ARAŞTIRMA MAKALESİ / *RESEARCH ARTICLE*

Correlation and Clinical Impact of Ambulatory, Home, and Office Measurements in Hypertensive Patients

Hipertansiyon Hastalarında Ambulatuar, Ev ve Ofis Ölçümlerinin Korelasyonu ve Klinik Etkisi

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ABSTRACT

Aim: *Hypertension is a major cardiovascular risk factor and the most common chronic disease. Being far from the targeted level in diagnosis and treatment has led to frequent questioning of measurement methods. Although out-of-office measurements are gaining prominence, the reliability and clinical effects of office and out-of-office measurement methods are open to question in terms of both usability and correlation. Our aim in this study was to evaluate the correlation of ambulatory, home, and office measurements and their clinical implications in hypertensive patients.*

Material and Method: *We evaluated out-of-office blood pressure measurements of patients who were followed up with a diagnosis of hypertension. Patients who were scheduled to have ambulatory blood pressure measurements were asked to have home measurements five days before this measurement. Oscillometric and auscultatory methods used for office measurements. Home measurements were performed with the patient's own calibrated devices. Ambulatory measurements were performed after five days of home follow-up.*

Results: *The study included 463 patients with a mean age of 49±15 years, 52% of whom were women. The number of patients diagnosed with non-regulated hypertension, based on home (256) and office (220) measurements, was much higher than the number of patients based on daytime (63) and average (87) ambulatory measurements. Among the patients considered regulated according to daytime ambulatory measurements, 157 (71.4%) were evaluated as hypertension according to office blood pressure, and 193 (75.4%) were assessed as non-regulated hypertension according to home blood pressure. When the correlation between blood pressure measurements was analyzed, it was observed that there was a high correlation between home and office blood pressure (r: 0.922, p<0.001) and a low correlation between ambulatory measurements and home and office blood pressure (r: 0.438, r: 0.459, p<0.001).*

Conclusion: *In a significant proportion of patients who were decided to be unregulated while being followed up with a diagnosis of hypertension due to office measurements, it was decided that the follow-up was regulated as a result of ambulatory measurements. The high correlation between home and office measurements and the low correlation between ambulatory measurements, which differs from these methods, are noteworthy.*

Keywords: *hypertension; out-of-office blood pressure; ambulatory blood pressure*

ÖZET

Amaç: *Hipertansiyon majör kardiyovasküler risk faktörü olmasının yanısıra en sık görülen kronik hastalıktır. Tanı ve tedavisinde hedeflenen düzeyden uzak olunması ölçüm yöntemlerinin sıkça sorgulanmasına neden olmuştur. Ofis dışı ölçümler ön plana çıkıyor olmakla birlikte ofis ve ofis dışı ölçüm yöntemlerinin güvenilirliği ve klinik etkileri hem kullanılabilirlik hem de korelasyon açısından sorgulanmaya açıktır. Bizim bu çalışmadaki amacımız hipertansiyon hastalarında ambulatuvar, ev ve ofis ölçümlerinin korelasyonunun ve bunun klinik etkilerinin değerlendirilmesidir.*

Materyal ve Metot: *Hipertansiyon tanısıyla takip edilen hastaların ofis dışı tansiyon ölçümleri değerlendirildi. Ambulatuvar tansiyon ölçümleri planlanan hastaların bu ölçümden beş gün öncesinde ev ölçümlerinin yapılması istendi. Ofis ölçümleri osilometrik ve oskülatuvar yöntemle ölçüldü. Ev ölçümleri hastaların kendi kalibre edilmiş cihazlarıyla yapıldı. Ambulatuvar ölçümler beş günlük ev takiplerinin sonrasında uygulandı.*

Bulgular: *Çalışmaya 49±15 yaş ortalamasına sahip ve %52'si kadın hastalardan oluşan 463 hasta dâhil edilmiştir. Ev (256) ve ofis (220) ölçümlerine göre regüle olmayan hipertansiyon tanısı alan hasta sayısı, gündüz (63) ve ortalama (87) ambulatuvar ölçümlerine göre regüle olmadığı tanısına varılan hastalardan çok daha fazlaydı. Gündüz ambulatuvar ölçümlerine göre regüle kabul edilen hastalardan 157 (%71,4)'si ofis tansiyonlarına göre, 193 (%75,4)'ü ev tansiyonlarına göre regüle olmayan hipertansiyon olarak değerlendirilmiştir. Tansiyon ölçümlerinin kendi aralarındaki korelasyona bakıldığında ev ve ofis tansiyonları arasında yüksek bir korelasyon (r: 0,922, p<0,001), ambulatuvar ölçümleri ile ev ve ilk ofis tansiyonları arasında ise düşük derecede bir korelasyon (r: 0,438, r: 0,459, p<0,001) olduğu gözlendi.*

