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Blood pressure control and complex health conditions in older adults : impact of recent hypertension management guidelines

Daniela Anker, MSc[a,b], Brigitte Santos-Eggimann, MD MPH DrPH[c], Marcel Zwahlen, PhD[d], Valérie Santschi, PharmD, PhD[e], Nicolas Rodondi, MD[a,f], Christina Wolfson, PhD[b], Arnaud Chiolero, MD PhD[a,b,g]

[a]Institute of Primary Health Care (BIHAM), University of Bern, Switzerland; [b]Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Montréal, Canada; [c]Center for Primary Care and Public Health (Unisanté), University of Lausanne, Switzerland; [d]Institute of Social and Preventive Medicine (ISPM), University of Bern, Switzerland; [e]La Source, School of nursing sciences, HES-SO University of Applied Sciences and Arts Western Switzerland, Switzerland; [f]Department of General Internal Medicine, Inselspital, Bern University Hospital, University of Bern, Switzerland; [g]Population Health Laboratory (#PopHealthLab), University of Fribourg, Switzerland

Corresponding author: Daniela Anker MSc, Institute of Primary Health Care (BIHAM), University of Bern, Switzerland; e-mail: daniela.anker@biham.unibe.ch

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Summary

The American College of Cardiology and the American Heart Association (ACC/AHA) 2017 guidelines for hypertension management lowered blood pressure (BP) thresholds to 130/80 mmHg to define hypertension while the European Society of Cardiology and the European Society of Hypertension (ESC/ESH) 2018 guidelines retained 140/90 mmHg. Both guidelines recommend adapting management for older patients with complex health conditions, without however clear indications on how to adapt. Our aims were to assess the impact of lowering BP thresholds on the prevalence of elevated BP and BP control, as well as the proportion of participants with a complex health condition across these BP categories. We used data from 3210 participants in the Lausanne cohort Lc65+ aged between 67 and 80 years. Hypertension diagnosis and antihypertensive medication use were self-reported. BP was measured three times at one visit. Some 51% of participants reported having hypertension and 44% reported taking antihypertensive medication. Compared with ESC/ESH thresholds, the prevalence of measured elevated BP was 24% percentage points higher and BP control was 24% percentage points lower using ACC/AHA thresholds. About one out of two participants with elevated BP and four out of five participants with uncontrolled BP had a complex health condition, i.e. frailty, multimorbidity or polypharmacy. To comply with ACC/AHA guidelines, considerable effort would be required to reach BP control. This is a serious challenge because a large share of hypertensive older adults have complex health conditions, a type of patients for whom there is no strong evidence on how to manage hypertension.

Summary table

What is known about the topic

- The American College of Cardiology and the American Heart Association (ACC/AHA) 2017 guidelines for hypertension management lowered blood pressure (BP) thresholds to 130/80 mmHg to define hypertension
- The European Society of Cardiology and the European Society of Hypertension (ESC/ESH) 2018 guidelines retained 140/90 mmHg
- Guidelines advise to adapt hypertension management for older patients with complex health conditions

What this study adds

- Among older adults (67 to 80 years), compared with ESC/ESH thresholds, the prevalence of elevated BP was 24% percentage points higher (39 vs 63%) and BP control was 24% percentage points lower (56 vs 32%) using ACC/AHA guidelines.
- About one out of two participants with elevated BP and four out of five participants with uncontrolled BP had a complex health condition.
- To comply with ACC/AHA guidelines, considerable effort would be required to reach BP control, a serious challenge especially with the frequent occurrence of complex health conditions among hypertensive older adults.

Introduction

Recent American and European hypertension management guidelines have proposed different blood pressure (BP) thresholds to define hypertension as well as different targets for BP control. In 2017, the American College of Cardiology and the American Heart Association (ACC/AHA) guidelines lowered the BP thresholds from 140/90 mmHg to 130/80 mmHg [1] (**Table 1**). The European Society of Cardiology and the European Society of Hypertension (ESC/ESH) guidelines 2018 retained the previous thresholds of 140/90 mmHg to define hypertension [2]. While the absolute health risk associated with a given level of BP increases substantially with age [3, 4], neither of these guidelines proposed specific thresholds for older adults.

Several studies have quantified the impact of lowering BP thresholds to 130/80 mmHg for the definition of hypertension in the general population, but only few had a specific focus on older adults [5, 6]. Nonetheless, the impact of lowering BP thresholds may be of major concern in older adults for several reasons. First, the prevalence of hypertension increases with age and is already high among older adults, reaching up to 75% in individuals aged 75 years and more [3]. Additionally, BP control rates are not satisfactory with current BP thresholds [3], hence, with the ACC/AHA threshold at <130/80 mmHg, BP control would be even more difficult to reach [7]. Second, there is still a strong debate around hypertension management in older adults, and the benefit-harm balance of targeting a BP below the ACC/AHA thresholds remains uncertain.

