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RESEARCH REPORT

Association of adult socioeconomic position with hypertension in older people

Enrique Regidor, Juan L Gutiérrez-Fisac, José R Banegas, Vicente Domínguez, Fernando Rodríguez-Artaño

Objective: To determine the role of obesity, adult behavioural risk factors, and markers of specific childhood exposures in the association between adult socioeconomic position and hypertension in a cohort of people aged 60 years and older.

Design: Cross sectional study.

Setting: Spain.

Participants: 4009 subjects representative of the Spanish non-institutionalised population aged 60 years and older.

Main outcome measure: Prevalence of hypertension according to education and social class, and proportion of excess difference in hypertension prevalence in lower socioeconomic groups explained by different risk factors for hypertension.

Results: The highest prevalence of hypertension was seen in subjects with less education and in those belonging to a low social class. In men, the hypertension risk factors analysed did not explain the difference in prevalence by education, but they explained almost half of the difference by social class. In women, these risk factors explained the differences in hypertension prevalence by education and a substantial part of the differences by social class. Central and general obesity, and physical inactivity were the risk factors that were the most important in this association in women.

Conclusions: In women, socioeconomic position has no direct effect on hypertension in the case of education and only a small effect in the case of social class. In contrast, most of the effect of education and half of the effect of social class on hypertension in men is direct or, at least, is not explained by the risk factors analysed. The mechanisms that can explain the association between socioeconomic position and hypertension in older men remain to be established.

Hypertension is an important risk factor for cardiovascular diseases, especially stroke. Most studies carried out in the developed countries have found a higher mean blood pressure and greater frequency of hypertension among people of lower socioeconomic status. This socioeconomic difference in hypertension is one of the reasons that has been mentioned to explain the association between educational level and stroke mortality in the developed countries. These studies have been carried out in young and/or middle aged subjects, however few investigations have evaluated the association between adult socioeconomic position and hypertension in older people. Furthermore, the few investigations made in older people have yielded inconsistent results.

The development of effective policy interventions to break the link between adverse adult socioeconomic position and stroke in older people requires evaluation of the possible existence of a relation between adult socioeconomic position and hypertension in this population group. The relation between adult socioeconomic position and arterial hypertension is complex. Hypertension depends on other factors such as obesity, physical inactivity, excessive alcohol consumption, sodium and potassium intake, and psychological stress. These factors show a relation with socioeconomic position in middle age, but in the elderly population this relation is less well known and, in some cases, there is evidence that its magnitude is smaller. In addition, some factors operating during childhood, such as socioeconomic circumstances or growth rate, are associated both with blood pressure and with socioeconomic position in adulthood.
the measurements of blood pressure have been previously reported.\textsuperscript{12} Basically, the study design called for two sets of six blood pressure measurements to be obtained from each subject. The first and second set were separated by a time interval (several hours, within the space of a single day), so that the average of both sets reflects more closely the usual blood pressure in each subject. In each set, three mercury based measurements were alternated with three automated based measurements (each mercury reading preceding each automated reading) with a two minute interval between each cuff inflation. The mean of all the blood pressure measurements was used for the analysis. Subjects were deemed to be hypertensive when their systolic blood pressure was \( \geq 140 \text{ mm Hg} \) or their diastolic blood pressure was \( \geq 90 \text{ mm Hg} \) or they were on current antihypertensive drug treatment.

### Measurement of socioeconomic position

The three measures of socioeconomic position most frequently used are education, social class based on occupation, and income. We analysed only the first two because no information on income was collected in this study. Education is an indicator that reflects material and psychosocial conditions during adulthood.\textsuperscript{13} Educational qualifications are strong predictors of occupation and, consequently, of income. In addition to economic resources, persons with higher educational level have a series of psychosocial resources such as a high sense of personal control over problematic events of daily life and a better knowledge and understanding of the lifestyles that constitute a risk for health. Educational level was grouped into three categories based on the highest educational level attained by the subject: low—illiterate persons and those who did not complete primary education; medium—subjects who completed primary education; and high—subjects who completed secondary or higher level education.

