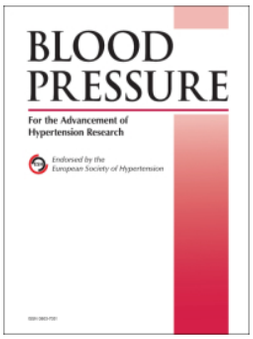

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RESEARCH ARTICLE

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Measurement of blood pressure in European Society of Hypertension Excellence Centres: a survey by the Young Investigators Group of the European Society of Hypertension

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ABSTRACT

Background: Office blood pressure (BP) measurement is the cornerstone of hypertension diagnosis and risk stratification. Inaccurate BP readings can lead to significant misclassification, often overestimating BP and prompting unnecessary lifelong treatment. The Young Investigators Group of the European Society of Hypertension (YIG-ESH) conducted a structured, comprehensive survey among ESH Excellence Centres with the primary objective of providing an updated overview of BP measurement practices in routine clinical care.

Methods: A 17-item survey was created to assess the different modalities, devices and techniques currently used for office BP measurement (OBPM) across ESH excellence centres. The survey was spread *via* email for 8 weeks (from December 2024 to February 2025).

Results: The survey was sent out to 216 recipients and 96 responses have been collected (response rate 44%) from 29 different countries. Automated electronic devices were used routinely in almost all outpatient facilities (96.7%), while manual auscultatory devices were used in 33.3% of the healthcare facilities. Among manual auscultatory devices, aneroid devices were used by the majority of the participants (73.6%) and mercury sphygmomanometers by 28.8%. BP was measured in seated (91.7%), standing (43.8%) and supine position (32.3%). Most of the respondents performed three (68.8%) or two (22.9%) BP measurements per outpatient. Home BP monitoring was routinely advised by 98.9% of the respondents providing precise instructions on how to perform the required home BP measurements.

Conclusion: Our survey reveals considerable discrepancies in BP measurement, even within highly specialised settings such as the ESH Excellence Centres, with substantial non-adherence to recommended guidelines.

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ESH excellence centres; hypertension; management; survey; office blood pressure

Introduction

Cardiovascular diseases remain the leading cause of mortality globally, with hypertension representing the most common and modifiable risk factor [1]. Hypertension contributes significantly to vascular and end-organ damage and often coexists with other chronic conditions, thereby amplifying cardiovascular risk [2,3]. Despite therapeutic advances and the availability of cost-effective antihypertensive medications, the global burden of hypertension remains high. Alarmingly, recent data suggest that less than 45% of adults with hypertension achieve adequate blood pressure (BP) control [4–6].

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From 1990 to 2019, the number of adults aged 30–79 years with hypertension doubled, reaching over 1.2 billion globally [6]. Although the age-standardised prevalence has remained relatively stable, this absolute increase reflects insufficient improvement in control strategies. Hypertension is directly responsible for approximately 8.5 million deaths annually due to stroke, ischaemic heart disease, other vascular complications, and end-stage chronic kidney disease [7,8]. In this context, improving the accuracy of hypertension diagnosis and management is a global health priority.

Office BP measurement (OBPM) remains the cornerstone of hypertension diagnosis and risk stratification. Inaccurate BP readings can lead to significant misclassification, either overestimating BP and prompting unnecessary lifelong treatment with associated side effects and costs or underestimating BP and missing critical opportunities for cardiovascular prevention. Even small systematic errors in BP measurement protocols or devices can result in millions of patients being misclassified, with serious public health implications [9].

Improvement of BP evaluation, *via* validated devices and standardised measurement protocols, is a key priority for better global hypertension control. In this regard, assessing real-world practices in BP measurement, particularly in centres of excellence, is essential to identify current standards, disparities, and variability in care. To this purpose, the Young Investigators Group of the European Society of Hypertension (YIG-ESH) conducted a structured, comprehensive survey among ESH Excellence Centres. ESH Excellence Centres are recognised centres with high-quality clinical practice and critical mass of patients dedicated to the management of hypertension all over the world. The total number of approved ESH Centres of Excellence is 211 (15 of them are associated centres). The Affiliated Centres of Excellence are located in 36 European countries and the Associated Centres of Excellence in 9 non-European countries (Argentina, Armenia, Australia, Brazil, Israel, Jordan, Lebanon, People's Republic of China and Venezuela).