Compared to middle-aged adults, older adults are at higher risk for cardiovascular disease (CVD) and a given BP reduction has a larger effect on CVD absolute risk reduction [8]. The

recent SPRINT trial confirmed the benefit of targeting a relatively low BP among older adults [9]. However, whether the results of the SPRINT trial can be applied to the general population of older patients has been highly debated [10], especially for older adults with complex health conditions, such as frailty, multimorbidity and polypharmacy. These uncertainties are mainly due to several studies, which have shown an increased risk of hypotensive-related falls, and cognitive and physical decline in the oldest-old and frail older adults with low BP [11-13]. As a result, general warnings to adapt management were included for older patients with complex health conditions in both guidelines.

Using data from a large population-based study of older adults [14], we assessed 1) the impact of lowering BP thresholds on the prevalence of elevated BP and on BP control, and 2) the proportion of complex health conditions among those with elevated and uncontrolled BP.

Methods

Population and data collection

We used data collected between 2014 and 2016 from participants in the Lausanne cohort Lc65+ who had complete data on systolic and diastolic BP [14]. The Lausanne cohort Lc65+ is an ongoing population-based observational study investigating the health in individuals aged 65 years and more. The cohort consists of three samples recruited upon written consent at 5 year intervals (2004, 2009, and 2014). For the recruitment of each sample, the Population Office of the city of Lausanne [15] was requested to extract a list of all residents born in a specific 5 year range (2004: sample 1, birth year 1934-1938; 2009: sample 2, birth year 1939-1943; 2014: sample 3, 1944-1948). The Population Office of the city of Lausanne is part of

the civil registration system of Switzerland; residents have to register moves to and moves away from Lausanne, as well as any changes in address.

A random selection of about two thirds of the extracted and eligible population was invited by mail to participate in the study [16]. Exclusion criteria were residency in a nursing home and inability to answer questionnaires due to advanced dementia. The study protocol of the cohort was approved by the Ethics Committee of the Faculty of Biology and Medicine of the University of Lausanne in Switzerland [14]. For this analysis, we used data collected at the most recent data collection for each of the three samples, that is, in 2014, 2016 and 2015 for sample 1, sample 2, and sample 3, respectively. The specific time points for data collection for each variable are summarized elsewhere [17].

Data on hypertension diagnosis and antihypertensive medication use were self-reported. BP was measured at the study center by research assistants using a standardized protocol. BP was measured after 10 to 20 minutes rest three times during one visit at 5 to 10 minute intervals using a clinically validated oscillometric automated device (Omron® 907 (HEM-907-E) digital automatic blood pressure monitor)) [18, 19]. An auscultatory method with an Erkameter 3000® mercury tensiometer and a Duophon® or a Littmann® stethoscope was used if the participants had heart rhythm abnormalities. BP measurements were made with cuffs for various mid-arm circumferences (17-22cm, 22-32 cm and 32-42 cm) on the left arm, unless for some medical reasons they had to be done on the right. During BP measurements, participants were asked to relax and sit in a comfortable position, with their back supported, left arm resting at the level of the heart on a support, and the palm of the hand up.

Definition of hypertension, antihypertensive medication use, elevated BP and BP control

Hypertension was defined as self-reported diagnosis of hypertension by a physician (reported at baseline or at most recent data collection) or current antihypertensive medication use at least once a week. Hypertension treatment was defined as self-reported current antihypertensive medication use at least once a week.

To define elevated BP and BP control, we referred to the definition of hypertension and BP target recommendations by the ESC/ESH 2018 and the ACC/AHA 2017 guidelines (**Table 1**). The European guidelines define hypertension as BP of 140/90 mmHg or higher and the ACC/AHA guidelines 2017 define hypertension as BP of 130/80 mmHg or higher; we therefore defined elevated BP-ESC/ESH as BP ≥ 140/90 mmHg and elevated BP-ACC/AHA as BP ≥ 130/80 mmHg [1, 2].

Regarding BP control, the ESC/ESH guidelines 2018 recommend targeting 130-139/70-79 mmHg in individuals aged 65 years and over and they recommend not to lower BP below 130/80 mmHg. They recommend accounting for the patient's clinical condition, concomitant treatments, and frailty status in deciding the BP level to target. They also recommend close monitoring of adverse effects during treatment. The ACC/AHA guidelines 2017 recommend targeting < 130/80 mmHg with no consideration of age. In persons aged 65 years and over with high comorbidity burden and limited life expectancy, they recommend to assess benefits and risks of treatment intensity. For our analyses, we defined BP control under the ESC/ESH guidelines among treated patients as BP <140/90 mmHg and BP control under the ACC/AHA guidelines as BP <130/80 mmHg.

