm Hg), and stage or grade ≥ 2 AHT (SBP ≥ 160 mm Hg or DBP ≥ 100 mm Hg). Where there was a disparity between SBP and DBP categories, subjects were placed in the higher category ('up-staging').^{2,3} Subjects were also classified by their SBP or DBP alone. The number and percentage of subjects in each SBP, DBP, and JNC-VI/WHO-ISH category were calculated, as was the percentage of subjects in each JNC-VI/WHO-ISH category that had disparate or congruent SBP and DBP levels. Data analyses were performed with the SPSS software package.¹³

Results

SBP vs DBP community burden

Of the total sample, 34.1% of subjects had systolic hypertension, 30.9% had diastolic hypertension, 52% had elevated SBP (high-normal, 18%, or AHT, 34%), and 45% had elevated DBP (Table 1). Stage 1 AHT was the most frequent type of hypertension,

Table 1 Prevalence and control of elevated blood pressure as per JNC-VI and WHO-ISH criteria

	No. (%)
<i>Elevated blood pressure (mm Hg)</i>	
Systolic hypertension (SBP ≥ 140)	690 (34.1)
High-normal SBP (SBP 130–139)	364 (18.0)
Diastolic hypertension (DBP ≥ 90)	624 (30.9)
High-normal DBP (DBP 85–89)	281 (13.9)
<i>Isolated hypertension (mm Hg)</i>	
Isolated systolic hypertension (SBP ≥ 140 /DBP < 90), total	243 (12.0)
Isolated systolic hypertension among untreated hypertensives	205 (30.6)
Isolated diastolic hypertension (SBP < 140 /DBP ≥ 90), total	175 (8.7)
Isolated diastolic hypertension among untreated hypertensives	144 (21.5)
<i>Control of blood pressure (mm Hg)</i>	
SBP < 140 among hypertensives	219 (24.0)
SBP < 140 among treated hypertensives	75 (31.0)
DBP < 90 among hypertensives	283 (31.0)
DBP < 90 among treated hypertensives	82 (34.0)

JNC-VI, Joint National Committee (see reference 2). WHO-ISH, World Health Organization-International Society of Hypertension (see reference 3). SBP, systolic blood pressure. DBP, diastolic blood pressure.

systolic (72% of hypertensives) and diastolic (70.9% of hypertensives). Whereas diastolic AHT was more frequent in young adults, systolic AHT tended to predominate above the age of 50 years (Figure 1a).

Prevalence of ISH was 12% and that of IDH, 8.7%. ISH was also more frequent than IDH among hypertensives not undergoing drug therapy ($n = 670$) (Table 1). IDH, unlike ISH, was relatively infrequent among older persons (Figure 1b).

Of hypertensives undergoing drug therapy ($n = 241$), 31% and 34% had their SBP and DBP controlled, respectively (Table 1). In the case of total hypertensives ($n = 911$), 24% had their SBP controlled and 31% their DBP controlled. While the percentage of people with a SBP < 140 mm Hg among all hypertensives decreased with age, those with DBP < 90 mm Hg increased somewhat with age (Figure 1c), reflecting progress of vascular disease. The results in Figure 1 were similar across the sexes (data not shown).

SBP vs DBP impact on blood pressure staging

Of the 1780 subjects not undergoing antihypertensive drug therapy, 18% had high-normal blood pressure, 26% had stage 1 AHT and 11% had stage ≥ 2 AHT based on JNC-VI and WHO-ISH criteria (Figure 2, left). These percentages remained similar when subjects were classified according to their SBP alone, but were lower when based on DBP alone, except in the case of stage ≥ 2 . Hence, blood pressure staging reflected SBP more closely than it did DBP, though the difference was not overly great.