Sonuç: *Ofis ölçümleri sonucu hipertansiyon tanısıyla takipli iken regüle olmadığına karar verilen hastaların çok önemli bir kısmında ambulatuvar ölçümler sonucu takibin regüle olduğuna karar verilmiştir. Ev ve ofis ölçümleri arasındaki yüksek korelasyon ile bu ölçüm yöntemlerinden ayrışan ambulatuvar ölçüm arasındaki düşük korelasyon dikkat çekicidir.*

Anahtar kelimeler: *hipertansiyon; ofis dışı kan basıncı; ambulatuvar kan basıncı*

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Introduction

Hypertension is the most common chronic disease and continues to be increasingly important as a major cardiovascular risk factor[1]. With the lowering of hypertension thresholds in current guidelines, the increase in its prevalence has become evident[2]. The clinical importance of hypertension is reinforced by the fact that it is a preventable risk factor, and blood pressure control dramatically reduces cardiovascular mortality and morbidity[3]. Every five mmHg decrease in systolic blood pressure is associated with a 13% reduction in the risk of cardiovascular events. In contrast, every two mmHg decrease in diastolic blood pressure is associated with a 12% reduction in the risk of cardiovascular events[4] –data obtained from office measurements. Despite the increasing number of treatment options and improved monitoring methods, treatment success is far from reaching the desired level. In this sense, it is clear that it is time for some innovations, especially in the new diagnosis and follow-up of hypertension, and it is obvious that current strategies need to be revised to achieve the targeted success at most points[5]. Ambulatory blood pressure measurement has significantly improved the disadvantages of office measurements in hypertensive patients and the general population[6].

For follow-up and treatment purposes, clinicians prefer office, home, or ambulatory blood pressure measurements by filtering the advantages and disadvantages of blood pressure measurement methods through their personal experience. Home measurements are often the out-of-office method of choice, and large analyses have demonstrated a clear association with cardiovascular events[7]. The HONEST study showed the prognostic value of morning systolic blood pressure measurements in predicting cardiovascular events. Its prognostic power is higher than office systolic measurements, especially in patients followed under treatment[8]. In the IDHOCO study, home measurements were shown to have a higher prognostic value in patients receiving treatment[7].

Out-of-office blood pressure monitoring is recommended to diagnose hypertension and the high-risk patient group[2,9,10]. Ambulatory blood pressure measurements have started to be given a leading role, with some limitations such as reachment difficulties and cost. The American College of Cardiology/American Heart Association (ACC/AHA) hypertension guidelines, the European Society of Cardiology (ESC) arterial hypertension guidelines, and the Turkish hypertension consensus report increasingly recommend ambulatory blood pressure measurement[2,11,12].

Ambulatory blood pressure measurements have been questioned in cardiovascular risk and mortality studies, and their value in this regard has been demonstrated[13–15]. Another important advantage of this measurement method, which brings an important power to clinicians in diagnosing and following hypertension, is the evaluation of blood pressure phenotypes of cardiovascular importance, such as masked hypertension and white coat hypertension. For example, masked hypertension can be diagnosed in 29.3% of patients diagnosed with prehypertension, and this diagnosis can be easily missed without out-of-office blood pressure measurement[16]. Similarly, superiority to office measurements has been demonstrated in hypertension phenotypes[17–19] known to have increased target organ damage, such as non dipper, nocturnal hypertension, and morning BP surge. Another advantage is the identification of hypotensive states, which may be an important obstacle to patient-physician cooperation in the treatment and follow-up of hypertension[20]. In this way, it can significantly reduce the rate of inadequate or unnecessary medication[11]. Despite all these important advantages and clear guideline recommendations, especially in patients with newly diagnosed hypertension, utilization rates are far from the desired levels[21,22]. At this point, home measurements still seem to be the first choice of clinicians for out-of-office blood pressure measurement due to their inclusion of the patient in the process, ease of application, and accessibility. In addition to the many advantages of ambulatory measurements, factors such as cost, accessibility, and intolerance of some patients can be counted among the disadvantages[2]. Home measurements have been shown to provide better blood pressure control than office measurements[23] and be superior to those in cardiovascular risk assessment[8,24]. Although cardiovascular outcomes and blood pressure control have been evaluated in many studies, the reliability of home measurements or their correlation with other measurement methods has received different attention. Office dependency on blood pressure measurement has been eliminated with technological developments, and the consistency and correlation of out-of-office measurements are especially important in the follow-up and treatment phase.

