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CLINICAL RESEARCH

Changes in blood pressure in a large cohort of elderly individuals: Study 3C

Évolution de la pression artérielle dans une large cohorte de personnes âgées : l'étude 3C

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Regression towards the mean

Summary
Objective. — Analysis of changes in blood pressure with a two-year interval, and of factors associated with this change, in a large cohort of elderly individuals.
Methods. — Follow-up of a cohort of 9294 individuals aged 65 years and over recruited from the general population for Study 3C. Changes in blood pressure are defined as the difference in its averages between the inclusion visit and the follow-up visit at 2 years. The factors associated with changes in systolic blood pressure were identified by univariate and multivariate analyses.
Results. — Systolic and diastolic blood pressure decreased on average by 7.60 mmHg and 4.45 mmHg respectively in 7659 individuals included in the study between the initial measurement and the follow-up at 2 years. The analyses revealed that the initial high blood pressure level was the main factor for this decrease that would be explained by a phenomenon of regression towards the mean.
Conclusion. — These results confirm the importance of repeating blood pressure measurements during several examinations for a good estimate of individual blood pressure values in this age range. It is also important to consider this phenomenon in studies including specific blood pressure estimates only.

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MOTS CLÉS
Pression artérielle ;
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Traitement antihypertenseur ;
Régression vers la moyenne

Résumé
Objectif. — Analyse de l'évolution de la pression artérielle à deux ans d'intervalle, ainsi que des facteurs associés à cette évolution, dans une grande cohorte de personnes âgées.
Méthodes. — Suivi d'une cohorte de 9294 personnes âgées de 65 ans et plus recrutées en population générale pour l'étude 3C. L'évolution de la pression artérielle est définie par la différence de ses moyennes entre la visite d'inclusion et celle de suivi à deux ans. Les facteurs associés à l'évolution de la pression artérielle systolique ont été systématiquement recherchés par analyses uni- et multivariées.
Résultats. — Chez les 7659 personnes incluses dans l'étude, la pression artérielle a diminué en moyenne de 7,60 mmHg pour la systolique et de 4,45 mmHg pour la diastolique entre l'examen initial et le suivi à deux ans. Les analyses montrent que le niveau initial élevé de pression artérielle est le facteur principal de cette diminution qui serait donc principalement expliquée par un phénomène de régression vers la moyenne.
Conclusion. — Ces résultats confirment l'importance de répéter les mesures de la pression artérielle lors de plusieurs examens pour une bonne estimation des chiffres individuels de pression artérielle dans cette tranche d'âge. Il est également important de tenir compte de ce phénomène dans les études ne comportant que des estimations ponctuelles de la pression artérielle.

Introduction

Vascular diseases, and more specifically cerebrovascular accidents, in the elderly are a major cause of mortality and handicap [1].

Hypertension is the most significant modifiable risk factor of these diseases [2]. Estimating its frequency, understanding its determinants, its detection and management are therefore part of the important public health challenges in a society like ours in which life expectancy increases regularly.

The baroreflex alters with ageing, leading to a significant increase in blood pressure variability [3]. This increased variability can be reflected by a pressure increase when measured by a professional (''white coat hypertension'' effect) or a decrease sometimes masking hypertension. Ageing also leads to increased arterial rigidity of the vascular wall, which increases systolic blood pressure and decreases or stabilises diastolic blood pressure [4]. Nevertheless, the impact of these various phenomena on blood pressure changes in time involving large samples of elderly individuals is not widely known.

In this study, we analysed changes in blood pressure between the inclusion visit and the follow-up visit at 2 years in a cohort of elderly individuals aged 65 years and over recruited from the general population, namely the Three-Cities Study (Study 3C) [5], and the factors associated with these changes.

Participants and methods

Study population

The participants of Study 3C were recruited between March 1999 and March 2001 from three French cities, namely Bordeaux, Dijon and Montpellier. They were healthy volunteers, aged 65 years and over, invited from electoral lists to participate in the study, and asked to return 2 years after inclusion. Everyone gave a written consent after the study protocol was approved by the Ethics Committee of the Hôpital de Bicêtre.

Collected data

The data collected initially and during the follow-up included the sociodemographic characteristics, the consumption of alcohol and tobacco, the main present and past medical events, medical management and the use of medications.