Definition of complex health conditions: frailty, multimorbidity and polypharmacy

Frailty status was determined based on Fried's phenotype model, which was described elsewhere [17]. Briefly, the model used a combination of 5 criteria: self-reported shrinking,

exhaustion, and low activity and measured weakness, and slowness. Participants were frail if they had at least three of these five criteria [14, 20]. Multimorbidity was defined when a participant reported 2 or more chronic diseases [21]. Chronic diseases included self-reported diagnoses of arthrosis, Alzheimer's disease, asthma, cancer, heart failure, coronary heart disease, chronic pulmonary disease, Parkinson's disease, ulcer, HIV, osteoporosis, hypercholesterolemia, hypertension and diabetes. Polypharmacy was determined if participants reported that they were taking five categories of medications at least once a week [22].

Definition of variables for baseline characteristics

Date of birth and sex were derived from the Population Office file. Socioeconomic characteristics, and other CVD risk factors, were based on self-report. Financial difficulties were determined when participants reported that they had had financial difficulties in the past 12 months, or had trouble making ends meet, or received means-tested subsidies for health insurance or received complementary financial support to supplement old-age pension. Hypercholesterolemia was determined if participants reported physician-diagnosed high cholesterol or cholesterol-lowering medication use. Diabetes was determined if participants reported physician-diagnosed diabetes or medication use for diabetes. History of CVD was determined if participants reported that they had been diagnosed with: coronary heart disease, stroke, heart insufficiency, cardiomyopathy, heart valve disease, or other cardiopathy, or if they reported medication use for the heart. BMI was calculated using measured height and weight.

Statistical analyses

We used data from all Lc65+ participants who were still alive and participating at the most recent data collection and we restricted our analytical sample to participants who had complete data for BP measures. We estimated the prevalence and 95% confidence interval (CI) for hypertension, antihypertensive medication use, elevated BP-ESC/ESH and elevated BP-ACC/AHA stratified by sex and age. Further, among treated hypertensive patients, we estimated the proportion and 95% CI of individuals with uncontrolled BP stratified by sex and age. Finally, among participants with elevated BP and with uncontrolled BP according to both guidelines separately, we estimated the proportion and 95% CI of individuals with a complex health condition, i.e. with frailty, multimorbidity, polypharmacy and with any one of the three.

Results

Of the 9887 persons invited to participate to the Lc65+ study, 3504 did not respond, 1201 refused to participate, and 451 were removed from the database (death, move outside the study area, institutionalization, end of life hospitalization, advanced dementia reported by relatives at enrollment); 4731 (48%) were eventually recruited. At the most recent data collection with physical measurements, 3651 individuals were still alive and participating. Of these, 441 had missing data for BP and were excluded from the current analyses, leaving an analytical sample of 3210 participants (**Figure 1**). In supplementary analyses, we identified no major difference between characteristics of the original sample of 3651 individuals and the analytical sample (supplementary Table S1).

The analytical sample consisted of 3210 participants aged between 67 and 80 years. The mean age of participants was 73.3 years (standard deviation (SD): 4.1) and 59% were women

(**Table 2**). In the whole sample, 51% of participants reported having hypertension and 44% reported taking antihypertensive medication. 35% had hypercholesterolemia, 11% diabetes, 26% a history of CVD and 16% were current smokers. 48% had two or more chronic diseases, 21% were taking 5 or more medications on a regular basis, and 3.6% were frail.

The prevalence of elevated BP-ESC/ESH (≥140/90 mmHg) was 39% (95% CI: 37% to 41%) while the prevalence of elevated BP-ACC/AHA (≥130/80 mmHg) was 63% (95% CI: 61% to 64%) **(Table 3)**, 24% (95% CI: 21% to 26%) percentage points higher. Women had a lower prevalence of elevated BP compared to men. In terms of absolute difference in the prevalence of elevated BP when comparing the ACC/AHA thresholds with the ESC/ESH thresholds, there were no substantial differences across age or sex strata. In supplementary analyses, we identified no major difference between characteristics of individuals with elevated BP under the ACC/AHA 2017 guidelines together with normal BP under the ESC/ESH 2018 and the analytical sample (supplementary Table S1).

Among participants treated for hypertension, the proportion of controlled BP-ESC/ESH (<140/90 mmHg) was 56% (95% CI: 54% to 59%) and the proportion of controlled BP-ACC/AHA (<130/80 mmHg) was 32% (95% CI: 30% to 35%), 24% (95% CI: 21% to 28%) percentage points lower. Women had a higher proportion of controlled BP compared to men (**Figure 2**). In terms of absolute difference in the proportion of BP control when comparing ACC/AHA threshold and ESC/ESH threshold, there were no substantial differences across age and sex strata.