The primary objective of the current study was to provide an updated overview of BP measurement practices in routine clinical care, including the types of devices used, measurement techniques, personnel involved, and adherence to standardised protocols. By identifying practice variability and pinpointing deficiencies in BP measurement techniques and guideline adherence, the findings aim to inform quality improvement efforts and reinforce accurate BP measurement as a cornerstone of effective and safe hypertension management across Europe and beyond.

Methods

The YIG-ESH elaborated a 17-item survey (Supplementary File 1) to assess the different modalities, devices and techniques currently used for office BP measurement (OBPM) across ESH Excellence Centres. The survey was spread *via* email for 8 weeks (from December 2024 to February 2025), with two reminders sent within that period. The questionnaire was accompanied by a cover letter, providing details regarding the aim of the survey, the organisation behind the study and informing participants on the time needed to complete the survey, as evaluated by the investigators. No possibility of forwarding the email was done to avoid duplicate responses.

Questionnaire

The survey was originally developed by CM and reviewed by PS and DF. Multiple-choice pre-coded type was used, with either a dichotomic (yes/no) or a wide range of responses depending on the question.

Statistical analysis

Statistical analysis was performed using the SPSS software version 24.0 (IBM, Chicago, Illinois, USA). Continuous data were expressed as means ± standard deviation (SD), while categorical ones as relative frequencies. We use descriptive statistics to describe the overall characteristics of the survey. The

results were represented as percentages and depicted as bar charts. Analysis of variance and χ^2 test, as appropriate, were used for exploratory statistics.

We defined accurate BP measurement as the presence of three simultaneous conditions in a single respondent [1]: measuring BP in both arms at least at the first visit [2], using upper arm validated cuff devices, and [3] taking three measurements with recording the average of the last two [10]. Other aspects were assessed but were not considered fundamental for defining accuracy or were difficult to evaluate through a survey. Orthostatic test was considered correctly performed according to methodology explained in the 2023 ESH guidelines [10,11].

The significance was set for a value of $p < 0.05$.

Results

The survey was sent out to 216 recipients and 96 responses have been collected (response rate 44%) from 29 different countries (Table 1), mainly from Europe (90,6%). Most respondents were from Greece (16.7%), Italy (9.4%) and France (8.3%). 78% of the respondents were working in university hospitals and 13% in tertiary hospitals (Table 2).

Automated electronic devices were used routinely in almost all outpatient facilities (96.7%), while manual auscultatory devices were used in 33.3% of the healthcare facilities (Table 2) with no difference among university and non-university hospitals ($p = 0.34$). Among manual auscultatory devices,

Table 1. Respondent characteristics – country of practice and healthcare facilities' characteristics.

Country of practice by geographical subregion*	N = 96 n (%)	
Northern Europe		
United Kingdom	6 (6.3)	
Finland	2 (2.1)	
Sweden	2 (2.1)	
Other	3 (3.1)	Estonia (1), Ireland (1), Norway (1)
Eastern Europe		
Hungary	4 (4.2)	
Czech Republic	3 (3.1)	
Poland	3 (3.1)	
Other	1 (1.0)	Romania (1)
Southern Europe		
Greece	16 (16.7)	
Italy	9 (9.4)	
Portugal	4 (4.2)	
Spain	3 (3.1)	
Other	1 (1.0)	Bosnia and Herzegovina (1)
Western Europe		
France	8 (8.3)	
Germany	6 (6.3)	
Switzerland	6 (6.3)	
Belgium	5 (5.2)	
Netherlands	2 (2.1)	
Other	3 (3.1)	Austria (1), Luxembourg (1), Monaco (1)
Western Asia		
Armenia	2 (2.1)	
Israel	2 (2.1)	
Turkey	2 (2.1)	
Other	2 (2.1)	Jordan (1), Lebanon (1)
South America		
Brazil	1 (1.0)	
Healthcare facility	N = 96 n (%)	
University hospital	75 (78.1)	
Tertiary hospital	12 (12.5)	
Secondary hospital	4 (4.2)	
Primary care	1 (1.0)	
Other/unspecified	4 (4.2)	
Approximate average number of outpatients appointments in the facility per month	N = 96 n (%)	
<100	17 (17.7)	
100–200	28 (29.2)	
>200	51 (53.1)	

*Subregions by United Nations geoscheme.

