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# Unveiling the gaps: Hypertension control beyond the cascade of care framework

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## Abstract

This study examines hypertension control beyond the cascade of care framework, which assesses awareness, treatment, and control sequentially. The analysis included 52 434 hypertensive adults (blood pressure (BP)  $\geq 140/90$  mm Hg and/or treatment in the past 6 months), aged 25–69, from the French population-based CONSTANCES cohort from 2012 to 2021. The authors assessed the typical “awareness, treatment, and control” scenario and characterized other possible control patterns. The authors found that 13% achieved control. This percentage rose to 19% when considering individuals who were not aware but treated and controlled. This alternative control scenario was associated with female sex, younger age, higher education, Northern-African origin, and reporting prior cardiovascular diseases (CVD). Sub-Saharan African origin, diabetes and overweight/obesity were associated with the typical control scenario. This study highlights that applying a typical sequential cascade of care approach may lead to the exclusion of some specific groups of participants who do not fit into the defined categories.

## KEYWORDS

care continuum, control, general population, hypertension-general, social differences

## 1 | INTRODUCTION

In recent years, the cascade of care framework has emerged as a valuable tool to assess hypertension control, and gaps in the care continuum.<sup>1–4</sup> Its decomposition of the hypertension care trajectory, into awareness, treatment, and control, has proven effective in evaluating control rates across countries.<sup>1–3</sup> A fundamental principle of this framework is that each successive step is a prerequisite for the next: awareness must precede treatment, and treatment must precede control. This study focuses on the alternative paths relevant to research using observational data that are not considered in this “typical”

hypertension care cascade and can nevertheless lead to hypertension control.

## 2 | METHODS

The CONSTANCES cohort design has previously been published.<sup>5</sup> Study participants visited health screening centers (HSC) for comprehensive health assessments, including doctor-administered questionnaires and three standardized blood pressure (BP) readings.<sup>6</sup> The CONSTANCES study team has furnished standardized procedures for

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data collection. Additionally, annually inspected calibrated oscillometric automated devices (specifically, OMRON1 705CP-II R or OMRON1 705IT R) with appropriately sized cuffs were supplied. BP measurements were conducted as follows: after a 5-min resting period in a lying position, three measurements were taken. The first measurement was on the right arm, followed by the second on the left arm with a 1-min interval. Subsequently, the third measurement was taken on the reference arm (identified as the arm with the highest value) after another 1-min interval. The average of the two reference arm measurements was utilized to determine systolic and diastolic BP. Consenting individuals were connected to the French National Health Data System (SNDS), providing data on antihypertensive treatment reimbursements.

## 2.1 | Definitions

Hypertension was defined as having a measured BP  $\geq 140/90$  mm Hg and/or having been reimbursed for at least one antihypertensive medication in the past 6 months.

Individuals with hypertension were considered aware if they reported hypertension in their medical history when answering the doctor-administered questionnaire.

Hypertensive patients were considered under treatment if they were reimbursed for at least one box of antihypertensive medication within 6 months before inclusion.

Control was determined if individuals with hypertension had an average BP  $< 140/90$  mm Hg.

The “typical control scenario” followed the traditional care cascade and was defined as the sequential pattern of awareness, treatment, and control.

The “alternative control scenario” was defined as the sequential pattern of unawareness, treatment, and control.

## 2.2 | Covariates

Biological sex and age were provided at inclusion. Highest level of education was self-reported at inclusion.

Migratory status was used as a proxy for ethnorracial group<sup>7</sup> and was assessed using the participant’s declaration of their and their parents’ geographical region of origin and their nationality at birth.<sup>8</sup> First- and second-generation immigrants were grouped together, as well as overseas department natives and descendants. The ethnorracial was coded as follows: the Majority group, the Overseas France group, the North African group, the Sub-Saharan African group, the Asian group, the Europe and others group.

History of other CVD (myocardial infarction, coronary artery disease, stroke, transient ischemic attack, abdominal aortic aneurysm, peripheral artery disease, heart failure, other) was either reported when answering the doctor-administered questionnaire or identified by medical reimbursements.

Diabetes was defined if participants reported type II diabetes, were receiving antidiabetic medication, or if their fasting blood glucose concentration  $> 7$  mmol/L.

Overweight/obesity was calculated at the HSC.