Among participants with elevated BP-ESC/ESH, 2.6% (95% CI: 1.8% to 3.6%) were frail, 49% (95% CI: 46% to 51%) were multimorbid, 22% (95% CI: 19% to 24%) were

polymedicated, and 52% (95% CI: 49% to 55%) were any one of the three, i.e., had a complex health condition (**Table 4**). Among participants treated for hypertension with uncontrolled BP-ESC/ESH, 3.1% (95% CI: 1.9% to 4.9%) were frail, 76% (95% CI: 73% to 80%) were multimorbid, 35% (95% CI: 31% to 39%) were polymedicated, and 79% (95% CI: 76% to 82%) were any one of the three, i.e., had a complex health condition. These proportions were similar if the ACC/AHA threshold was used for defining elevated and uncontrolled BP.

Discussion

Elevated BP is high among older adults and only about half of treated hypertensive older adults have their BP controlled under the currently applied 2018 ESC/ESH guidelines. Applying the 2017 ACC/AHA guidelines threshold of 130/80 mmHg for diagnosing hypertension leads to a large increase in the prevalence of elevated BP and a large decrease in BP control in our sample. The prevalence of elevated BP was 39% under ESC/ESH 2018 and 63% under ACC/AHA 2017, 24% percentage points higher. The proportion of controlled BP among individuals treated for hypertension was 56% under ESC/ESH 2018 and 32% under ACC/AHA 2017, 24% percentage points lower. Finally, about one of two participants with elevated BP and four out of five participants with uncontrolled BP had a complex health condition using either threshold.

The prevalence of elevated BP and BP control vary across time, countries and studies, for the most part because they depend on how hypertension and elevated BP are defined, on BP measurement procedures, and on the age distribution of participants. Danon-Hersch et al. found that, in a subgroup of participants aged 65 to 75 years in a cohort study including

residents of the city of Lausanne in Switzerland, the prevalence of hypertension (BP ≥140/90 mmHg or treated for hypertension) was 75% in men and 59% in women and the prevalence of BP control (<140/90 mmHg) among the treated was 24% in men and 26% in women [23]. In another study by Brindel et al. including 9090 participants aged 65 years and more from 3 cities in France, the prevalence of elevated BP (BP ≥140/90 mmHg) was 63% and the prevalence of hypertension (BP ≥140/90 mmHg or treated for hypertension) was 78% [24].

Several studies have investigated the impact of the 2017 ACC/AHA guidelines on prevalence and control of elevated BP. Nevertheless, to our knowledge, only few focused on older adults. For instance, Khera et al. assessed the impact of applying the threshold of 130/80 and 140/90 mmHg on the prevalence of hypertension on the American and the Chinese population aged 45 to 70 years. They found that the prevalence of hypertension increased from 50% to 63% in the American sample and from 38% to 55% in the Chinese sample [5]. In a more recent study by Gijón-Conde et al., the prevalence of hypertension increased from 33% to 47% in a population aged 18 years and over and from 76% to 87% in the subgroup of participants aged 75 years and more [6]. They also found that the prevalence of controlled BP among treated hypertensive individuals decreased markedly, from 38% to 25%.

As in all observational research, our study does have limitations. Firstly, data on hypertension diagnosis and antihypertensive medication use were self-reported. The reliability may be questionable especially with regard to older participants, who may have difficulty recalling diagnoses and especially treatments. Secondly, while the study is population-based, the representativeness of our analytical sample is disputable. With a participation proportion of 48%, there may have been some selection bias. Furthermore, 12% of participants withdrew from the study and 8% died, which may have introduced some attrition and survivorship bias

[25]. Taken together, these factors may have led to a sample that is healthier and more educated compared to the general population in the same age range. Regardless of which guideline is considered, the prevalence of elevated BP may have been underestimated and control rates overestimated [26, 27].

A third limitation is that BP was measured three times at one visit, what is suitable for detecting elevated BP at the time of the visit but not for detecting sustained elevated BP. BP fluctuates with time, according to the time of the day, but also depending on the day, the month and the season [28, 29]. Similarly, three measurements at one visit are not sufficient for detecting hypertension in the participants and deciding upon the initiation or intensification of antihypertensive medication. For diagnosing hypertension, guidelines recommend having repeated BP readings at several visits, or using home or ambulatory BP monitoring, to have a better estimate of the true sustained elevated BP, particularly among older adults [1, 2].

On the other hand, our study has several strengths. It is based on data from a carefully conducted study focusing on a population of older age. Loss to follow-up is a major threat to longitudinal studies but the investigators made an active and sustained effort to collect data on each participant as long as possible, mitigating attrition. For instance, for participants having trouble getting to the research center due to physical or cognitive impairments, research assistants performed home visits following a standardized study protocol. Follow-up was also maintained as far as possible for individuals entering a nursing home. Another strength of our study is the accuracy of BP measurements. BP was measured by trained research assistants following a standardized protocol that was maintained across years and samples.