Table 2. Clinical blood pressure assessment.

	Total	University hospitals	Non-university hospitals
What type of blood pressure measuring device do you routinely use?	N = 96 n (%)	N = 76	N = 20
Manual auscultatory devices	32 (33.3)	23(31)	8 (42)
Mercury sphygmomanometer	9 (9.4)	6	3
Aneroid sphygmomanometer	23 (24.0)	10	10
Hybrid device (LED/LCD display or digital countdown)	15 (15.6)	9	6
Automated electronic devices	93 (96.9)	52(69)	11(58)
Automated oscillometric	79 (82.3)	62	17
Automated auscultatory	20 (20.8)	17	3
Semiautomated (manual inflation)	4 (4.2)	2	2
Which cuff sizes are available in your facility?	N = 95 n (%)	76	19
Small adult	68 (71.6)	59(77)	16(84)
Adult	94 (98.9)	74(99)	18(95)
Large adult	92 (96.8)	73(97)	18(95)
Where (on which arm) do you usually measure blood pressure?	N = 94 n (%)	74	20
Both arms at every visit	6 (6.4)	4(6)	2(5)
Both arms at first visit only	78 (83.0)	60(82)	17(90)
Dominant arm	5 (5.3)	4(6)	1(5)
Non-dominant arm	5 (5.3)	5	0
In which patient position do you routinely measure blood pressure?	N = 96 n (%)	76	19
Seated	89(90)	69(92)	17(90)
Standing	3(3.2	3(4)	0
Supine	5(5.3)	3(4)	2(11)
Do you perform unattended blood pressure measurement?	N = 96 n (%)	75	21
No	58 (60.4)	44(59)	12(63)
Yes	38 (39.6)	31(41)	7(37)
In every patient	10		
In patients with known white coat hypertension	17		
For research purposes	11		

aneroid devices were used by the majority of the participants (73.6%) and mercury sphygmomanometers by 28.8%. Regarding cuff size, adult and large adult cuff were available respectively in 99% and 97% of the centres while small adult cuff only in 72% of the centres. Wrist devices were used by 9.4%, and cuffless devices by 27.1% of the respondents. Cuffless devices are reported to be used by 28% of the participants form university hospitals and 21% for non-university hospitals ($p = 0.54$), mainly from central Europe. Unattended BP measurement was routinely performed by 39.6% of the respondents, with similar rate among university and non-university hospitals (41% vs 37%, $p = 0.72$).

BP measurements were performed by physicians (75%), specialised nurses (41%), general nurses (32%) and certified technicians (7.3%). BP was measured in seated (91.7%), standing (43.8%) and supine position (32.3%). Most of the respondents performed three (68.8%) or two (22.9%) BP measurements per outpatient (Table 2). Combining the three key accuracy criteria – taking at least three readings, measuring in both arms and using exclusively upper-arm cuff devices – only 48% of respondents adhered to the recommendations.

An orthostatic test was mainly performed in selected patients (76.0%) with symptoms of orthostatic hypotension, neurological diseases, diabetes, or those older than 65 years (Table 3). Regarding the methodology used for the orthostatic test, different modalities have been reported in terms of position changes, number of BP measurements after the postural change and time interval between the measurements (Figure 1). Orthostatic test was performed correctly in 45.5% of the participants, more often among those working in university hospital compared to secondary or tertiary hospitals (51.9% vs 16.7%, $p < 0.05$).