At this point, it is a clear fact that the success rate in the follow-up of a major risk factor such as hypertension, with treatment rates that are still not at the desired level despite the availability of treatment alternatives, should be increased. In this study, we aimed to investigate the correlation of ambulatory blood pressure

measurements, which have become clinically mandatory at many points, with office and home measurements and the clinical implications of this correlation.

Material and Methods

This study was conducted in two different centers between 01.06.2022–31.11.2022. Ambulatory blood pressure measurement was planned in patients with a diagnosis of hypertension who applied to the outpatient clinic in six months, and 463 patients were included in the study.

Patients over 18 years of age who were not planning to change their treatment and who had been receiving treatment for at least one month were included in the study. Patients were informed about the study, and written informed consent was obtained. Patients who refused to participate in the study and had a previous cardiovascular event were excluded. Office measurements were made by oscillometric and auscultatory methods using regularly calibrated devices with an arm cuff. Ambulatory blood pressure measurements were performed with regularly calibrated ambulatory blood pressure monitors. Patients with a complete 24-hour measurement and at least 70% of the measurements could be evaluated were included in the study. The patient monitored home measurements twice daily, both in the morning and evening, five days before the ambulatory blood pressure evaluation. For home measurements, the patients were required to perform the measurements themselves. Patients who were unable to meet this requirement were excluded from the study.

Limit values and stages for office, home, and ambulatory measurements were assessed as described in the European Society of Cardiology guidelines for managing arterial hypertension.

In office measurements, the patient's blood pressure was measured after resting in a sitting position for 5 minutes. Two measurements were taken, and the averages of these measurements were recorded. An automated device was used in one measurement, while the traditional auscultatory method was used in the other. For office measurements, the average of the two measurements was recorded.

The recommendation for home measurements is that the patient rest in a calm environment for 5 minutes, then sit in a sitting position with the back and arm resting on something. Each time, two measurements were taken in each arm and averaged. No additional recommendations were made beyond those made in routine practice in this way, aiming to reflect real-life data more clearly. All patients were requested to perform this measurement five consecutive days before the ambulatory measurement appointment. For home measurements, the device used by the patient must be on the list of validated devices. Patients who did not have were excluded from the study.

Ambulatory measurements were performed with validated and regularly calibrated Suntech® oscillometric devices. On the day of ambulatory measurements, the patient was advised not to isolate herself and to continue her daily routine similarly. She was told to keep her arm still during the measurement moments. For ambulatory measurements, comparisons were made over day, night and averages.

All patients included in the study were administered a mini-survey of two questions to assess patient comfort with ambulatory measurements (Table 1). The results have been saved.

Table 1. *Mini-questionnaire assessing ambulatory measurement comfort for patients*

Did the ambulatory blood pressure measurement cause any discomfort in your daily life and during sleep at night?
Yes No
If yes, which item best describes this feeling of discomfort?
○ Very mild
○ Mild
○ Moderate
○ Severe
○ Very severe

The local ethics committee's decision approved our study numbered 23/02-06.

Statistical Analysis

Analyses were performed using IBM Statistical Package for Social Sciences (SPSS) program version 20.0 for Windows® statistical program (IBM Inc. Chicago, IL, USA). Number, percentage, mean, standard deviation, median, minimum, and maximum were used to present descriptive data. The Kolmogorov-Smirnov Test evaluated the conformity of the data to normal distribution. The Pearson chi-square and Fisher's Exact tests were used to compare categorical data. The T-test was used to compare two independent numerical data, and the Mann-Whitney U test was used when the data were not equally distributed. The Pearson correlation

Table 2. *Averages of blood pressure measurements*

Parameter	N	Minimum	Maximum	Mean	SD
Mean systolic (mmHg)	463	91	164	118.59	14.67
Mean diastolic (mmHg)	463	53	101	72.12	10.17
Night systolic (mmHg)	463	79	157	118.94	15.22
Night diastolic (mmHg)	463	48	105	71.92	10.73
Daytime systolic (mmHg)	463	86	155	118.43	15.69
Daytime diastolic (mmHg)	463	49	100	72.32	11.24
Home systolic (mmHg)	463	100	160	134.89	17.05
Home diastolic (mmHg)	463	30	100	80.88	9.80
Office first systolic (mmHg)	463	100	160	133.69	15.34
Office first diastolic (mmHg)	463	60	95	81.78	9.08
Office second systolic (mmHg)	463	100	155	131.13	15.76
Office second diastolic (mmHg)	463	60	100	80.94	9.63

SD: Standard Deviation.