### Measurement of hypertension risk factors

Studies have been made of a number of lifestyle related exposures and early life experiences that play an important part in the origins of hypertension.\textsuperscript{15} Among the former factors are high body weight and central obesity, excessive consumption of alcohol, physical inactivity, and excessive consumption of cured meat products—as an indicator of high sodium intake. The latter factors have included height as an indicator of growth rate in childhood and father’s occupation as an indicator of childhood socioeconomic circumstances.

Body mass index (BMI) was calculated as weight (in kg) divided by height (in metres) squared. A study participant was considered to be obese if they had a BMI \( \geq 30 \text{ kg/m}^2 \) and to have central obesity when waist circumference was greater than 102 cm in men and 88 cm in women.\textsuperscript{16} Subjects were asked about the type of physical exercise done in their free time; in the case of unemployed or retired persons, exercise at any time was considered. A person whose only reported leisure time activity was completely sedentary—reading, watching television, etc.—was considered to be physically inactive.

### Table 1: Age adjusted prevalence (95% confidence interval)—in percentage—of risk factors for hypertension in Spanish people aged 60 years and older according to educational level

<table>
<thead>
<tr>
<th>Risk factors for hypertension</th>
<th>Educational level</th>
<th>Number of people</th>
<th>p Value for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Educational level</td>
<td>Number of people</td>
<td>p Value for trend</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Middle</td>
<td>Low</td>
</tr>
<tr>
<td>General obesity</td>
<td>1503</td>
<td>31.0</td>
<td>(26.0, 36.9)</td>
</tr>
<tr>
<td>Central obesity</td>
<td>1616</td>
<td>46.1</td>
<td>(40.5, 52.1)</td>
</tr>
<tr>
<td>Physical inactivity</td>
<td>1611</td>
<td>24.4</td>
<td>(20.0, 29.8)</td>
</tr>
<tr>
<td>Heavy alcohol intake</td>
<td>1616</td>
<td>11.0</td>
<td>(8.0, 15.2)</td>
</tr>
<tr>
<td>Heavy intake of cured meats</td>
<td>1616</td>
<td>19.0</td>
<td>(15.1, 24.0)</td>
</tr>
<tr>
<td>Short stature</td>
<td>1616</td>
<td>21.4</td>
<td>(17.2, 26.7)</td>
</tr>
<tr>
<td>Low childhood social class</td>
<td>1588</td>
<td>31.9</td>
<td>(27.0, 37.7)</td>
</tr>
</tbody>
</table>

*\(p\) Value for departure from a linear trend \(<0.05\).
inactive. Alcohol intake was measured using a quantity-frequency index. Heavy drinkers were considered to be those with a daily consumption of more than 50 ml (men) or 30 ml (women) of absolute alcohol. Participants were asked about their weekly intake of different types of food. Consumption of cured meats at least four days per week was considered to be excessive. Participants were also divided into four categories based on quartiles of the height distribution. Cut off points for height quartiles were estimated for men and women separately. Father’s occupation was measured in the same way as the subject’s occupation, and was grouped into two categories: non-manual workers and self employed farm workers, and manual workers.

**Statistical analysis**

The age adjusted prevalence of hypertension risk factors by the variables characterising adult socioeconomic position was estimated using binomial regression analysis. These estimates included subjects with complete information on all socioeconomic variables and for each of the risk factors. Self employed farm workers were excluded from the evaluation of the association between social class and hypertension.

**RESULTS**

Table 1 shows that men and women with low educational level had the highest prevalence of general obesity, central obesity, physical inactivity, short stature, and manual social class in childhood. Men with low educational level also presented a higher prevalence of excessive alcohol consumption. These hypertension risk factors do not show such a clear relation with social class in men, except for excessive alcohol consumption.
higher prevalence of hypertension (66.4% in men and 69.8% in women) than those with high educational level (59.8% in men and 64.8% in women) (table 3), although in women the difference was not statistically significant. In men, the prevalence difference between subjects with high and low educational level changed 18% after adjusting for all the potential explanatory factors. In women, the gradient in the prevalence of hypertension almost disappeared after adjusting for the potential explanatory factors. The factors that explained the largest percentage of the prevalence difference between women with high and low educational level were central obesity (58%) and physical inactivity (26%) (table 3).