The substantial increase in the prevalence of elevated BP and decrease in the proportion of controlled BP if the ACC/AHA threshold was applied has important implications. Bress et al. estimated that achieving the 2017 ACC/AHA thresholds over 10 years of treatment could prevent 3 million CVD events in the adult population in the United States, that is 1.4 million more compared to thresholds <140/90 mmHg. These authors also estimated that achieving the 2017 ACC/AHA thresholds would produce a large number of serious adverse events. Of notice, these numbers were estimated with the strong assumption of perfect BP control [30]. In terms of hypertension management, applying the ACC/AHA recommendations would imply huge increases in efforts from health care providers and patients for hypertension management to lower BP. It would also require an increase in the capacity and a strengthening of the accountability of the health system to conduct surveillance and monitoring, and to respond appropriately to BP levels [31]. Furthermore, because BP control is currently already poor, one major concern is whether the ACC/AHA threshold is concretely reachable in clinical practice.

Opinions diverge on whether the ACC/AHA thresholds should be adopted or not. Wilt et al. were sceptical that the benefit-harm balance of lowering BP below 130/80 mmHg in the population falls on the side of benefit [7]. They mentioned that the ACC/AHA 2017 guidelines do not adequately weight the potential benefits against potential harms, costs and individual patient preferences [7]. Potential risks for patients may include overdiagnosis, labelling, and adverse effects due to unnecessary medication intake [32]. Bell et al. analyzed the incremental health benefits, i.e., CVD and mortality reduction, and the incremental harms, i.e., labeling, financial burden, and treatment burden, of lowering BP thresholds to the ACC/AHA levels in different patient groups, and they concluded that incremental harms and benefits were roughly in balance in the elderly population [33]. Conversely, some others see

the expanded definition of hypertension as an important public health opportunity, the primary aim of which is not to reduce or to control BP, per se, but to maximize CVD risk reduction in individuals and in the population [34]. In other words, more ambitious targets would contribute to shifting BP levels downwards in the population.

Finally, divergences in recommendations result partly from the absence of strong evidence especially for individuals with complex health conditions [35]. The ESC/ESH 2018 recommends accounting for the patient's clinical condition, concomitant treatments, and frailty in the decision on whether to treat hypertension and the ACC/AHA 2017 recommends an assessment of risks and benefits of the intensity of hypertension treatment in patients with high comorbidity burden and limited life expectancy (**Table 1**). According to our results, a large proportion of older adults are either frail, polymedicated, or multimorbid, stressing the need for further trials in this population [2, 3, 13].

In conclusion, the prevalence of elevated BP under the currently applied ESC/ESH guidelines is high among older adults, and applying the ACC/AHA hypertension management guidelines would likely lead to a much larger proportion of older adults treated for elevated BP. Further, currently only about half of treated hypertensive older adults have their BP controlled, and, if the ACC/AHA guidelines were applied, BP control would drop even lower. To comply with the recent American guidelines, considerable effort in hypertension detection and antihypertensive treatment intensification would be required to lower BP below 130/80 mmHg among older adults. At the same time, it is still debated whether more intensive treatment is beneficial in older adults, especially considering the high prevalence of complex health conditions in older adults, for whom the evidence from clinical trials is weak, leaving health care professionals with unclear recommendations and uncertainty.

Conflict of interests

There is no conflict of interest to disclose.

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496 2018;72(11):1313-6.