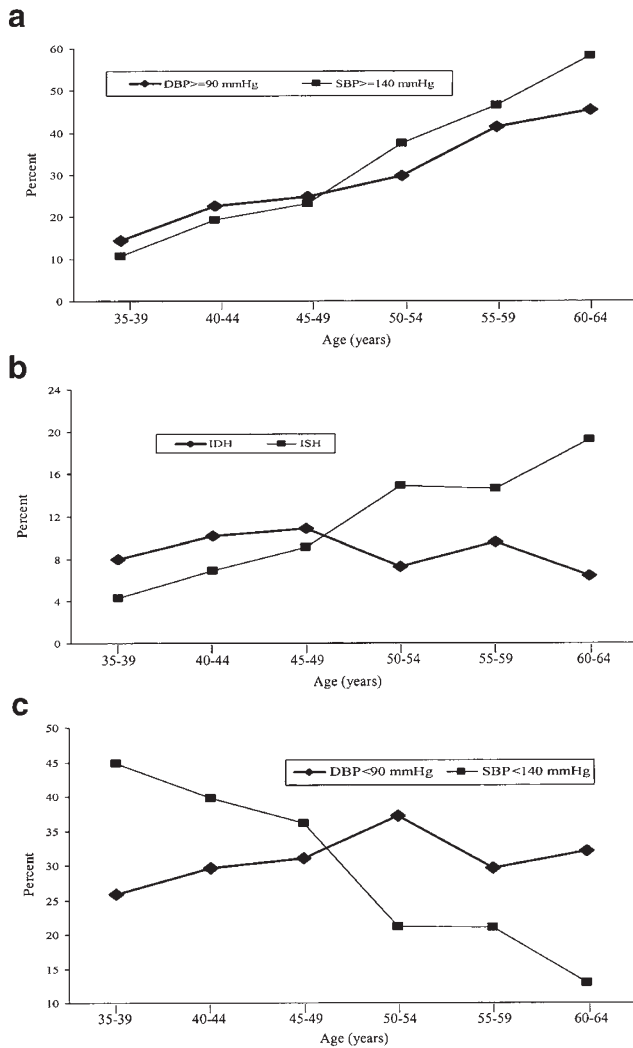


Figure 1 Prevalences of systolic hypertension and diastolic hypertension (a), isolated systolic hypertension (ISH) and isolated diastolic hypertension (IDH) (b), and control of systolic blood pressure (SBP) and diastolic blood pressure (DBP) among hypertensives (c), by age.

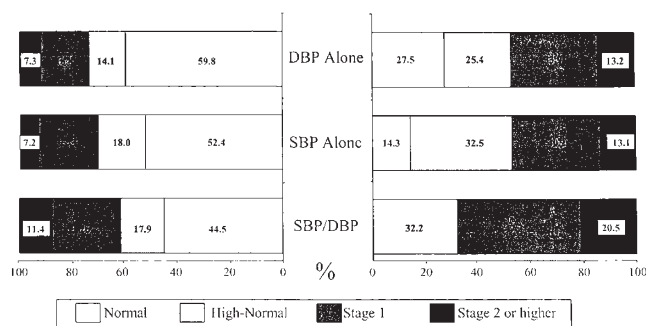


Figure 2 Percentage distribution of blood pressure categories among untreated subjects (left), and among subjects with high-normal blood pressure or hypertension (right), based on JNC-VI and WHO-ISH criteria (references 2 and 3), SBP alone and DBP alone. SBP, systolic blood pressure. DBP, diastolic blood pressure. SBP/DBP, use of both SBP and DBP.

In all, 1083 subjects (60.8%) had congruent SBP and DBP levels (Table 2), and 39.2% had disparate SBP and DBP levels, with 22.5% being up-staged on the basis of their SBP, and 16.7% on the basis of their DBP. Therefore, SBP alone correctly classified JNC-VI/WHO-ISH staging in 83.3% (60.8% + 22.5%) of subjects, whereas DBP alone correctly classified 77.5% (60.8% + 16.7%) of subjects.

There were 988 subjects who had high-normal pressure or AHT. This group is of particular interest because they are potentially eligible for initial drug therapy under JNC-VI recommendations. The disparity in SBP and DBP levels was significantly ($P < 0.01$) greater among those with high-normal pressure or hypertension (Figure 2, right) than among untreated subjects as a whole, with 85.8% having elevated SBP and 72.5%, elevated DBP. Of these 988 subjects (Table 2), 29.5% had congruent SBP and DBP levels, 40.4% were up-staged on the basis of their SBP, and 30.1% were up-staged on the basis of their DBP. Thus, SBP alone correctly classified joint staging in 70% of subjects vs 60% for DBP alone.