Table 3  Age adjusted prevalence (in percentage) of hypertension and prevalence difference adjusted for hypertension risk factors according to educational level

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Middle</th>
<th>Low</th>
<th>% Reduction*</th>
<th>High</th>
<th>Middle</th>
<th>Low</th>
<th>% Reduction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>301</td>
<td>580</td>
<td>735</td>
<td></td>
<td>178</td>
<td>721</td>
<td>1219</td>
<td></td>
</tr>
<tr>
<td>Age adjusted prevalence</td>
<td>59.8</td>
<td>64.1</td>
<td>66.4</td>
<td></td>
<td>64.8</td>
<td>65.9</td>
<td>69.8</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence difference (95% confidence interval) adjusted for:

<table>
<thead>
<tr>
<th>Factor</th>
<th>High</th>
<th>Middle</th>
<th>Low</th>
<th>% Reduction*</th>
<th>High</th>
<th>Middle</th>
<th>Low</th>
<th>% Reduction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>4.3</td>
<td>(2.4, 11.8)</td>
<td>6.6</td>
<td>(0.0, 14.0)</td>
<td>0.0</td>
<td>(6.4, 9.6)</td>
<td>0.0</td>
<td>(13.5)</td>
</tr>
<tr>
<td>Age and general obesity</td>
<td>0.0</td>
<td>(1.5, 12.4)</td>
<td>5.9</td>
<td>(0.5, 13.0)</td>
<td>0.0</td>
<td>(6.9, 13.2)</td>
<td>0.0</td>
<td>(2.1)</td>
</tr>
<tr>
<td>Age and central obesity</td>
<td>0.0</td>
<td>(19.12.0)</td>
<td>6.8</td>
<td>(0.0, 14.0)</td>
<td>0.0</td>
<td>(7.7, 7.3)</td>
<td>0.0</td>
<td>(5.1)</td>
</tr>
<tr>
<td>Age and physical activity</td>
<td>0.0</td>
<td>(2.5, 11.6)</td>
<td>4.7</td>
<td>(0.4, 14.0)</td>
<td>0.0</td>
<td>(7.7, 10.0)</td>
<td>0.0</td>
<td>(5.0)</td>
</tr>
<tr>
<td>Age and heavy alcohol intake</td>
<td>0.0</td>
<td>(4.4, 11.8)</td>
<td>4.1</td>
<td>(0.4, 14.0)</td>
<td>0.0</td>
<td>(4.9, 8.5)</td>
<td>0.0</td>
<td>(5.0)</td>
</tr>
<tr>
<td>Age and heavy intake of cured meats</td>
<td>0.0</td>
<td>(2.6, 13.8)</td>
<td>4.1</td>
<td>(0.5, 13.6)</td>
<td>0.0</td>
<td>(6.4, 9.6)</td>
<td>0.0</td>
<td>(5.0)</td>
</tr>
<tr>
<td>Age and height</td>
<td>0.0</td>
<td>(2.6, 11.7)</td>
<td>6.5</td>
<td>(0.0, 13.8)</td>
<td>0.0</td>
<td>(6.9, 13.3)</td>
<td>0.0</td>
<td>(6.0)</td>
</tr>
<tr>
<td>Age and father's social class</td>
<td>0.0</td>
<td>(5.0, 13.5)</td>
<td>5.6</td>
<td>(0.0, 14.0)</td>
<td>0.0</td>
<td>(6.9, 9.3)</td>
<td>0.0</td>
<td>(6.4)</td>
</tr>
<tr>
<td>Age and all factors</td>
<td>0.0</td>
<td>(19.11.7)</td>
<td>4.5</td>
<td>(1.2, 12.9)</td>
<td>0.0</td>
<td>(4.4, 5.0)</td>
<td>0.0</td>
<td>(3.8, 5.5)</td>
</tr>
</tbody>
</table>

* Percentage of the age adjusted prevalence difference in low educational level explained by the adjustment factors.