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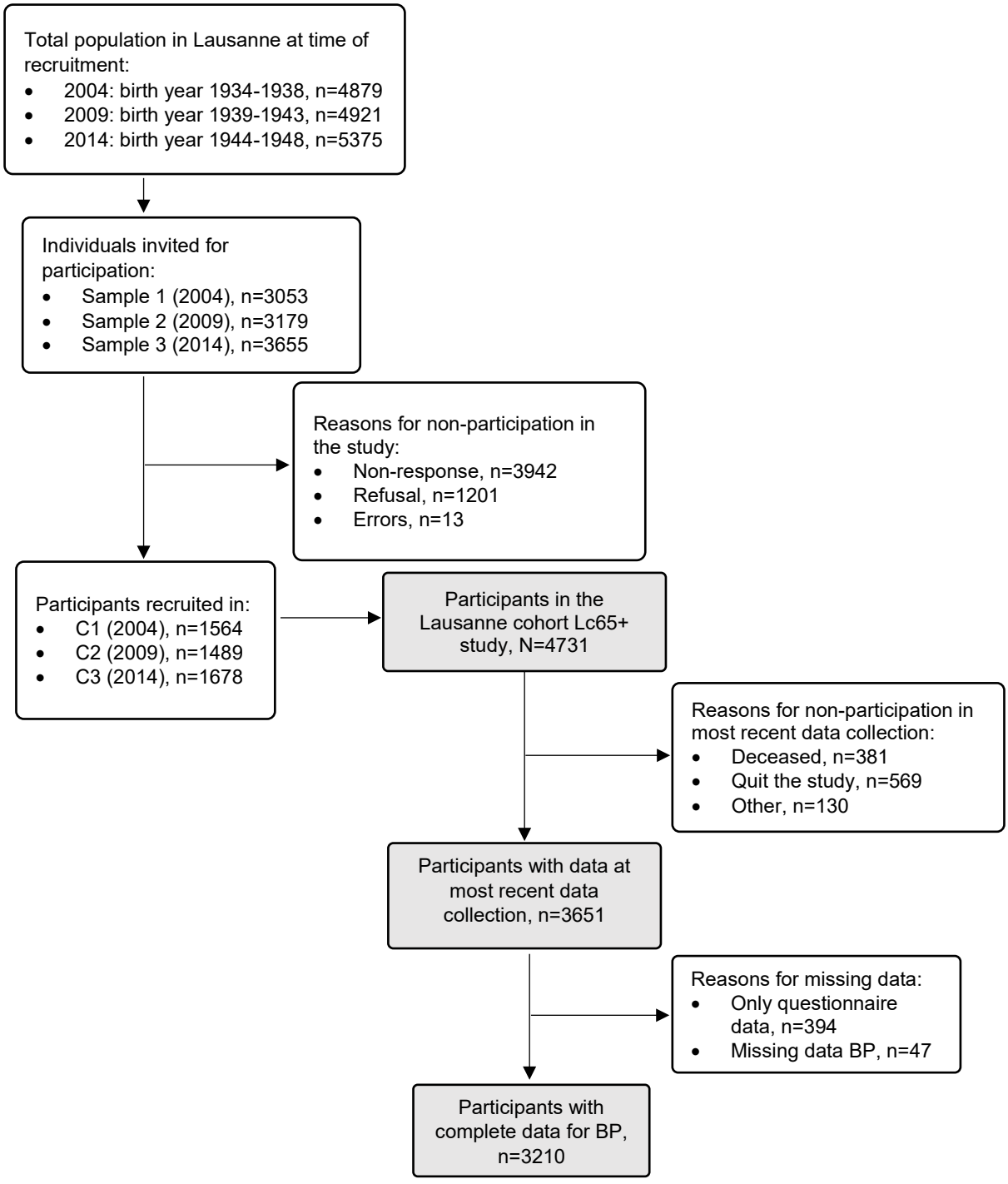
Figure 1. Flow chart with total target population at each sampling period, number of residents invited, recruited and included in our analytical sample [35].



C1, sample 1, for which recruitment started in 2004; C2, sample 2, for which recruitment started in 2009; C3, sample 3, for which recruitment started in 2014; N, total number of participants in the Lc65+; n, number of individuals.

Figure 2. Prevalence and 95% CI of individuals with controlled blood pressure (BP) according to ESC/ESH 2018 BP thresholds (<140/90 mmHg) compared to ACC/AHA thresholds (<130/80 mmHg), stratified by sex and age group [1, 2]. yr: years; ESC/ESH: European Society of Cardiology/European Society of Hypertension; ACC/AHA: American College of Cardiology and the American Heart Association; BP: blood pressure; CI, confidence interval.

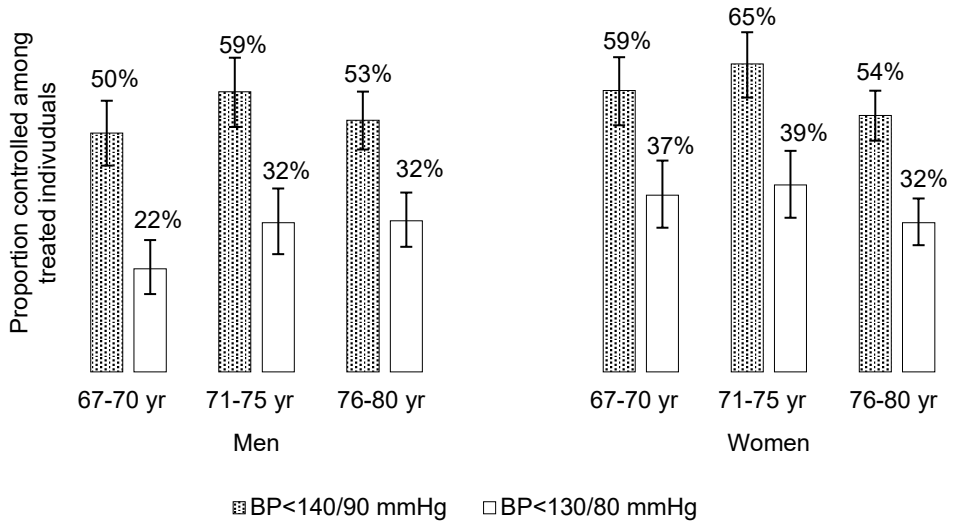


Table 1. Blood pressure (BP) thresholds for the definition of hypertension, for the initiation of antihypertensive treatment, and BP target during treatment recommended by the European Society of Cardiology/European Society of Hypertension (ESC/ESH) guidelines 2018 and the American College of Cardiology and the American Heart Association (ACC/AHA) guidelines 2017 [1, 2].