Figure 3 depicts the influence of age on the proportions of subjects that were respectively up-staged on the basis of SBP and DBP alone. These proportions were higher for SBP for those aged above 50 years. In the <50-year age group ($n = 879$), 66% had congruent SBP and DBP levels, 15% were up-staged on the basis of their SBP, and 19% were up-staged on the basis of their DBP. SBP correctly classified JNC-VI and WHO-ISH staging in 81% of subjects (vs 85% for DBP alone). In the ≥ 50 -year age group ($n = 901$), 55% had congruent SBP and DBP levels, 30% were up-staged on the basis of their SBP, and 15% were up-staged on the basis of their DBP. Hence, SBP alone correctly classified staging in 85%

Table 2 Number of untreated subjects in each category as per JNC-VI and WHO-ISH criteria, based on SBP and DBP levels

SBP (mm Hg)	DBP (mm Hg)				Row total
	Normal <85	High-normal 85–89	Stage 1 90–99	Stage ≥2 ≥100	
Normal (<130)	792	97	42	2	933
High-normal (130–139)	150	71	85	15	321
Stage 1 (140–159)	107	69	164	57	397
Stage ≥2 (≥160)	15	14	44	56	129
Column total	1064	251	335	130	1780

Diagonal numbers (in bold type) represent subjects with congruent levels of SBP and DBP as per JNC-VI and WHO-ISH classification (see references 2 and 3). Numbers below and to the left of the diagonal represent subjects that were up-staged on the basis of their SBP. Numbers above and to the right of the diagonal represent subjects that were up-staged on the basis of their DBP. SBP indicates systolic blood pressure and DBP, diastolic blood pressure.

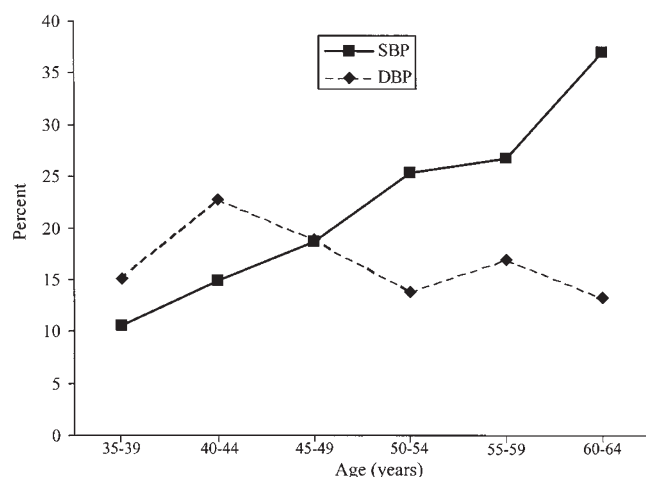


Figure 3 Percentages of untreated subjects that were up-staged on the basis of systolic blood pressure (SBP) and diastolic blood pressure (DBP), by age.

of subjects (vs 70% for DBP alone). The situation was similar across the sexes (data not shown).

Lastly, on applying JNC-VI/WHO-ISH criteria to the 241 subjects with antihypertensive drug therapy, 43% had congruent SBP and DBP levels, 33% were up-staged on the basis of their SBP and 24% were up-staged on the basis of their DBP.

Discussion

SBP vs DBP community burden

Our results highlight that it is only for ages above 50 years that systolic hypertension is the more frequent type of AHT. The Multiple Risk Factor Intervention Trial (MRFIT), conducted in the United States,⁷ reported 23.6% of men aged 35–57 years as having systolic AHT and 27.3%, diastolic AHT. The corresponding figures for Spanish men aged 35–57 years were 25% and 25%, respectively. Moreover, the MRFIT found prevalence of systolic AHT to exceed that of diastolic AHT for ages above 50–54 years, much as in Spain. Since blood pressure was taken three times on one occasion, a degree of overestimation of hypertension prevalence could have occurred in our study.

Our data show an appreciable magnitude of ISH, which affects 16% of men and 18% of women aged 55–64 years, and constitutes a frequent form of AHT (27% of all AHT) even in the middle-age range. Despite registering lower figures, the magnitude of IDH is in no way negligible: indeed, it is only for ages above 50 years in both sexes that ISH exceeds IDH. Among untreated persons under 50 years of age, ISH frequency was 21% for the US⁶ vs 25% for Spain, whereas IDH frequency was 47% for the US vs 36% for Spain.