## 2.3 | Study participants

We pooled data from 196 304 adults included in the CONSTANCES cohort (2012–2021). We excluded individuals with missing data on hypertension treatment reimbursements, measures, or self-report. We also excluded pregnant women. Finally, we selected individuals aged 25–69. In our sample of 174 606 French adults, 30% ( $n = 52\,434$ ) had hypertension.

Descriptive analyses were performed on typical and alternative control scenarios. Each characteristic was described comparing respondents who achieved control via the alternative scenario, to those in the typical scenario, using logistic regressions.

## 3 | RESULTS

When considering the typical care cascade framework, among the 52 434 individuals with hypertension, 35.6% were aware, 32.2% aware and treated, and 13.0% had control of their hypertension (Figure 1A).

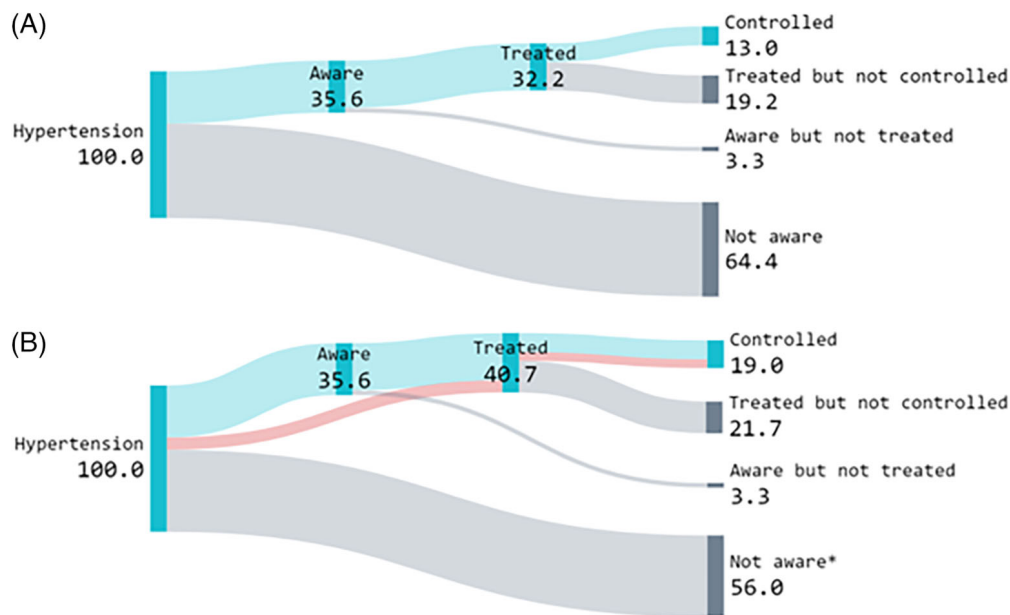
When considering the alternative scenario (Figure 1B), the proportion of those in the control group rose to 19.0%, because individuals with hypertension who were not aware, but who were treated and controlled (6.0%) were included. Overall, the “Treated” share in the second graph rose to 40.7% compared to the first graph. This increase was due to an additional 8.4% of individuals with hypertension who were not aware but were treated.

Compared to the typical control path, the alternative path to achieve control (not aware, treated, controlled) was positively associated with being a woman, younger age, pre-existing CVD, having a postgraduate degree, and being of the North African group. It was negatively associated with having diabetes, overweight/obesity, and being part of the Sub-Saharan African group (Table 1).

## 4 | CONCLUSIONS

In a large French cohort, we used observational data to identify that 19.0% of hypertensive patients achieved control, among whom one third were rendered invisible if the criteria of a typical cascade of care framework were applied.

The use of the cascade of care framework has proved efficient in the identification of the loss of patients throughout the hypertension care *continuum*, and in determining hypertension control in the general population. Many recent major observational studies have used this framework<sup>1–3</sup> enabling a systematic approach and contributing to improved comparability between periods and countries.<sup>1,2</sup>



**FIGURE 1** Hypertension care cascade and paths to achieve control. (A) Hypertension care cascade and the typical path to achieve control. (B) Hypertension care cascade and an alternative path to achieve control. The blue path represents the “typical” path to hypertension control according to the cascade of care framework. The red path represents an “alternative” path to hypertension control: not aware, treated, controlled. \*To the exception of respondents who were both not aware and treated.