Home BP monitoring was routinely advised by 98.9% of the respondents, and 98.9% provided precise instructions on how to perform the required home BP measurements.

Table 3. Assessment of orthostatic blood pressure response.

Do you perform an orthostatic test?	N = 96 n (%)
Yes, in all patients	20 (20.8)
Yes, in selected patients	73 (76.0)
Patients with symptoms of orthostatic hypotension	72
Patients with neurological disease	47
Patients older than 65 years of age	45
Patients with diabetes	41
All patients at first visit	4
Patients with low blood pressure on routine measurement	2
Other	2
No	3 (3.1)
How do you perform an orthostatic test?	N = 93 n (%)
Seated to standing position	46 (49.5)
Supine to standing position	41 (44.0)
Supine to seated to standing position	7 (7.5)
How many times do you measure blood pressure after postural change?	N = 92 n (%)
Once	25 (27.1)
1 minute after postural change	6
2 minutes after postural change	7
3 minutes after postural change	2
5 minutes after postural change	1
Other or unspecified	9
Twice	56 (60.9)
1 and 2 minutes after postural change	3
1 and 3 minutes after postural change	30
1 and 5 minutes after postural change	4
Other or unspecified	19
Three times	9 (9.8)
1, 3 and 5 minutes after postural change	3
Other or unspecified	6
Five times	2 (2.2)
1, 2, 3, 5 and 10 minutes after postural change	1
1, 2, 3, 4 and 5 minutes after postural change	*1*

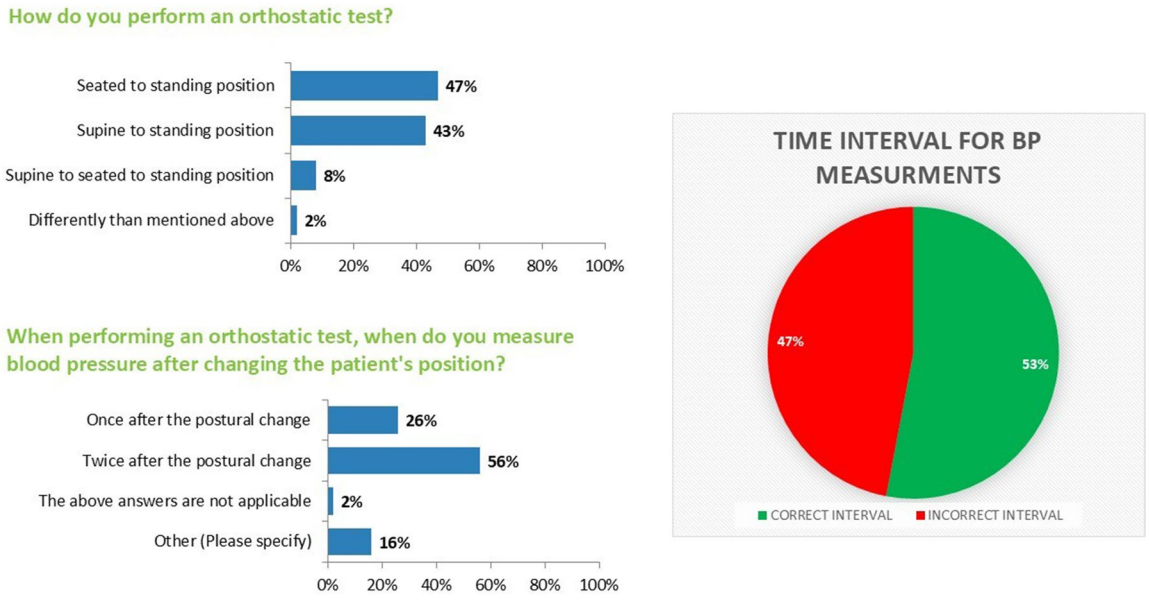

Figure 1. Reported methodology for orthostatic test.

Discussion

Our survey reveals considerable discrepancies in blood pressure measurement, even within highly specialised settings such as the ESH Excellence Centres, with substantial non-adherence to recommended guidelines.