Table 3. *Demographic data of hypertension patients*

Parameter	N (n=463)	Percentage (%)
Gender		
Male	221	47.7
Female	242	52.3
Risk Factors		
DM	66	14.3
Hyperlipidemia	87	18.8
Coronary artery disease	57	12.3
COPD	5	1.1
Anxiety	93	20.1
Medications		
ACE/ARB	88	19
Ca channel blocker	267	57.7
Combined	239	51.6
Beta blocker	197	42.5
MRA	6	1.3
Hypertension (mmHg)		
Mean	87	18.8
Night	126	27.2
Daytime	63	13.6
Home	256	55.3
Office first	220	47.5
Office second	171	36.9

DM; Diabetes Mellitus, COPD; Chronic Obstructive Pulmonary Disease, MRA; Mineralocorticoid Reseptor Antagonist;

test was used to determine the correlation between measurements.

Results were considered significant at $p<0.05$.

Findings

The mean age of the 463 patients included in the study was 49.26±15.83 years, and the age distribution range was 19–84. Of the patients, 242 (52.3%) were female and 221 (47.7%) were male. When the mean blood pressure measurements of the patients were analyzed, it was found that home (134.9/80.9 mmHg) and office (133.7/81.8 mmHg) measurements were higher than the other measurements (Table 2). Anxiety 93 (20.1%) and hyperlipidemia 87 (18.8%) were more prevalent than the other diseases (Table 3). The most commonly used antihypertensive drug group was Ca channel blockers [267 (57.7%)] (Table 3).

Table 4. *Correlation between blood pressure measurements*

Parameter		Mean Systolic (mmHg)	Home Systolic (mmHg)	Office First Systolic (mmHg)	Office Second Systolic (mmHg)
Mean Systolic (mmHg)	r value	1.000	0.438	0.459	0.514
	p value	-	<0.001	<0.001	<0.001
Home Systolic (mmHg)	r value	0.438	1.000	0.922	0.759
	p value	<0.001	-	<0.001	<0.001
Office First Systolic (mmHg)	r value	0.459	0.922	1.000	0.811
	p value	<0.001	<0.001	-	<0.001
Office Second Systolic (mmHg)	r value	0.514	0.759	0.811	1.000
	p value	<0.001	<0.001	<0.001	-

The number of patients judged to be unregulated based on home (256) and office (220) BPs was much higher than on daytime (63) and average (87) ambulatory measurements. Among the patients who were considered regulated according to daytime ambulatory measurements, 157 (71.4%) were evaluated as non-regulated according to office blood pressure and 193 (75.4%) according to home measurements (Table 3).

When the correlation between blood pressure measurements was analyzed, it was observed that there was a high correlation between home and first-office blood pressures (r: 0.922, $p<0.001$) and a low correlation between ambulatory measurements and home and office blood pressures (r: 0.438, r: 0.459, $p<0.001$) (Table 4).

The number of patients evaluated as regulated in all blood pressure measurements was 140 (30.2%). When these patients were compared with patients with unregulated hypertension, it was observed that controlled blood pressure was significantly higher in the female gender (p: 0.003), DM (p: 0.021), and hyperlipidemia ($p<0.001$) groups. It was found that blood pressure regulation was lower in the ACE/ARB group ($p<0.001$), while there was no significant difference between the two groups in other antihypertensives (Table 5).

Table 5. *Comparison of patients with regulated and unregulated blood pressure*

Parameter	Regulated (n=140)	Unregulated (n=323)	p value
Age (Mean ± SD)	48.09±8.71	49.76±18.05	0.296
Gender			
Male	52	169	**0.003**
Female	88	154	
Resume			
DM	12	54	**0.021**
Hyperlipidemia	10	77	**<0.001**
Coronary artery disease	12	45	0.107
COPD	1	4	0.523
Anxiety	23	70	0.196
Medications			
ACE/ARB	13	75	**<0.001**
Ca channel blocker	84	183	0.504
Any combination	78	161	0.246
Beta blocker	65	132	0.266
MRA	0	6	0.114

SD: Standard Deviation; DM: Diabetes Mellitus; COPD: Chronic Obstructive Pulmonary Disease; ACE/ARB: Angiotensin Converting Enzyme/Angiotensin Reseptor Blocker; MRA: Mineralocorticoid Reseptor Antagonist.