However, one of the main disadvantages of this framework is that a proportion of people who achieve control might not be captured because they fall between the gaps of typical classification. As shown in our study by the share of individuals with hypertension in the alternative control scenario. To our knowledge, most studies do not include them in their assessment of hypertension control.

Different hypotheses can be made on the basis of the respondents' characteristics. First, antihypertensive treatment can be used as a preventive treatment for other CVD,<sup>9</sup> or be used as a treatment for prehypertension (130/80 mm Hg  $\leq$  BP < 140/90 mm Hg) for patients with a history of other CVD.<sup>10–12</sup> Indeed, in our study, having a history of other CVD was strongly associated with the alternative control path, which corroborates this hypothesis. When considering only individuals with a history of other CVD, the control rate rose from 18.3% in the typical path to 32.3% considering the alternative path, while it rose from 11.5% in the typical path to 15.2% in the alternative path individuals without any history of other CVD (Figure S1). Some individuals might therefore be categorized as hypertensive because they receive treatment, without having elevated BP levels, potentially introducing a selection bias creating an overestimation of hypertension prevalence that needs to be addressed. For example, in our study, 78% of individuals in the alternative path were under  $\beta$ -blockers versus 49% of individuals in the typical path (Table S1).  $\beta$ -blockers are recommended in the management of myocardial infarction, coronary heart disease and heart failure,<sup>13</sup> and were mainly present in individuals with these diseases in our study (Table S2). Furthermore, the selected molecules to identify an “antihypertensive treatment” in an administrative dataset such as the SNDS (Figure S2) might also contribute to a definition bias. Another hypothesis revolves around the potential ambiguity in

reporting hypertension. It is possible that having a controlled BP might lead some patients to report not having hypertension, contributing to reporting bias. Furthermore, some respondents with controlled hypertension might also be undergoing treatment without a comprehensive understanding of the diagnosis, which could cause some ethical issues. Although our data does not allow us to evaluate the extent to which this situation is prevalent, studies in the USA,<sup>14</sup> Ireland,<sup>15</sup> and Italy<sup>16</sup> have shown that not knowing their diagnosis or treatment plan is not unusual when patients are discharged from hospitals. This underlines the importance of physician-patient communication in a patient's treatment plan, especially when hypertension is diagnosed in the hospital, which might be more frequent in France than in other countries, due to the absence of large-scale detection campaigns in the population.<sup>17</sup>

Our study found that the alternative control path was associated with overweight/obesity, diabetes, and older age. We hypothesize that respondents with these demographics and medical conditions may be more likely to be engaged in the healthcare system, potentially contributing to a better insertion in the hypertension care *continuum*. The alternative control scenario was more likely among women. This could partially be due to a lack of sex and sex-sensitive approaches in the design, analysis and interpretation of research on hypertension.<sup>18</sup> The alternative control scenario was also associated with a postgraduate degree. This could stem from the higher hypertension unawareness rate among the most educated in the CONSTANCES cohort.<sup>19</sup> Sub-Saharan African origin was correlated to the typical control. This may be the result of clinical guidelines which recommended a targeted and tailored approach to hypertension management towards this group.<sup>20</sup> Further research is essential to elucidate the patterns of hypertension management based on the respondents' sex and ethnoracial group,