Table 4  Age adjusted prevalence (in percentage) of hypertension and prevalence difference adjusted for hypertension risk factors according to social class

<table>
<thead>
<tr>
<th></th>
<th>Non-manual workers</th>
<th>Skilled manual workers</th>
<th>Unskilled manual workers</th>
<th>% Reduction*</th>
<th>Non-manual workers</th>
<th>Skilled manual workers</th>
<th>Unskilled manual workers</th>
<th>% Reduction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of participants</td>
<td>588</td>
<td>620</td>
<td>255</td>
<td></td>
<td>705</td>
<td>678</td>
<td>346</td>
<td></td>
</tr>
<tr>
<td>Age adjusted prevalence</td>
<td>63.3</td>
<td>65.6</td>
<td>67.9</td>
<td></td>
<td>63.9</td>
<td>69.9</td>
<td>70.0</td>
<td></td>
</tr>
</tbody>
</table>

Prevalence difference (95% confidence interval) adjusted for:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Non-manual workers</th>
<th>Skilled manual workers</th>
<th>Unskilled manual workers</th>
<th>% Reduction*</th>
<th>Non-manual workers</th>
<th>Skilled manual workers</th>
<th>Unskilled manual workers</th>
<th>% Reduction*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>2.3</td>
<td>(2.9, 8.0)</td>
<td>6.4</td>
<td>(0.7, 11.8)</td>
<td>0.0</td>
<td>(5.0, 11.0)</td>
<td>0.0</td>
<td>(11.5)</td>
</tr>
<tr>
<td>Age and general obesity</td>
<td>0.0</td>
<td>(1.6, 9.5)</td>
<td>4.7</td>
<td>(1.9, 11.3)</td>
<td>0.0</td>
<td>(5.0, 11.4)</td>
<td>0.0</td>
<td>(11.4)</td>
</tr>
<tr>
<td>Age and central obesity</td>
<td>0.0</td>
<td>(2.7, 11.7)</td>
<td>3.7</td>
<td>(0.3, 14.1)</td>
<td>0.0</td>
<td>(4.2, 11.5)</td>
<td>0.0</td>
<td>(11.5)</td>
</tr>
<tr>
<td>Age and physical activity</td>
<td>0.0</td>
<td>(2.5, 7.5)</td>
<td>4.6</td>
<td>(2.1, 11.3)</td>
<td>0.0</td>
<td>(6.4, 10.3)</td>
<td>0.0</td>
<td>(11.0)</td>
</tr>
<tr>
<td>Age and heavy alcohol intake</td>
<td>0.0</td>
<td>(2.8, 8.1)</td>
<td>3.7</td>
<td>(2.1, 11.5)</td>
<td>0.0</td>
<td>(5.5, 10.7)</td>
<td>0.0</td>
<td>(10.6)</td>
</tr>
<tr>
<td>Age and heavy intake of cured meats</td>
<td>0.0</td>
<td>(2.9, 8.0)</td>
<td>5.6</td>
<td>(1.9, 11.9)</td>
<td>0.0</td>
<td>(5.6, 10.7)</td>
<td>0.0</td>
<td>(11.4)</td>
</tr>
<tr>
<td>Age and height</td>
<td>0.0</td>
<td>(3.0, 7.9)</td>
<td>4.2</td>
<td>(2.1, 11.6)</td>
<td>0.0</td>
<td>(5.4, 10.7)</td>
<td>0.0</td>
<td>(11.0)</td>
</tr>
<tr>
<td>Age and father's social class</td>
<td>0.0</td>
<td>(3.3, 7.6)</td>
<td>3.1</td>
<td>(2.0, 11.9)</td>
<td>0.0</td>
<td>(5.1, 10.7)</td>
<td>0.0</td>
<td>(11.4)</td>
</tr>
<tr>
<td>Age and all factors</td>
<td>0.0</td>
<td>(3.5, 7.6)</td>
<td>2.5</td>
<td>(3.6, 10.7)</td>
<td>0.0</td>
<td>(5.1, 10.7)</td>
<td>0.0</td>
<td>(11.4)</td>
</tr>
</tbody>
</table>

* Percentage of the age adjusted prevalence difference in unskilled manual workers explained by the adjustment factors.
and hypertension is attributable to social mobility, as it is unlikely that the association between social class remains essentially stable after age 20–25 years. Likewise, education and hypertension is implausible because education may be associated with within-person blood pressure variability. This bias, if it existed, would have moved the association toward the null.