Discussion

Our main finding in this study was that 71.4% of the patients who were followed up with a diagnosis of hypertension and/or were judged to be unregulated in office conditions were evaluated as regulated by ambulatory blood pressure measurements. Our second important result is that although there is a high correlation between office and home measurements, the correlation between these and ambulatory measurements is low.

Out-of-office blood pressure measurement is recommended at diagnosis and in high-risk patients. The European Society of Cardiology/European Society of Hypertension (ESC/ESH) arterial hypertension guidelines and the American College of Cardiology/American Heart Association (ACC/AHA) hypertension guidelines strongly recommend out-of-office measurement at the diagnostic stage[2,6,15]. It is widely used as out-of-office, home and ambulatory measurements. While some advantages and disadvantages of both measurement methods come to the fore, it is undoubtedly a fact that clinicians use home measurements extensively in practice during follow-up and diagnosis. In this sense, although it provides a serious advantage that the patient is included in the follow-up, the reliability of a method used with this frequency has been questioned by researchers, especially with the recent prominence of ambulatory blood pressure assessment. At this point, office measurements are another corner of the question mark.

Ambulatory blood pressure measurements have become more prominent with the current guidelines. While the ESC/ESH guidelines for arterial hypertension emphasize some special conditions for ambulatory blood pressure measurement, the Turkish HT consensus report's recommendation to be used whenever possible reinforces the importance attributed to this measurement method[6,27].

Ambulatory and home measurements were compared with office measurements, particularly regarding cardiovascular disease risk assessment and outcomes. However, the correlation between these measures and their impact on diagnostic and therapeutic approaches has not received the same attention. Banegas JR[13] et al. concluded that ambulatory measurements are a stronger predictor of all-cause mortality than office measurements. In this study, the mean office systolic blood pressure was 147 mmHg for surviving patients, while the mean daytime systolic blood pressure was 131 mmHg in 24-hour measurements. Despite having different patient groups and study purposes, if these averages are evaluated for diagnostic purposes, similar to the results in our study, clinical measurements in the same patient group would indicate a diagnosis of stage I hypertension.

In contrast, the same would not be true for ambulatory daytime measurements. In another study evaluating type 2 diabetic patients, ambulatory blood pressure measurements were compared with office measurements in terms of cardiovascular risk classification, and a clear difference was obtained in the direction of ambulatory measurements[15]. Along with this unsurprising result, it is noteworthy that the mean clinical systolic measurement in the entire patient population was 148 mmHg at baseline. In contrast, the daytime mean was 131 mmHg in 24-hour measurements.

In the study by Uallachain GM[25] et al., interesting results were obtained comparing ambulatory and office measurements. Treatment was changed in 38% of patients, new treatment was initiated in 32%, and in 14% of patients who were considered hypertensive based on office measurements, the diagnosis was excluded by ambulatory measurement, and medication was discontinued. In our study, 157 (71.4%) patients diagnosed with stage I hypertension in office measurements were excluded by ambulatory measurements. In light of all

these data, there are other problems with office measurements, which are frequently questioned regarding cardiovascular risk assessment and endpoints, and where ambulatory measurements are found to be more valuable than office measurements in most studies. When the impact of office and ambulatory measurements on diagnosis and treatment is evaluated, it is obvious that ambulatory measurements will play a game-changing role at most points.

The correlation between ambulatory and home measurements was evaluated in some studies, and it was concluded that a moderate correlation was found[26]. However, researchers need to have clearer results on this issue. A meta-analysis evaluating these two measures concluded that which measure has better predictive power for CV risk[27] needs to be clarified. In another study, cardiovascular events and mortality endpoints of home and ambulatory measurements were evaluated, and the results obtained were insufficient to make a clear judgment[28]. In parallel, one study emphasized the stronger association of ambulatory measurements with left ventricular mass index and wall thickness, [14] while another study showed that home measurements were more strongly associated[29]. While all these studies focused on endpoints, the home and ambulatory measurement correlation assessment has yet to be emphasized much. The results of our study emphasize the inconsistency of office measurements, the correlation between home and office was also demonstrated. In this respect, the reliability of home measurements is again questionable. Indeed, in addition to evidence[30] that home measurements are not always reported accurately by patients, [31] it has also been shown that they may cause patient preconditioning that causes anxiety in the measurements.

Making a clear assessment of the reliability of home measurements and their correlation with ambulatory measurements is becoming scientific confusion. In this respect, we need to question the reliability and correlation of home and office measurements.

It is known that including the patient in the follow-up in home measurements increases medication adherence[32] and reduces the rate of clinic visits in follow-up[33]. This improves patient compliance and tolerance to home measurements and makes a clear contribution to assessing different blood pressure phenotypes[34]. It has also been shown to increase patient compliance with treatment medication[35].