Among the sociodemographic variables, our analysis considered age (from 65 to 74 years, from 75 to 84 years and $\geq$ 85 years), gender, the number of years within the study (< 10 years and $\geq$ 10 years) and lifestyle.

The body mass index (BMI) was calculated from the weight and height measured during examination (in kg/m^2), and obesity was defined by a BMI greater or equal to 30 kg/m^2. Biochemistry parameters including serum cholesterol and fasting blood glucose levels were determined: diabetes was defined by a blood glucose level greater or equal to 7 mmol/l (1.26 g/l) or the use of diabetic treatment, and hypercholesterolaemia was defined by a cholesterol level greater or equal to 7.25 mmol/l (2.80 g/l) or the use of lipid-lowering treatment.

The list of medications taken regularly during the previous month was determined from the boxes of medications and prescriptions. These medications were coded according to the French translation of the Anatomical Therapeutical Chemical (ATC) classification of the World Health Organisation (WHO). Concerning the consumption of alcohol and tobacco, the participants were classified as current consumers on the one hand, and non- or former consumers on the other. The history of vascular diseases (myocardial infarction, chest angina, and cerebrovascular accidents) and the vascular risk factors (hypertension, hypercholes-

terolaemia and diabetes) were determined by asking the patient.

The period since the last blood pressure measurement was divided into two parts (less than one month and one month or more) and the consultation frequency with a general practitioner was divided into three parts (at least every 2 months, 3 or 4 times a year and 0 to twice a year).

Blood pressure: measurement and definition of variables

During inclusion and follow-up, blood pressure was measured twice at each individual's home after 5 minutes in a seating position using a standard cuff placed around the right arm and an electronic monitor, the OMRON M4, validated by the British Hypertension Society and the Agence française de sécurité sanitaire des produits de santé (French health product safety agency). We used the average of both blood pressure measurements in the analyses, noted as SPB for systolic pressure and DPB for diastolic pressure. SBP values were divided into four classes (< 140 mmHg, 140 to 159 mmHg, 160 to 179 mmHg and $\geq$ 180 mmHg). Pulse pressure (PP) was defined as the difference between the SBP and the DBP.

A participant had to have at least one blood pressure measurement at the initial visit and at the two-year follow-up to be eligible for the study.

Individuals without a blood pressure measurement at the initial visit, or at the two-year follow-up, and individuals not seen at 2 years (deceased or lost to follow-up) were excluded.

High blood pressure (HBP) was defined as a SBP above or equal to 140 mmHg and/or a DBP above or equal to 90 mmHg. Persons were considered hypertensive, if the blood pressure was high or if they were taking an antihypertensive treatment, unless this was being given for a cardiac disease other than hypertension as defined in a previous article [6].

The HBP thresholds are those recommended by the WHO for the management of hypertension in adults [7] but we also performed analyses with higher thresholds (160/95 mmHg) still used for elderly individuals: as the general interpretation remained unchanged, we will only present the results with the WHO definition of hypertension.

The variable of main relevance was the difference in blood pressure measurements between the two-year visit and the inclusion visit, noted as BP_2-BP_0, and calculated for SBP, DBP and PP. An increase in blood pressure between both visits therefore corresponded to a positive value in this difference.

Since SBP is a better vascular risk predictor in the elderly individual [8], we detailed changes in SBP and the associated factors.

Analysis plan

The characteristics at inclusion were described, and then compared with those of the non-included group so as to identify any possible bias.

The averages of the initial and two-year blood pressure measurements (SBP, DBP, PP), and of their differences between inclusion and follow-up at 2 years, were studied.

The change in SBP was analysed by considering several factors, namely age, gender, years of study, lifestyle, obesity, diabetes, hypercholesterolaemia, consumption of tobacco and alcohol, history of cardiovascular diseases, period since the last blood pressure measurement, frequency of consultations with general practitioner, blood pressure at inclusion and antihypertensive treatment at the initial visit or at the follow-up visit at 2 years [7–10].

In order to better understand the respective roles of the blood pressure level and the antihypertensive treatment (at inclusion and 2 years later), we performed a strata analysis with crossover of these variables.