	ESC/ESH 2018			ACC/AHA 2017		
	Definition of HTN	**BP threshold for antihypertensive treatment initiation**	**BP targets**	**Definition of HTN**	**BP threshold for antihypertensive treatment initiation**	**BP targets**
All adults	• ≥140/90	• ≥140/90	• First objective <140/90 • Second objective <130/80 (not <120/70)	• ≥130/80	• ≥130/80 in secondary prevention • ≥130/80 in primary prevention with a 10-year ASCVD risk ≥10% • ≥140/90 in primary prevention with a 10-year ASCVD risk <10%	• HTN + 10-year ASCVD risk ≥10%: <130/80 is recommended • HTN + 10-year ASCVD risk <10%: <130/80 is reasonable
Older adults	• ≥140/90	• 80 yr and more: ≥160/90	• 65 yr and more: systolic BP 130-139 with close monitoring of adverse effects (not < 130/70) • The decision to treat HTN must take into account the patient's clinical condition, concomitant treatments, and frailty	• ≥130/80	• Individuals aged >79 yr old generally have a 10-year ASCVD risk ≥10%, therefore the treatment threshold is ≥130/80	• 65 yr and more: • Noninstitutionalized, ambulatory, community-dwelling patients: <130 • Patient with high burden of comorbidities and limited life expectancy: risk and benefits of treatment intensity have to be assessed

BP values are in mmHg. BP: blood pressure; CVD: cardiovascular disease; HTN: hypertension; yr: years; ESC/ESH : European Society of Cardiology/European Society of Hypertension; ACC/AHA: American College of Cardiology and the American Heart Association; ASCVD: Atherosclerotic Cardiovascular Disease.

Table 2. Baseline characteristics of participants (n=3210)

Characteristics		n (%)
Sex	Women	1888 (59)
	Men	1322 (41)
Age [years], mean (SD)		73.3 (4.1)
Socioeconomic characteristics	Living alone	2113 (66)
	Education	
	Basic compulsory	527 (16)
	Apprenticeship	1239 (39)
	High school	805 (25)
	University	631 (20)
	Financial difficulties	834 (26)
	Missing at least one variable in socioeconomic characteristics	80 (2.5)
BP [mmHg], mean (SD)	Systolic BP	135.1 (18.5)
	Diastolic BP	76.3 (11.0)
Hypertension	Hypertension	1622 (51)
	Hypertension treatment	1401 (44)
	Missing hypertension or antihypertensive treatment	6 (0.2)
Other CVD risk factors	Hypercholesterolemia	1138 (35)
	Diabetes	356 (11)
	History of CVD	824 (26)
	Smoking	
	Current smoker	516 (16)
	Former smoker	1308 (41)
	Never smoker	1376 (43)
	Missing at least one variable in other CVD risk factors	28 (0.9)
BMI category	Underweight (BMI < 18.5 kg/m^2)	48 (2)
	Normal (BMI 18.5-24.9 kg/m^2)	1139 (35)
	Overweight (BMI 25-29.9 kg/m^2)	1304 (41)
	Obese (BMI ≥ 30 kg/$^{m2)}$	709 (22)
	Missing	10 (0.3)
Multimorbidity		1740 (48)
Polypharmacy		751 (21)
Frailty		114 (3.6)

Values are counts (%) unless indicated otherwise. n: number of participants; SD: standard deviation; BP: blood pressure; CVD: cardiovascular disease; multimorbidity: ≥ self-reported chronic diseases; polypharmacy: self-reported use of ≥ 5 medication at least once a week.

Table 3. Prevalence and 95% confidence interval (CI) of hypertension (diagnosed with, or treated for), antihypertensive treatment, elevated BP-ESC/ESH (≥140/90 mmHg) and elevated BP-ACC/AHA (≥130/80 mmHg), stratified by sex and age [1, 2].

	Men				Women				Men & Women
	67-70 yr (n=465)	71-75 yr (n=367)	76-80 yr (n=490)	All age groups (n=1322)	67-70 yr (n=607)	71-75 yr (n=526)	76-80 yr (n=755)	All age groups (n=1888)	All age groups (n=3210)
Hypertensive	54 (50-59)	56 (51-61)	61 (57-66)	57 (55-60)	38 (34-42)	44 (39-48)	53 (49-57)	46 (43-48)	51 (49-52)
Treated for hypertension	50 (44-55)	46 (42-51)	55 (50-59)	50 (48-53)	31 (28-35)	37 (33-41)	47 (44-51)	39 (37-41)	44 (42-46)
Elevated BP-ESC/ESH (≥ 140/90 mmHg)	45 (41-50)	45 (40-50)	48 (44-53)	46 (44-49)	31 (27-35)	30 (26-34)	39 (35-43)	34 (32-36)	39 (37-41)
Elevated BP-ACC/AHA (≥ 130/80 mmHg)	74 (69-78)	66 (61-71)	69 (64-73)	70 (67-72)	55 (51-59)	54 (50-59)	63 (59-66)	58 (56-60)	63 (61-64)

BP: blood pressure; n: number of participants; yr: years; ESC/ESH : European Society of Cardiology/European Society of Hypertension; ACC/AHA: American College of Cardiology and the American Heart Association.