Control of elevated blood pressure leaves much room for improvement, inasmuch as less than one-third of subjects with systolic or diastolic AHT have their SBP or DBP controlled, a finding consistent

with the low therapy compliance in Spain.¹⁴ However, the difference between SBP and DBP control is not very great, with SBP only being smaller than DBP control for ages above 50 years. Other studies also reported differential control of SBP and DBP. For middle-aged subjects in Italy, the PAMELA study reported SBP control in 12.6% and DBP control in 17.5% of hypertensives.¹⁵ Overall, these data may indicate that physicians pay less attention to SBP than to DBP or, alternately, that it is more difficult to control SBP with currently available drugs.⁸ Despite the fact that 66% of all Spanish hypertensives undergoing treatment are in monotherapy, a regimen that achieves little control of AHT (and of SBP in particular), Spanish physicians nevertheless make control-enhancing changes in treatment in only 12% of patients with uncontrolled hypertension.⁹

SBP vs DBP impact on blood pressure staging

Our study has the advantage of using a general population sample representative of the middle-aged segment of an entire country, in which the staging impact of SBP and DBP may be different to that in samples that are less representative or older. Overall, SBP is more important than DBP in the determination of blood pressure staging and eligibility for therapy, yet the difference between SBP and DBP is nevertheless not extremely pronounced. Indeed, the percentages of subjects that were up-staged on the basis of SBP or DBP alone are favourable to SBP solely for ages above 50 years. Lastly, the exclusion of subjects with cardiovascular disease had no effect whatsoever on the principal results.

In Spain, SBP seems to be a similar staging determinant than in MRFIT. With respect to males aged <60 years, 35.1% of Spaniards with high-normal blood pressure or AHT were classified in their respective blood pressure categories on the basis of SBP alone, 36.1% were classified on the basis of DBP alone, and 28.8% had congruent SBP and DBP levels. The corresponding figures in MRFIT⁷ were 32.4%, 39.7%, and 27.9%, respectively. Not only were our results akin to those of the MRFIT, they were based on a population having a similar age range and use of a similar blood pressure measurement protocol.

The results from the nationally representative sample of Spain were consistent with those from its counterpart in the US NHANES III.⁶ For untreated people aged <50 years with high-normal blood pressure or AHT, 35% of individuals in Spain were up-staged by SBP alone vs 35% in the US NHANES III study. The corresponding percents up-staged by DBP alone were 42% in Spain and 46% in the US. For untreated subjects ≥50 years with high-normal or AHT, 44% of individuals in Spain were up-staged by SBP alone vs 85% in the US. The corresponding percents up-staged by DBP alone were 22% in Spain

and 7% in the US. The differences between SBP and DBP upstaging frequencies for subjects ≥ 50 years were much greater in the US than in Spain, probably reflecting that the population subgroup for Spain was 50–65 years of age, whereas in NHANES was ≥ 50 years. Overall, these findings in Spain reinforce the findings of SBP upstaging found in US studies when demographic differences are taken appropriately into account, and also reinforce the new concept of DBP upstaging in the younger age group advanced by Franklin *et al*⁶ based on NHANES data.

In conclusion, SBP constitutes a greater community burden than DBP, and has a greater impact on blood pressure staging, in Spain's middle-aged population. Focusing solely on DBP gives rise to a classification error, inasmuch as it underestimates the number of hypertensives, leading in turn to the possible omission of treatment in a considerable number of subjects. Greater emphasis on SBP is therefore called for in determining blood pressure stage and in hypertension management in Spain, in line with recent American guidelines.¹⁰ Nonetheless, the differences between SBP and DBP we found are not very great within the middle-aged segment of the population. Age is an important modifier of SBP- vs DBP-related prevalence, control and staging impact. Only among subjects over age 50 years is SBP a better classifier of blood pressure than DBP and a better indicator of the burden of both hypertension and low control. Accordingly, our results should not be allowed to diminish the importance of DBP, especially among the youngest segment.

The above suggest that JNC-VI and WHO-ISH guidelines,^{2,3} which assign relatively similar roles to SBP and DBP in blood pressure level classification and management, are reasonably appropriate for a country such as Spain, but specifically referred to the middle-aged segment of the population (more specifically people < 50 years), a segment that accounts for approximately half of all Spanish hypertensives. Thus, for most hypertensives SBP seems to be the principal criterion, in accordance with more recent guidelines.¹⁰

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