We simultaneously analysed the roles of the different variables on the changes in SBP using step-by-step multiple linear regression arranged in ascending order: the explicative variables were those with a clinical meaning, namely age, gender, lifestyle, diabetes and history of cardiovascular diseases, antihypertensive treatment and SBP level at inclusion.

Changes in PP within the 2 years following inclusion were also studied but since the general interpretation was unchanged, we only present the results with SBP.

A $p < 0.05$ value was considered significant. The statistical analysis was performed using the SAS version 9.1 software (SAS Institute, Cary, NC, United States).

Results

Characteristics of the sample

Out of 9294 participants in the 3C Study, 371 with no blood pressure measured at the initial visit were excluded from the analysis. At the follow-up visit of 2 years, 1264 participants (including 25 deceased) had no measure of their blood pressure and were also excluded. In total, the sample included 7659 participants (Fig. 1).

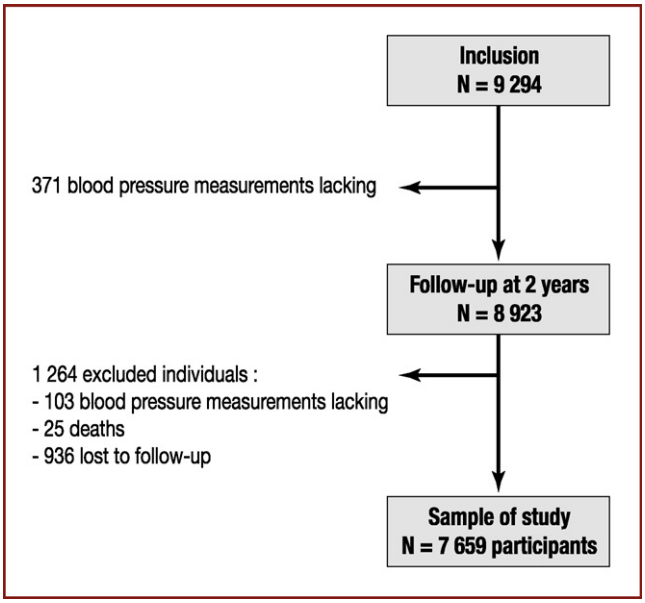

Figure 1. Participants in study on the changes in blood pressure between the inclusion visit and the follow-up visit at 2 years.

The characteristics of the sample at inclusion are detailed in Table 1: the average age was 74 years, 61% of participants were women, 13% were obese, 10% were diabetic and 9% had a history of cardiovascular diseases.

The average blood pressure was 146.5/82.3 mmHg and the average PP was 64.5 mmHg. Close to half of participants received an antihypertensive treatment and over three quarters had hypertension according to the convention indicated earlier.

The comparisons of the sample with the non-included individuals revealed that the latter were older (76.1 [standard deviation = 6.1] vs 74.2 [5.4] years, $p < 0.0001$) and had a higher vascular risk: more diabetes (15% vs 10%), more hypertension (81% vs 77%) and greater history of cardiovascular diseases (13% vs 9%).

Variations in blood pressures

Between the two-year visit and the initial visit, we observed a decrease of 7.60 mmHg in SBP and 4.45 mmHg in DBP (Table 2). The corresponding PP drop was 3.15 mmHg. This SBP drop was observed in all strata defined in the analysis plan (Table 3): it appeared to increase with age and the presence of obesity. The factor associated with the greatest SBP variability was the initial blood pressure rate; thus, the SBP increased by 1.17 mmHg in those with an initial SBP rate below 140 mmHg, and decreased in all other strata, down by 30 mmHg in those with an initial SBP above 180 mmHg (Table 3).

The use of an antihypertensive treatment (upon inclusion in the study or 2 years later) was also associated with a decrease in SBP during follow-up. To continue exploring these results, we studied the SBP variation by looking at the combinations of blood pressure rate upon inclusion with the use of an antihypertensive treatment.

Impact of the initial blood pressure rate and antihypertensive treatment on the changes in blood pressure

In normotensive participants upon inclusion in the study (SBP $\leq$ 140 mmHg and DBP $\leq$ 90 mmHg) and not taking any treatment, the SBP was practically unchanged during follow-up in those still not taking an antihypertensive treatment ($SBP_2 - SBP_0 = 0.08$ mmHg, Table 4). However, when a treatment was initiated, we observed an average SBP decrease of approximately 4.3 mmHg. In normotensive participants

Table 1 Characteristics of sample.