Home measurements have been compared with office measurements in some studies. A meta-analysis found that blood pressure control was better in home measurements than office measurements[23]. The Finn-Home study shows that home measurements are significantly superior to office measurements regarding cardiovascular risk correlation[24]. Other studies compare the two measurement methods regarding cardiovascular risk and events and show the superiority of home measurements[8,24,36]. From another perspective, when the correlation of home, office, and ambulatory measurements was evaluated in these studies, the mean systolic blood pressure values were found to be 135.2 mmHg for both home and office measurements, especially during the follow-up period in the study by Shimada K[8] et al. However, in some studies, the results are different. In another study comparing home and ambulatory measurements with outcomes of cardiovascular events or mortality, the systolic mean of office measurements was 131.6 mmHg compared to 123.6 mmHg for home measurements[28]. In the study by Ragot S[37] et al., home and ambulatory measurements were correlated at the beginning of treatment, whereas office measurements were not. In our study, the correlation between home and office measurements was significant, whereas ambulatory measurements did not share this correlation. At this point, home measurements, which seem more dependent on personal characteristics, may give different results in societies at different sociocultural levels. The significant correlation observed between office and home measurements in our study may be parallel to these data in the existing literature, and the dissociation of the ambulatory measurement at this point emphasizes the question mark regarding home measurements.

In addition to the advantages of ambulatory measurements, such as reflecting the blood pressure values that the patient is exposed to in their own living space or in daily life conditions that seem more appropriate, a significant negative aspect that can be counted is seen in terms of patient comfort. As a result of the mini-survey in which the study patients were asked to evaluate whether they felt discomfort related to the 24-hour ambulatory measurement, 87% found it moderately or more uncomfortable. Higher compliance with home measurements and patient involvement in their treatment are considered among the advantages of ambulatory measurements reported in some studies. In contrast, patient comfort and less accessibility are considered to be the most prominent disadvantages

of ambulatory measurements. One study said that this aspect of ambulatory measurement limits its practical applicability[36]. Likewise, ambulatory measurements are not well tolerated by patients, especially at night[38]. In this respect, the results of our study support this view. An additional result is the question mark regarding the effect of inconvenience on the ambulatory measurements.

Some studies have evaluated ambulatory measurements as cost-effective[21,39], and our results may support this. Indeed, our results showed that ambulatory measurement, a more competent measurement method, significantly reduced the rate of new initiation or up-titration of medication in our patient population. Considering the positive effects of proper blood pressure control in cardiovascular and many other systems, cost-effectiveness becomes even more significant[40].

Considering all these data, the power of ambulatory blood pressure measurements to guide treatment in hypertensive patients is seen. The data in our study support the existing literature in the same patient group. This may play an important role in initiating pharmacologic treatment or titration of medication in clinical follow-up. The place of home measurements alone in decision-making seems open to question.

Conclusion

In our study, ambulatory measurements significantly excluded the follow-up results decided by office measurements. Considering the correlation between home measurements, where clinicians feel safer regarding patient follow-up and treatment, and office measurements, a serious question arises.

One of the important results of our study is that home measurements, which have been substituted at most points in clinical practice where office measurements are being used less and less as decision-makers, appear to be significantly discordant with ambulatory measurements. This result may reduce the importance attributed to home measurements in many studies, which is important because it is currently one of the most preferred measurement methods in clinical practice. In this sense, our study raises scientific attention about the reliability of home measurements, but large-scale studies are needed to provide a stronger recommendation.

Limitations

Considering the prevalence and incidence of hypertension, the number of patients in our study needs to be increased to make a stronger recommendation. Another limitation is the adjustment of cuff sizes to make blood pressure measurements more personalized. In our study, patients' own devices and standard cuff sizes were used in home measurements, while two sizes of cuffs, large and small, were used in ambulatory measurements. Our third limitation is that follow-up data, which could strengthen the consistency of our results, should have been collected.