**TABLE 1** Factors associated with an alternative control within the care cascade (compared to typical).

Characteristic	Descriptive statistics			Adjusted model		
	Typical control scenario, N = 6838 <sup>a</sup>	Alternative control scenario, N = 3142 <sup>a</sup>	p-value <sup>b</sup>	OR <sup>c</sup>	95% CI <sup>c</sup>	p-value
<b>Sex</b>			<.001			
Men	3218 (47%)	1275 (41%)		-	-	
Women	3620 (53%)	1867 (59%)		1.38	1.25,1.52	<.001
<b>Age</b>	60 (54,65)	54 (44,62)	<.001	0,94	0.93,0.94	<.001
<b>Ethnoracial groups</b>			<.001			
Majority group	5669 (83%)	2550 (81%)		-	-	
Overseas France group	96 (1.4%)	39 (1.2%)		0.73	0.47, 1.10	.13
North African group	221 (3.2%)	168 (5.3%)		1.42	1.13,1.78	.003
Sub-Saharan African group	110 (1.6%)	30 (1.0%)		0.53	0.33,0.81	.004
Asian group	59 (0.9%)	32 (1.0%)		0.98	0.60, 1.58	>.9
European and Others group	683 (10.0%)	323 (10%)		1.07	0.92,1.25	.4
<b>Education level</b>			<.001			
High school	3980 (58%)	1579 (50%)		-	-	
Undergraduate	1910 (28%)	1001 (32%)		1.06	0.95, 1.18	.3
Postgraduate	948 (14%)	562 (18%)		1.24	1.09,1.42	.002
<b>History of CVD</b>						
No				-	-	
Yes	2121 (31%)	1614 (51%)	<.001	3.77	3.41,4.18	<.001
<b>Diabetes</b>						
No				-	-	
Yes	1000 (15%)	235 (7.5%)	<.001	0.62	0.53,0.73	<.001
<b>Overweight/Obesity</b>						
No				-	-	
Yes	4866 (71%)	1603 (51%)	<.001	0.50	0.45,0.55	<.001

<sup>a</sup>n (%); Median (IQR).

<sup>b</sup>Pearson's Chi-squared test; Wilcoxon rank sum test.

<sup>c</sup>OR, odds ratio; CI, confidence interval.

aiming to gain a comprehensive understanding of the factors contributing to the alternative control scenario observed, particularly among individuals of North African heritage.

The cascade of care framework was initially introduced in the 2000s to assess the loopholes in the sexually transmitted illness (STI) care continuum. HIV likely represents the most established and successful application of the model.<sup>21</sup> More recently, its use has been adapted to other communicable (other STI, hepatitis C) and noncommunicable diseases (diabetes, hypertension).<sup>21</sup> Perlman and coworkers while examining care continua for HIV, hepatitis C, and tuberculosis warn that adapting the model to any disease must imply a disease-focused reflection on the definitions of each of its stages. In the case of hypertension, the traditional definition of treatment might not be well adapted, as it very often comprises medical treatment only, although lifestyle and diet adaptation are a part of the treatment, and sometimes suffice without the need for pharmacological intervention.

As a linear path to treatment, the cascade of care has shown some limitations. Regarding HIV, Hallett and Eaton<sup>22</sup> suggested considering "side door entries," that is, entries or reentries in the cascade of care that do not occur at the front door of the cascade, in our case awareness. A scenario put forward by the authors is the "drop-out reinitiating" scenario. In the case of hypertension, where adherence to the treatment is low,<sup>23</sup> we hypothesize that reentering the cascade through the treatment side-door is possible. Perlman and coworkers also question the scenario in which aware and treated patients relapse after having had control of their condition for a period of time. To our knowledge, this has not been examined for hypertension. Therapeutic inertia, failure to adequately intensify or up-titrate treatment, is common in hypertension management,<sup>12</sup> and could lead patients to reenter the cascade at a previous step.

Finally, although our methodology to assess prevalence and the different steps of the cascade of care in the general population has

largely been validated and published,<sup>1,2,12</sup> it still shows limitations. BP measurements in a single visit does not suffice to confirm a clinical diagnosis of hypertension.<sup>12</sup> Hypertension prevalence based on data collected in multiple visits might be lower than our estimations,<sup>2</sup> especially in populations that are not used to frequent BP measurements.<sup>24</sup> Our study might therefore overestimate hypertension prevalence and underestimate control. Furthermore, the choice of molecules to define hypertensive treatment is rarely communicated in epidemiological studies, often due to insufficient data, although it may lead to a selection bias.

In conclusion, using the typical hypertension cascade of care framework might contribute to underestimating control, overestimating prevalence, and excluding social-specific groups. The approach developed in this study is especially relevant to observational research on hypertension in the general population, although the alternative control scenario highlighted here should be tested on different study types so as to improve the understanding of hypertension control and identify more specific areas for improvement.

#### AUTHOR CONTRIBUTIONS

**Léna Silberzan:** Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Software; Visualization; Writing—original draft; Writing—review & editing. **Nathalie Bajos and Michelle Kelly-Irving:** Conceptualization; Supervision; Validation.

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#### CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

#### DATA AVAILABILITY STATEMENT

Data are available on reasonable request. Anonymized data will be shared by request to the CONSTANCES scientific committee.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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