	N = 7659
Sociodemographic factors	
Average age (standard deviation) (Years)	74.0 (5.4)
Age group (%)	
65—74	57.2
75—84	38.1
≥ 85	4.7
Men (%)	39.0
Years of study ≥ 10 years (%)	39.5
Lifestyle (%)	
Alone	36.1
In relationship	60.2
Other	3.7
Medical history and cardiovascular risk factors	
Obesity[a] (%)	12.7
Diabetes[b] (%)	9.6
Hypercholesterolaemia[c] (%)	37.7
Current smokers (%)	5.3
Current drinkers (%)	80.6
Cardiovascular diseases[d] (%)	9.2
Medical management	
Last blood pressure measurement under 1 month ago (%)	61.4
Frequency of consultation with general practitioner (%)	
At least twice monthly	36.2
3 to 4 times a year	39.6
0 to twice a year	24.2
Antihypertensive treatment (%)	48.8
Blood pressure average upon inclusion (standard deviation) (mmHg)	
SBP	146.5 (21.7)
DBP	82.3 (11.3)
PP	64.5 (16.8)
Hypertension[e] upon inclusion (%)	77.1

[a] Body mass index ≥ 30 kg/m^2.
[b] Blood glucose ≥ 7 mmol/l (1.26 g/l) or diabetes treatment.
[c] Cholesterol level ≥ 7.25 mmol/l (2.80 g/l) or lipid-lowering treatment.
[d] Surgery of leg arteries if arteritis, cerebrovascular accident, myocardial infarction and heart surgery.
[e] Systolic blood pressure ≥ 140 mmHg and diastolic blood pressure ≥ 90 mmHg or antihypertensive treatment.

Table 2 Blood pressure averages and their differences between follow-up at 2 years (BP_2) and inclusion (BP_0).

	BP_0	BP_2	$BP_2 - BP_0$
SBP (SD) in mmHg; [range]	146.5 (21.7) [85.5; 261.0]	138.9 (21.0) [71.0; 240.5]	−7.60 (19.80) [−98.00; 79.50]
DBP (SD) in mmHg; [range]	82.3 (11.3) [50.5; 154.0]	77.9 (11.1) [42.5; 159.5]	−4.45 (11.16) [−70.00; 89.50]
PP (SD) in mmHg; [range]	64.5 (16.8) [15.0; 138.5]	61.1 (16.1) [17.0; 147.5]	−3.15 (15.26) [−93.50; 66.00]

Average in mmHg (standard deviation) [range]. SBP: Systolic blood pressure; DBP: Diastolic blood pressure; PP: Pulse pressure.

Table 3 Factors associated with the difference in systolic blood pressure between the follow-up at 2 years (SBP_2) and inclusion (SBP_0).

	SBP_2-SBP_0
Age group (years)	
65-74	−7.28 (18.62)
75-84	−7.86 (21.11)
≥ 85	−9.40 (23.28)
Gender	
Woman	−7.77 (19.85)
Man	−7.49 (19.84)
Years of study	
< 10 years	−7.60 (20.25)
≥ 10 years	−7.59 (19.23)
Lifestyle	
Alone	−7.10 (20.20)
In relationship	−7.92 (19.54)
Obesity[a]	
No	−7.42 (19.61)
Yes	−8.89 (21.09)
Diabetes[b]	
No	−7.62 (19.65)
Yes	−7.12 (21.55)
Hypercholesterolaemia[c]	
No	−7.35 (19.51)
Yes	−7.91 (20.36)
Consumption of tobacco	
Current smokers	−7.68 (19.93)
Non- or former smokers	−6.13 (18.31)
Consumption of alcohol	
Current drinkers	−7.44 (19.75)
Non- or former drinkers	−8.25 (20.21)
Cardiovascular diseases[d]	
No	−7.50 (19.61)
Yes	−8.55 (22.05)
Period since last blood pressure measurement	
< 1 month	−7.28 (20.20)
≥ 1 month	−8.11 (19.22)
Frequency of consultation with general practitioner	
At least once or twice/month	−7.02 (21.22)
3 to 4 times/year	−8.44 (19.54)
Never or less than twice/year	−7.09 (18.11)
Systolic blood pressure upon inclusion	
< 140 mmHg	1.17 (16.83)
140−159 mmHg	−7.91 (17.15)
160−179 mmHg	−17.30 (18.62)
≥ 180 mmHg	−30.04 (21.30)
Antihypertensive treatment upon inclusion	
No	−6.88 (18.01)
Yes	−8.36 (21.58)
Antihypertensive treatment at 2 years	
No	−5.11 (17.21)
Yes	−9.69 (21.59)