References

1. Zhou B, Bentham J, Bixby H, Di Cesare M, Danaei G, Cowan JM, et al. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 populationbased measurement studies with 19. 1 million participants. Lancet. 2017;389:37–55.
2. Whelton PK, Carey RM, Aronow WS, Casey DE Jr, Collins KJ, Dennison Himmerfarb C, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/ APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation. 2018;138:e426–e83.
3. Ettehad D, Emdin CA, Kiran A, Anderson GS, Callender T, Emberson J, et al. Blood pressure lowering for prevention of cardiovascular disease and death: a systematic review and meta-analysis. Lancet. 2016;387:957–67.
4. Verdecchia P, Gentile G, Angeli F, Mazzotta G, Mancia G, Reboldi G. Influence of blood pressure reduction on composite cardiovascular endpoints in clinical trials. Journal of Hypertension. 2010;28:1356–65.
5. Yusuf S, Wood D, Ralston J, Reddy KS. The World Heart Federation's vision for worldwide cardiovascular disease prevention. Lancet. 2015;386(9991):399–402.
6. Hansen TW, Kikuya M Thijs L, Björklund-Bodegård K, Kuznetsova T, Ohkubo T, et al.; IDACO investigators. Prognostic superiority of daytime ambulatory over conventional blood pressure in four populations: a meta-analysis of 7030 individuals. Journal of hypertension. 2007;25(8):1554–64.
7. Niiranen TJ, Asayama K, Thijs L, Johansson JK, Ohkubo T, Kikuya M, et al. Outcome-driven thresholds for home blood pressure measurement: International Database of Home blood pressure in relation to Cardiovascular Outcome. Hypertension. 2013;61:27–34.
8. Shimada K, Kario K, Kushiro T, Teramukai S, Zenimura N, Ishikawa Y, et al. Prognostic significance of on-treatment home and clinic blood pressure for predicting cardiovascular events in hypertensive patients in the HONEST study. Journal of Hypertension. 2016;34(8):1520–7.
9. Liu LS, Wu ZS, Wang JG, Wang W, et al. 2018 Chinese guidelines for prevention and treatment of hypertension. A report of the revision committee of Chinese Guidelines for. Prevention and Treatment of Hypertension. J Geriatr Cardiol. 2019;16:182–241.