There are three main types of errors in BP measurement: patient-related (recent intake of food, alcohol, caffeine or nicotine, low ambient temperature, bladder distension, or white-coat effect), device-related (use of inappropriate devices such as manual, wrist or cuffless devices, or uncalibrated equipment), and procedure-related (insufficient rest before or between readings, incorrect body position, inappropriate cuff size, or talking or moving during the measurement).

In our survey, we focused on device and procedure-related errors, given the difficulty of systematically and reliably assessing patient-related factors.

One in four respondents to the survey did not perform three or more BP measurements per visit. Multiple readings help to reduce the impact of short-term BP variability and to mitigate the alerting reaction associated with the first measurement [12]. Other studies have shown that averaging 2–3 readings correlates more closely with ambulatory BP monitoring (ABPM) and with cardiovascular outcomes [13]. Almost 20% of respondents also reported not measuring BP in both arms, even at the first visit, despite guideline recommendations. Assessing BP in both arms is important to detect inter-arm differences, allow for subsequent measurements to be taken on the arm with the higher BP, and to raise suspicion of subclavian or brachiocephalic artery stenosis. Up to one fifth of patients present with a systolic BP difference ≥10 mmHg between arms, particularly those with diabetes, chronic kidney disease, or established cardiovascular disease [10]. Wrist devices, reported as being used by some respondents, are recommended only when upper-arm measurements are not feasible (e.g. in patients with conical arms) but are otherwise associated with systematic errors [11]. Cuffless devices, which were also reported, are not validated for clinical use and should be avoided [10]. When combining the three key accuracy criteria – taking at least three readings, measuring in both arms and using exclusively upper-arm cuff devices – only 48% of respondents adhered to the recommendations. This means that approximately half of the specialists did not assess BP accurately, even within excellence centres. However, several determinants of measurement quality have not been evaluated, including the pre-measurement rest period, appropriate cuff sizing, the interval between repeated measurements, and the measurement environment. All these elements might even reduce the real number of ESH excellence centres fully adherent to correct BP measurements.

The survey also highlighted additional, though less frequent, inconsistencies in BP measurement practices. Manual devices, although once considered the gold standard, are prone to observer-related errors, digit preference, and bias, thus automatic monitors should be preferred. More than half of respondents did not perform orthostatic measurements in patients for whom guidelines recommend them, such as those with symptoms of postural hypotension, neurological disorders, diabetes, or older age (>65 years). Protocols for orthostatic BP varied considerably between centres, particularly with regard to timings and body position. Accurate assessment of orthostatic BP provides important information about the adequacy of treatment, and in some cases supports down titration in patients at risk of postural hypotension [11]. Almost all respondents advised patients to perform home BP monitoring (HBPM). Although most of the evidence base is derived from OBPM, HBPM allows the identification of specific phenotypes such as white-coat and masked hypertension, is more reproducible [14–16], and better predicts cardiovascular events [17–19]. In addition, HBPM is relatively inexpensive and may improve adherence and BP control [19,20]. For these reasons, HBPM is recommended in all major guidelines alongside OBPM, particularly when specific phenotypes are suspected or for long-term monitoring of treated hypertension [10,21]. A relatively high proportion of respondents reported performing unattended BP measurements. Evidence for the usefulness of unattended BP is limited, especially in terms of cardiovascular outcome prediction, and correlation with OBPM is low [22,23]. Consequently, ESH guidelines do not recommend its routine use. However, unattended BP readings are often closer to out-of-office measurements, as they reduce the white-coat effect [24]. This may be of value in the management of selected patients. The ESC guidelines recommend that unattended BP should be used according to local resources and preferences.

There is some debate about the reasons behind poor adherence to guideline-recommended measurement protocols. First, the full protocol can take more than 10 min, which is often impractical in busy clinics with high patient volumes. Second, logistical constraints, such as limited availability of

validated and calibrated devices or appropriately sized cuffs, can hinder best practice implementation. Third, suboptimal office conditions (e.g. noisy, crowded, or uncomfortable settings) may prevent ideal measurements. Finally, and perhaps most importantly, many healthcare professionals are not fully familiar with the detailed recommendations made by major guidelines and may not perceive small deviations as clinically significant, even in specialised centres.