Average in mmHg (standard deviation).
[a] Body mass index ≥ 30 kg/m^2.
[b] Blood glucose ≥ 7 mmol/l (1.26 g/l) or diabetes treatment.
[c] Cholesterol level ≥ 7.25 mmol/l (2.80 g/l) or lipid-lowering treatment.
[d] Surgery of the leg arteries if arteritis, cerebrovascular accident, myocardial infarction and heart surgery.

on antihypertensive treatment — controlled hypertensives — the SBP increased by approximately 3.5 mmHg 2 years later, and as expected, this increase was higher in those who had discontinued an antihypertensive treatment (SBP_2-SBP_0 = 7.2 mmHg) than in those still taking the treatment ($SBP_2 - SBP_0$ = 3.2 mmHg).

Among the individuals with an initial HBP, the SBP decreased at 2 years in both those who had an antihypertensive treatment upon admission to the study (−12.2 mmHg) and those without treatment (−13.6 mmHg). In both these groups, the decrease was more significant with an antihypertensive treatment at 2 years. Finally, we should emphasize that the blood pressure drop in this group with a HBP upon inclusion was regardless of the use of an antihypertensive treatment during follow-up, and this is witnessed in those without antihypertensive treatment upon inclusion (−10.5) as much as in those with treatment (−7.5) (Table 4).

Factors associated with a SBP variation in multivariate analysis

Table 5 presents the multiple linear regression results applied to changes in SBP after adjusting for the center. The Student's *t* test result is provided for each coefficient.

The variables associated with a SBP increase during follow-up are age, diabetes, antihypertensive treatment upon inclusion and gender. However, initial increased SBP, history of cardiovascular diseases and relationship lifestyle were associated with a drop in blood pressure.

Discussion

Study 3C was conducted among the general population in individuals aged 65 years and over, volunteers who were not in-patients, and perhaps more concerned with their health and in a better general condition than the entire population of elderly individuals as they experienced good medical management (frequent consultation with a general practitioner, regular measurement of blood pressure, antihypertensive treatment).

Table 4 Difference in blood pressure between follow-up at 2 years (SBP_2) and inclusion (SBP_0) according to the pressure rate at inclusion and antihypertensive treatment at inclusion and at 2 years.

Upon inclusion	Follow-up at 2 years		
	Total	Without treatment	With treatment
SBP < 140 mmHg and DBP < 90 mmHg			
Without treatment numbers (%)	1753 (22.9)	1594 (20.8)	159 (2.1)
SBP_0	124.9 (10.5)	124.8 (10.6)	125.9 (9.6)
SBP_2	124.6 (16.5)	124.9 (16.5)	121.6 (16.4)
SBP_2-SBP_0	−0.31 (15.36)	0.08 (15.21)	−4.29 (16.27)
With treatment numbers (%)	1149 (15.0)	93 (1.2)	1056 (13.8)
SBP_0	127.1 (9.9)	123.1 (11.0)	127.4 (9.7)
SBP_2	130.6 (18.0)	130.3 (18.8)	130.6 (18.0)
SBP_2-SBP_0	3.52 (18.54)	7.18 (18.68)	3.19 (18.51)
SBP ≥ 140 mmHg or DBP ≥ 90 mmHg			
Without treatment numbers (%)	2169 (28.3)	1714 (22.4)	455 (5.9)
SBP_0	157.1 (15.6)	155.3 (14.1)	163.9 (18.8)
SBP_2	144.9 (18.7)	144.9 (17.9)	145.2 (21.8)
SBP_2-SBP_0	−12.19 (18.26)	−10.47 (16.92)	−18.66 (21.41)
With treatment numbers (%)	2588 (33.8)	95 (1.2)	2493 (32.6)
SBP_0	161.0 (16.7)	158.2 (16.2)	161.1 (16.7)
SBP_2	147.4 (20.4)	150.7 (21.9)	147.2 (20.3)
SBP_2-SBP_0	−13.63 (20.72)	−7.47 (19.97)	−13,86 (20.72)

Average in mmHg (standard deviation); SBP: Systolic blood pressure; DBP: Diastolic blood pressure.