The association may have been underestimated because of survival bias. Hypertension is associated with the occurrence of cardiovascular diseases; because mortality from these diseases affects men in middle age, the probability of finding socioeconomic differences in hypertension in men who live past 60 is small. Mortality from cardiovascular diseases before age 60 is less frequent in women, therefore the effect of survival bias on the results in women was probably smaller. This underestimate may explain the lack of statistical significance in some results.

On the other hand, some 29% of those selected did not participate in the study. It is possible that persons with a low socioeconomic position could have had a lower response rate because more of them were sick or had hypertensive associated conditions. If this was the case, the associations would have been underestimated. However, there were no important differences between responders and a random sample of non-responders with respect to educational level.

DISCUSSION
Principal findings
The men and women in our study with low educational level and belonging to the low social class had a higher prevalence of hypertension than those with a high level of education and belonging to the high social class. The magnitude of the socioeconomic differences in the age-adjusted prevalence of hypertension is small, and in some cases the differences were not significant. However, the consistency of the results in men, on the one hand, and in women, on the other, suggests that the risk factors that explain the small socioeconomic variation in the prevalence of hypertension differ by sex. In men, the hypertension risk factors analysed did not explain the difference in prevalence by education, but they explained almost half of the difference in prevalence by social class. Social class in childhood was the risk factor that explained most of the excess prevalence of hypertension in those with low social class. In contrast, in women, these risk factors explained most of the differences in hypertension prevalence by education and a substantial part of the differences by social class. Central obesity, general obesity, and physical inactivity were the risk factors that played the most important part in this association.

Study limitations
This study is cross sectional, thus it is necessary to consider the possibility of reverse causality or survival bias. Reverse causality as an explanation for the association between education and hypertension is implausible because education remains essentially stable after age 20–25 years. Likewise, it is unlikely that the association between social class and hypertension is attributable to social mobility, as hypertension is usually an asymptomatic disease. Furthermore, in women the hypothesis of reverse causality can be ruled out in the results by social class, because most women were assigned to the husband’s social class.

The association may have been underestimated because of survival bias. Hypertension is associated with the occurrence of cardiovascular diseases; because mortality from these diseases affects men in middle age, the probability of finding socioeconomic differences in hypertension in men who live past 60 is small. Mortality from cardiovascular diseases before age 60 is less frequent in women, therefore the effect of survival bias on the results in women was probably smaller. This underestimate may explain the lack of statistical significance in some results.

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Strengths of the study
The results are derived from a representative sample of the population with a participation rate similar to or higher than that of other large epidemiological studies. The distribution of our population by age, sex, and educational level was similar to that of the sampling framework. The possibility that those who participated are healthier than persons in the general population would not affect our results, as it is highly unlikely that the association between socioeconomic position and hypertension is weaker or operates in the opposite direction among non-participants.

To our knowledge, this is the first study that has evaluated the part played by hypertension risk factors in the association between socioeconomic position during adulthood and the prevalence of hypertension in the elderly population. Furthermore, we incorporated central obesity, whereas most studies of this subject have used only body mass index as a measure of body fat.

We measured blood pressure up to 12 times throughout the day, using mercury and automated devices. We believe that this has minimised the possible misclassification bias associated with within-person blood pressure variability. This bias, if it existed, would have moved the association toward the null.

Comparison with other studies and probable explanations
Very few studies have evaluated the relation between socioeconomic position and the prevalence of hypertension in elderly persons, thus the possibilities of comparison with the results of other studies are limited. Nevertheless, the inverse relation seen between hypertension and socioeconomic position agrees with the findings of most studies carried out in the adult population in developed countries.