The importance of accurate BP measurement has been thoroughly established in the literature, which is why all international guidelines emphasised adherence to correct protocols [10,21,25]. Overestimation can result in mislabelling normotensive individuals as hypertensive, exposing them unnecessarily to lifelong treatment, psychological distress, and adverse drug effects. Underestimation, on the other hand, can delay diagnosis and treatment, increasing the risk of hypertension mediated organ damage and cardiovascular events [11,26]. Misclassification also influences treatment initiation and titration, potentially leading to inappropriate therapy. Furthermore, because clinical trials and epidemiological studies use rigorous BP measurement protocols, applying trial-based thresholds in real-world settings where less precise methods are used may lead to misalignment between evidence and practice [27,28]. Finally, inaccurate diagnosis contributes to unnecessary costs for individuals and healthcare systems, either from inappropriate treatment or from complications due to untreated hypertension.

Non-adherence to measurement guidelines by clinicians has been well documented. Direct observation studies show that physicians rarely follow all recommended steps, and in one study, none of the observed BP measurements made by 84 physicians fully complied with guidelines [29]. In primary care, hypertension diagnosis is often based on incomplete or misinterpreted OBPM, with many cases relying on only one or two readings instead of the recommended three or more [30]. Two surveys of primary care teams found that most of them did not perform BP measurements at least three times per visit, did not consistently use proper patient positioning and almost all had significant gaps in knowledge regarding proper protocols for accurate assessment of BP [31,32]. A survey among clinicians specialised in hypertension, mainly cardiologists, found that accurate BP measurement (defined as bilateral measurement, multiple readings, and a 5-minute rest before measurements) was performed by only 23% of respondents. Despite this, most clinicians reported being confident in their BP assessments [33]. Two surveys in ESH Excellence Centres have previously examined protocol adherence, but these primarily focused on ambulatory and home BP practices [34,35].

The main strength of the present study is its large sample size, including numerous Excellence Centres across different countries. To our knowledge, this is the first survey specifically designed to evaluate office BP measurement practices in ESH Excellence Centres.

The findings of this study should be interpreted in light of several limitations. First, the survey achieved a response rate of 44%, which introduces the possibility of non-response bias; centres that chose not to participate may systematically differ from those that responded especially regarding adherence to current guidelines, potentially affecting the representativeness of the results. Second, although respondents were distributed across 29 countries, the sample may still lack full geographical balance, and differences in regional practices or resources might not be fully captured. Third, the survey targeted only ESH Excellence Centres, which limits the generalisability of the findings to broader healthcare settings, including non-accredited or smaller institutions that may operate under different constraints or workflows. Finally, as with any self-reported online survey, responses are subject to reporting bias and variability in how questions were interpreted across centres and we cannot exclude the presence of social desirability bias related to a systematic research error, in which the participant presents answers that are more socially acceptable than their true opinions or behaviours.

Building on the insights from this survey, future research should aim to expand data collection beyond ESH Excellence Centres to include a broader spectrum of clinical settings, enabling a more comprehensive understanding of practice variability across Europe and beyond. Furthermore, efforts should be directed towards harmonising BP measurement strategies across countries, as the adoption of standardised measurement protocols is essential for ensuring data comparability, improving diagnostic accuracy, and ultimately contributing to better patient outcomes.

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Author contributions

CRediT: **Costantino Mancusi**: Conceptualization, Data curation, Formal analysis, Investigation, Methodology; **Petra Sinigoj**: Investigation, Validation, Writing – review & editing; **Christina Antza**: Supervision, Writing – review & editing; **Andrej Belančić**: Writing – review & editing; **Justina Motiejunaite**: Writing – review & editing; **Paolo Palatini**: Methodology, Writing – review & editing.

Disclosure statement

The authors report there are no competing interests to declare.

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Data availability statement

Available for reasonable research questions, if asked.

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