Measurement of blood pressure upon inclusion and at 2 years

There was little difference between the two blood pressure measurements at inclusion and the two-year follow-up visit, and the average of these two measurements was calculated automatically so as to have a low variance of accuracy.

Representativeness of the sample

The individuals included in our study presented with an average blood pressure at inclusion of 146.54/82.30 mmHg, which was higher than that (122.9/72.1 mmHg) measured in an American study involving adults from the general population [9], but only 2.65% of patients studied had grade 3 blood pressure (SBP ≥ 180 and DBP ≥ 110 mmHg). However, the prevalence of hypertension in these individuals (77.11%) was comparable to that (76%) seen in a survey conducted among French general practitioners [11] involving a population of the same age.

The 3C individuals ''not included'' in our study had no higher blood pressures than those included, despite having a greater cardiovascular risk (advanced age, diabetes, smoking, cardiovascular diseases — myocardial infarction, heart surgery (bypass), coronary angioplasty (dilation), surgery to leg arteries if arteritis, cerebrovascular accident — and hypertension).

Factors associated with variation in blood pressure observed 2 years after inclusion

The multifactorial study revealed that age, diabetes and hypertension treatment at inclusion were significantly associated with a SBP increase, while gender, history of cardiovascular diseases, hypertension treatment at 2 years and initial blood pressure were significantly associated with a SBP decrease.

Table 5 Multivariate analysis of factors associated with changes in systolic blood pressure between inclusion and follow-up at 2 years.

Variables	Multiple regression coefficients	p^*
Constant	−9.74	0.001
Age	0.11	0.004
Man	3.61	< 0.0001
Diabetes[a]	2.27	0.001
Relationship lifestyle	−1.67	0.0003
Cardiovascular diseases[b]	−2.12	< 0.001
Antihypertensive treatment upon inclusion	1.25	0.003
Systolic blood pressure upon inclusion < 140 mmHg		
140—159 mmHg	−9.47	< 0.0001
160—179 mmHg	−18.78	< 0.0001
≥ 180 mmHg	−31.61	< 0.0001

* p: probability adjusted for the center.
[a] Blood glucose ≥ 7 mmol/l or diabetes treatment.
[b] Surgery of the leg arteries if arteritis, cerebrovascular accident, myocardial infarction and heart surgery.

Age

SBP increases significantly with age, which has already been observed [12], and results from age correlations with antihypertensive treatment (at inclusion and at 2 years), history of cardiovascular disease and obesity.

Diabetes and cardiovascular history

SBP increases with diabetes but decreases with history of cardiovascular diseases, consistent with an American study in which diabetic patients were not significantly better controlled and patients with a history were better controlled [6,9].

Gender

SBP decreases more dramatically in women than men, as opposed to the result [13] that found no significant difference in control with gender, but according to an observation on blood pressure measurements at inclusion only [6] when women were better controlled than men.

Possible causes of variation in blood pressure

Overall, blood pressure was lower after 2 years in included individuals, without any significant variation in the heart rate (HR in bpm = 70.0 [10.7] at inclusion vs 69.9 [11.1] after 2 years).

In normotensive individuals (treated or not at inclusion and treated or not 2 years later), the average SBP was stable from inclusion to 2 years: its variation was at most 7 mmHg, a value that corresponds with a seemingly normal increase in a patient treated at inclusion but not at 2 years.

In hypertensive individuals treated at 2 years, and treated or not at inclusion, SBP decreased, which may result from an antihypertensive treatment since the most significant decrease was observed in the cases not treated at inclusion.

In hypertensive individuals not treated at 2 years but treated at inclusion, SBP decreased, which may be explained by diet and physical activity.