Table 4. Proportion with 95% confidence interval (CI) of complex health conditions among participants with elevated BP and uncontrolled BP.

		Complex health condition, % (95% CI)			
	Total n	**Frail**	**Multimorbid**	**Polymedicated**	**Frail, multimorbid or polymedicated**
Men					
with elevated BP					
≥ 140/90	611	2.6% (1.5-4.2)	47% (43-51)	21% (18-25)	50% (46-54)
≥ 130/80	920	2.3% (1.4-3.5)	48% (45-52)	23% (20-25)	51% (48-55)
treated for HTN and with uncontrolled BP					
≥ 140/90	308	3.6% (1.8-6.4)	78% (73-83)	36% (30-42)	81% (76-85)
≥ 130/80	478	3.1 (1.7-5.0)	76% (72-80)	36% (31-40)	79% (75-83)
Women					
with elevated BP					
≥ 140/90	637	2.5% (1.4-4.1)	50% (46-54)	22% (19-25)	55% (51-58)
≥ 130/80	1091	3.4 (2.4-4.7)	47% (44-50)	21% (18-23)	52% (49-55)
treated for HTN and with uncontrolled BP					
≥ 140/90	309	2.6% (1.1-5.1)	74% (69-79)	34% (28-39)	77% (72-82)
≥ 130/80	482	3.7% (2.2-5.7)	75% (71-79)	33% (29-37)	78% (75-82)
All participants					
with elevated BP					
≥ 140/90	1248	2.6% (1.8-3.6)	49% (46-51)	22% (19-24)	52% (49-55)
≥ 130/80	2011	2.9% (2.2-3.7)	48% (45-50)	21% (20-23)	52% (49-54)
treated for HTN and with uncontrolled BP					
≥ 140/90	617	3.1% (1.9-4.9)	76% (73-80)	35% (31-39)	79% (76-82)
≥ 130/80	960	3.4% (2.3-4.7)	76% (73-78)	34% (31-37)	79% (76-81)

BP: blood pressure; n: number of participants; HTN: hypertension; CI, confidence interval.

Table S1. Baseline characteristics of participants in the original sample (n=3651), the analytical sample (n=3210), and in individuals (n=763) with elevated BP under ACC/AHA 2017 and normal BP ESC/ESH 2018.

Characteristics		Original sample	Analytical sample	Sample with elevated BP under ACC/AHA 2017
Sex	Women	59%	59%	60%
	Men	41%	41%	40%
Age [years], mean (SD)		73.4 (4.1)	73.3 (4.1)	73.0 (4.1)
Socioeconomic characteristics	Living alone	66%	66%	69%
	Education			
	Basic compulsory	18%	16%	16%
	Apprenticeship	39%	39%	42%
	High school	25%	25%	24%
	University	19%	20%	18%
	Financial difficulties	29%	27%	25%
	Missing at least one variable in socioeconomic characteristics, n (%)	419 (11%)	80 (2.5%)	18 (2.4%)
Hypertension	Hypertension	46%	45%	46%
	Hypertension treatment	44%	44%	45%
	Missing hypertension or antihypertensive treatment, n (%)	25 (0.7%)	6 (0.2%)	1 (0.1%)
Other CVD risk factors	Hypercholesterolemia	36%	36%	36%
	Diabetes	12%	11%	12%
	History of CVD	26%	26%	23%
	Smoking			
	Current smoker	17%	16%	15%
	Former smoker	40%	41%	40%
	Never smoker	43%	43%	45%
	Missing at least one variable in other CVD risk factors, n (%)	78 (2.1%)	28 (0.9%)	6 (0.8%)
BMI category	Underweight (BMI < 18.5 kg/m^2)	1.5%	1.5%	0.7%
	Normal (BMI 18.5-24.9 kg/m^2)	36%	36%	35%
	Overweight (BMI 25-29.9 kg/m^2)	41%	41%	40%
	Obese (BMI ≥ 30 kg/$^{m2)}$	22%	22%	24%
	Missing, n (%)	442 (12%)	10 (0.3%)	2 (0.3%)
Multimorbidity		48%	47%	46%
Polypharmacy		23%	23%	21%

Frailty	3.4%	3.6%	3.4%

Values are percentages unless indicated otherwise. n: number of participants; SD, standard deviation; BP: blood pressure; CVD: cardiovascular disease; multimorbidity: 2 or more self-reported chronic diseases; polypharmacy: self-reported use of 5 medication or more at least once a week.