10. Jones NR, McCormack T, Constanti M, McManus RJ. Diagnosis and management of hypertension in adults: NICE guideline update 2019. British Journal of General Practice. 2020;70(691):90–91.
11. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. J Hypertens. 2018;36:1953–2041.
12. Aydogdu S, Guler K, Bayram F, Altun B, Derici U, Abacı A, et al. Turk hipertansiyon uzlası raporu 2019. Turk Kardiyol Dern Ars. 2019;47(6):535–46.
13. Banegas JR, Ruilope LM, de la Sierra A, Vinyoles E, Gorostidi M, de la Cruz JJ, et al. Relationship between clinic and ambulatory bloodpressure measurements and mortality. N Engl J Med. 2018;378:1509–20.
14. Mancia G, Zanchetti A, Agabiti-Rosei E, Benemio G, De Cesaris R, Fogari R, et al. Ambulatory blood pressure is superior to clinic blood pressure in predicting treatment-induced regression of left ventricular hypertrophy: SAMPLE Study Group-Study on Ambulatory Monitoring of Blood Pressure and Lisinopril Evaluation. Circulation. 1997;95:1464–70.
15. Salles GF, Leite NC, Pereira BB, Nascimento EM, Cardoso CR. Prognostic impact of clinic and ambulatory blood pressure components in high-risk type 2 diabetic patients: the Rio de Janeiro Type 2 Diabetes Cohort Study. Journal of Hypertension. 2013;31(11):2176–86.
16. Thijs L, Hansen TW, Kikuya M, Björklund-Bodegård, K, Li Y, Dolan E; IDACO Investigators. The International Database of Ambulatory Blood Pressure in relation to Cardiovascular Outcome (IDACO): protocol and research perspectives. Blood Pressure Monitoring. 2007;12(4):255–62.
17. Chen Y, Liu J, Zhen Z, Zuo Y, Lin Q, Liu M, et al. Assessment of left ventricular function and peripheral vascular arterial stiffness in patients with dipper and nondipper hypertension. J Investig Med. 2018;66:319–24.
18. Wang C, Deng W, Gong WY, Zhang J, Zhang QZ, Ye ZC, et al. Nocturnal hypertension correlates better with target organ damage in patients with chronic kidney disease than a nondipping pattern. J Clin Hypertens. 2015;17:792–801.
19. Kawauchi D, Hoshide S and Kario K. Morning home blood pressure and cardiovascular events in a Japanese general practice population over 80 years old: the JHOP study. Am J Hypertens. 2018;31:1190–6.
20. DivisonGarrote JA, Banegas JR, De la Cruz JJ, Escobar-Cervantes C, De la Sierra A, Gorostidi M, et al. Hypotension based on office and ambulatory monitoring blood pressure. Prevalence and clinical profile among a cohort of 70, 997 treated hypertensives. J Am Soc Hypertens. 2016;10:714–23.
21. Lovibond K, Jowett S, Barton P, Caulfield M, Heneghan C, Hobbs FD, et al. Cost-effectiveness of options for the diagnosis of high blood pressure in primary care: a modelling study. Lancet. 2011;378:1219–30.
22. Siu AL; U. S. Preventive Services Task Force. Screening for high blood pressure in adults: US Preventive Services Task Force recommendation statement. Ann Intern Med. 2015;163:778–786.
23. Duan Y, Xie Z, Dong F, Wu Z, Lin Z, Sun N, et al. Effectiveness of home blood pressure telemonitoring: a systematic review and metaanalysis of randomised controlled studies. J Hum Hypertens. 2017;31:427–37.
24. Niiranen TJ, Hänninen M, Johansson J, Reunanen A, Jula AM. HomeMeasured Blood Pressure Is a Stronger Predictor of Cardiovascular Risk Than Office Blood Pressure. Hypertension. 2010;55:13461351.
25. Uallachain GN, Murphy G, Avalos G. The RAMBLER study: the role of ambulatory blood pressure measurement in routine clinical practice a cross-sectional study. Ir Med J. 2006;99:276–79.
26. Stergiou GS, Skeva II, Zourbaki AS, Mountokalakis TD. Selfmonitoring of blood pressure at home: how many measurements are needed? J Hypertens. 1998;16:725–31.
27. Shimbo D, Abdalla M, Falzon L, Townsend RR, Muntner P. Studies comparing ambulatory blood pressure and home blood pressure on cardiovascular disease and mortality outcomes: a systematic review. J Am Soc Hypertens. 2016;10:224–34. e17.
28. Sega R, Facchetti R, Bombelli M, Cesana G, Corrao G, Grassi G, et al. Prognostic value of ambulatory and home blood pressures compared with office blood pressure in the general population: follow-up results from the Pressioni Arteriose Monitorate e Loro Associazioni (PAMELA) study. Circulation. 2005;111:1777–83.
29. Shimbo D, Pickering TG, Spruill TM, Abraham D, Schwartz JE, Gerin W. Relative utility of home, ambulatory, and office blood pressures in the prediction of end-organ damage. Am J Hypertens. 2007;20:476–82.
30. Johnson KA, Partsch DJ, Rippole LL, McVey DM. Reliability of self-reported blood pressure measurements. Arch Intern Med. 1999;159:2689–93.
31. Logan AG, Dunai A, McIsaac WJ, Irvine MJ, Tisler A. Attitudes of primary care physicians and their patients about home blood pressure monitoring in Ontario. J Hypertens. 2008;26:446–52.
32. Parati G, Omboni S, Albini F, Piantoni L, Giuliano A, Revera M, et al. TeleBPCare Study Group. Home blood pressure telemonitoring improves hypertension control in general practice. The TeleBPCare study. J Hypertens. 2009;27:198–203.
33. Wilson MD, Johnson KA. Hypertension management in managed care: the role of home blood pressure monitoring. Blood Press Monit. 1997;2:201–06.
34. Parati G, Pickering TG. Home blood-pressure monitoring: US and European consensus. Lancet. 2009;373:876–8.
35. Fletcher BR, Hartmann-Boyce J, Hinton L, McManus RJ. The effect of self-monitoring of blood pressure on medication adherence and lifestyle factors: a systematic review and meta-analysis. American Journal of Hypertension. 2015;28(10):1209–21.
36. Mengden T, Weisser B. Monitoring of Treatment for Arterial Hypertension: The Role of Office, Home, and 24 h Ambulatory Blood Pressure Measurement. Dtsch Arztebl Int. 2021;118(27–28):473–478.
37. Ragot S, Genès N, Vaur L, Herpin D. Comparison of three blood pressure measurement methods for the evaluation of two antihypertensive drugs: feasibility, agreement, and reproducibility of blood pressure response. American Journal of Hypertension. 2000;13(6):632–9.
38. Viera AJ, Lingley K, Hinderliter AL. Tolerability of the Oscar 2 ambulatory blood pressure monitor among research participants: a cross-sectional repeated measures study. BMC Medical Research Methodology. 2011;11(1):1–7.
39. Krakoff LR. Cost-effectiveness of ambulatory blood pressure: a reanalysis. Hypertension. 2006;47:29–34.
40. Ardahanli I, Akhan O, Aslan R, Akyuz O. The relationship between blood pressure regulation and alexithymia variability in newly diagnosed essential hypertension patients. Journal of Surgery and Medicine. 2021;5(8):768–771.