As was found in our study, the magnitude of the observed association in these investigations is small.

Policy implications
These results offer ample possibilities for policy interventions and for clinical practice in older women. However, the mechanisms that can explain the association among older men remain to be established.
Various studies have assessed the role of hypertension risk factors in this association and have found that these factors explain the socioeconomic gradient in hypertension. It has also been found that obesity is the risk factor that explains most of the association between socioeconomic position and hypertension.24 Most of these studies have focused exclusively on general obesity, despite the fact that central obesity shows a stronger correlation than general obesity with blood pressure and other cardiovascular risk factors, in both adults24 and the elderly.25 In our study, this high correlation between central obesity and blood pressure is clearly evident in women, as seen in the fact that it explains a larger part of the observed association than general obesity.

Some studies have found the magnitude of the association between socioeconomic position and hypertension to be lower in men than in women, and some have even found no association in men. These findings could be attributed to the fact that the socioeconomic gradient in obesity in men is smaller than in women, or to the absence of this gradient in men, as seen in some studies.26 In some places the relation between socioeconomic position and hypertension in men has emerged recently,23–25 and some authors point out that this has coincided with the emergence of the socioeconomic gradient in obesity.7 This hypothesis could explain the lack of significant differences in hypertension prevalence by social class in men, as neither general obesity nor central obesity showed an association with social class in men.

The lack of variation in the obesity measures by socioeconomic position in men is not the only factor that explains the different results found in men and women. Some risk factors probably have a different effect on hypertension in men and women. For example, physical inactivity shows an important socioeconomic variation in men and women, but does not explain the socioeconomic differences in hypertension prevalence in men. This is also the case of social class in childhood, which is the risk factor that explains the largest part of the difference in hypertension prevalence between low and high social class in men. A previous study in this population found that low social class in childhood is associated with a higher prevalence of hypertension in men, but not in women.26 The strong association observed between social class in childhood and social class in adulthood is undoubtedly responsible for this finding.

Other factors not measured in this study are probably responsible for the results found in men. This requires further investigation of hypertension risk factors not included in our study. Some of these factors could be the psychosocial stressors.15 An increase in blood pressure has been shown in different situations of prolonged exposure to psychological demands when the possibilities for controlling the situation are perceived as limited.27 Various epidemiological studies support the idea that psychosocial stress among persons in low socioeconomic strata contribute to differences in blood pressure.28–30 There are some life events that can increase stress in elderly persons. One such event is retirement.16 In our study this event would have affected only the men, as the employment rate in the cohort of women studied was low. In theory, better educated and higher occupational class subjects would experience the greatest loss after retirement because they have more job involvement together with greater autonomy and decision making capacity. This could explain the small differences in hypertension prevalence by socioeconomic position in men. However, the sense of control in better educated and higher class older men is probably greater than in less well educated and working class subjects, because they have more resources that allow them to adapt to the change. On the other hand, women may experience increased stress when their husbands retire because of having to cope with their spouses at home and having to manage on a reduced income, which could partly explain the differences in hypertension prevalence by socioeconomic position in women.

In summary, a recent review of socioeconomic status and hypertension concludes that there is little evidence that socioeconomic level increases hypertension through mechanisms other than the known risk factors.7 Our study shows that the socioeconomic differences in hypertension prevalence in an elderly population are small, and suggests that in women the direct effect of socioeconomic status on hypertension is practically absent in the case of education and is small in the case of social class. The same situation does not occur in men, for whom most of the effect of education and half of the effect of social class on hypertension is direct or, at least, is not explained by the risk factors analysed. These results offer possibilities for policy interventions and for clinical practice in older women. They also suggest the need to study whether interventions aimed at increasing physical activity and promoting weight loss can successfully reduce socioeconomic differences in these risk factors. However, the mechanisms that can explain the association among older men remain to be established.

CONTRIBUTORS
E Regidor and JL Gutiérrez-Fisac formulated the hypothesis. All authors contributed to the analysis, data interpretation, and writing of this study. E Regidor is the guarantor of the article.

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Conflicts of interest: none declared.

Ethical approval for the use of these data was not required.

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