Finally, in hypertensive individuals treated neither at 2 years or inclusion, SBP also decreased a little (average variation of 10 mmHg), which may be partly explained by an overestimation of blood pressure at the inclusion visit.

We therefore observed that SBP decreased in hypertensive individuals, all the more so when the initial blood pressure was higher.

A first explanation is a variation in the measurement method. Nevertheless, all BP measurements were performed at home by investigators using an automatic BP measuring device. They first trained on several occasions on the BP measuring method with this type of device by using a booklet summarising the main points. As the study progressed, we also compared the BP values measured by the different investigators without noting any significant difference between the average BP values taken by each investigator. It is therefore unlikely that the changes in BP figures may be related to a measurement error.

A second explanation for the SBP decrease could be offered by the hypertensive individuals with no initial treatment and the intervention of a practising physician. The practising physician having found an increase SBP may have placed the patient on treatment. Treatment compliance was important with our participants because elderly individuals generally tend to be more persistent with their treatment and to tolerate its side effects [14].

If the patient was already receiving a treatment, the practising physician may have also encouraged the regular use of a current treatment, enabling to improve compliance. However, this is not a major explanation as the most significant blood pressure decrease was observed in patients with no initial treatment or two-year treatment.

A third explanation is that SBP was overestimated at the inclusion visit by the ''white coat hypertension'' effect: blood pressure in the elderly increases due to the apprehension created by the visit of an unknown person and inclusion in a study, and this effect would be weakened at 2 years because the elderly individual would find themselves in a familiar situation.

A fourth explanation, valid for all hypertensive individuals, is that the health and diet practices usually recommended by the French national health authority (HAS) [15] (decrease consumption of salt and meat, increase physical exercise), which were not encouraged by the Study 3C, may have been recommended by general practitioners. These practises are actually not always beneficial to elderly individuals, who sometimes prefer to restrict themselves to health and dietary advices. Nevertheless, we did not observe any behavioural change in diet or physical activity in this cohort. In addition, these practices could have led to a weight loss, which was not observed in the patients studied (weight in kg 67.4 [12.8] at inclusion and 67.5 [13.1] after 2 years).

One last explanation is provided by the phenomenon of regression towards the mean [16], very well-known in the field of hypertension: this effect, which appears when extreme values (very high or very low) are numerous at the first measurement, and which is purely statistical because related to the intra-individual variability [15], enables to understand that the very high (or very low) values will be closer to the mean value by decreasing (or by increasing). This explanation completes the previous ones, particularly because the regression towards the mean may have followed the ''white coat hypertension'' effect.

Since blood pressure variability is more intense in elderly individuals [17], the age of people monitored in the cohort may have contributed to the increase in this phenomenon: the emphasis of BP decrease with age observed in this study is suggestive of this hypothesis. We could then assume that the BP measurement in elderly individuals, due to a more significant apprehension during the inclusion visit, was overestimated. The BP drop during follow-up would then be a return to the usual values for these participants.

These results confirm the importance of measuring BP at different times before establishing a diagnosis of hypertension in an elderly individual. They also call for careful observation of the results from studies in which this repeated measurement is impossible to perform for practical reasons, specifically studies involving large groups of individuals like epidemiological studies or therapeutic trials. Ignoring this phenomenon would lead to overestimating the frequency of hypertension or the efficacy of therapeutic measures in elderly individuals.

Conclusion

This study revealed a strong blood pressure variability in 7659 participants aged 65 years and over from the inclusion visit to the follow-up visit at 2 years: mainly, treatment for hypertension during inclusion was associated with a small increase in blood pressure (when there was no treatment at 2 years) while ongoing treatment noted at the two-year follow-up was associated with a notable decrease, which justified hypertension treatment of the elderly individual.

These results are explained by a combination of different phenomena (mainly the ''white coat hypertension'' effect and the regression towards the mean) and it is impossible to differentiate these phenomena with the data available.

While descriptive, this study highlights the clinical significance of reliable blood pressure measurement: the results underline the need to multiply measurements in elderly individuals because every isolated blood pressure measurement risks being biased. It is therefore essential to repeat the measurement at relatively short time intervals (two visits spaced out by a few days) to establish blood pressure accurately.

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