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## Comparison of Automated Office Blood Pressure With Office and Out-Off-Office Measurement Techniques

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**Comparison of automated office blood pressure with office and out-off-office measurement techniques: a systematic review and meta-analysis.**

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1 **Abstract**

2 Automated office blood pressure (AOBP) has emerged as valuable tool to assess  
3 patient's blood pressure (BP) status, but the lack of strong evidences to establish a  
4 threshold value for hypertension diagnosis limits its use in clinical practice.

5 We aimed at synthesizing the published literature through a meta-analysis of studies  
6 comparing AOBP with other BP measurement techniques and at analysing the  
7 differences between AOBP and physician's office BP, non-physician's office BP,  
8 daytime ambulatory BP monitoring (ABPM) and home BP monitoring (HBPM). We  
9 searched PubMed database for articles published up to April 2018; eligible studies  
10 compared AOBP with office and/or out-of-office measurement techniques and  
11 reported the BP differences or BP values obtained. Twenty-six studies, for a total of  
12 7,116 patients were included in the analysis. AOBP values were lower than physician  
13 (systolic blood pressure, SBP -10.48 mmHg [95% CI -13.15 to -7.81] / diastolic blood  
14 pressure, DBP -4.44 mmHg [95% CI -6.07 to -2.80]) and non-physician office ones  
15 (SBP -6.89 mmHg [95% CI -8.75 to -5.04] / DBP -3.82 mmHg [95% CI -4.86 to -  
16 2.78]). No significant differences were detected between AOBP and daytime ABPM  
17 (SBP -1.85 mmHg [95% CI -4.50 to 0.79] / DBP 0.12 mmHg [95% CI -1.42 to 1.66])  
18 and HBPM (SBP -2.65 mmHg [95% CI -8.42 to 3.12]) / DBP -1.67 mmHg [95% CI -  
19 4.20 to 0.87]).

20 AOBP readings did not differ significantly from out-of-office blood pressure, still  
21 remaining an office technique; it may improve hypertension diagnosis by overcoming  
22 some of office BP limitations, including the white-coat effect.

23

24 **Key words:** hypertension; automated office blood pressure; meta-analysis;  
25 ambulatory blood pressure monitoring; white-coat effect.

## 1 **Introduction**

2 Office Blood Pressure (OBP) has been traditionally considered as the standard blood  
3 pressure (BP) measurement technique for hypertension diagnosis<sup>1,2</sup>, however several  
4 factors may lead to inaccurate readings. OBP is in fact poorly reproducible,  
5 particularly the auscultatory method, it can be responsible for the white coat effect  
6 and does not allow to detect masked hypertension<sup>3,4</sup>. To overcome these limitations,  
7 besides the recommendation of using out-of-office techniques as ambulatory BP  
8 monitoring (ABPM) and home BP monitoring (HBPM)<sup>1,2</sup>, a fully automated  
9 unattended BP measurement technique, referred to as Automated Office Blood  
10 Pressure (AOBP), has been developed and gained increasing popularity over the last  
11 years. It has been designed to record multiple BP readings in the healthcare centre,  
12 with the patient resting alone in a quiet room<sup>5</sup>. Three automated oscillometric devices,  
13 the BpTRU, the Microlife WatchBP Office and the Omron 907 XL, are currently  
14 available and have been used to compare AOBP with other measurement techniques<sup>6</sup>.  
15 Since the first study with the BpTRU device<sup>4</sup>, a number of reports demonstrated that  
16 BP values are lower when measured with AOBP compared with OBP, thus  
17 confirming the expected decrease in white coat effect<sup>7-9</sup>. Similarly, the correlation  
18 between AOBP readings and awake ABPM has been extensively investigated,  
19 producing conflicting results<sup>4,10</sup>, while few studies analysed the relationship between  
20 AOBP and HBPM<sup>11,12</sup>. For all these advantages, AOBP could represent an attractive  
21 alternative or an integrative option for BP measuring in the office setting. The results  
22 of the SPRINT trial<sup>13</sup>, in which AOBP was used as BP measurement technique, led  
23 the 2017 American College of Cardiology (ACC)/American Heart Association (AHA)  
24 hypertension guideline<sup>2</sup> to lower the diagnostic threshold for hypertension diagnosis  
25 to  $\geq 130/80$  mmHg.

1 Despite having emerged as a valuable tool to assess the patient's BP status, the lack of  
2 strong evidences to establish a threshold value for hypertension diagnosis<sup>3,14</sup> limits the  
3 use of AOBP in clinical practice and only the 2016 hypertension Canadian guideline<sup>15</sup>  
4 currently recommends AOBP as the preferred method to measure office BP.  
5 Therefore, the aim of our study is to compare unattended AOBP measurement with  
6 office and out-of-office measurement techniques, such as physician and non-  
7 physician (nurses or technicians) office BP, daytime ABPM and HBPM through a  
8 meta-analysis.

9

## 10 **Methods**

11 All supporting data are available within the article and its online supplementary files.

### 12 Search strategies, eligibility criteria and information sources.

13 We conducted a systematic research through the PubMed database for publications on  
14 AOBP and its comparison with other BP measurement techniques, up to April 2018,  
15 without starting date restriction. Different keyword combinations were used to  
16 identify clinical studies on AOBP: in particular we chose as search terms for titles and  
17 abstracts: “unattended OR automated office OR unattended office” AND “blood  
18 pressure OR office blood pressure OR home blood pressure monitoring OR  
19 ambulatory blood pressure OR ABPM OR HBPM OR OBP”. Then, we examined the  
20 [www.clinicaltrials.gov](http://www.clinicaltrials.gov) website to identify published and on-going trials on AOBP.

### 21 Study selection and data collection process

22 Articles eligible for inclusion in the analysis were reports comparing AOBP with  
23 other BP measurement techniques, in particular, daytime ABPM, HBPM, classical  
24 physician's office and nurse or technicians office BP measurements. Studies were  
25 considered for inclusion if the reports satisfied the following inclusion criteria: (1) a

1 detailed study protocol; (2) use of unattended AOBP as BP measurement technique in  
2 accordance with the established recommendations<sup>3,15</sup>; (3) comparison between  
3 unattended AOBP readings and physician OBP and/or non physician (nurse or  
4 technician) OBP and/or daytime ABPM and/or HBPM; (4) unattended AOBP  
5 measured with one of the three validated available devices and reporting of the AOBP  
6 device used (BpTRU, BpTRU Medical Devices, Coquitlam, BC, Canada / Omron  
7 HEM-907, OMRON, Kyoto, Japan / MicrolifeWatchBP Office, Microlife, Tapei,  
8 Taiwan); (5) reporting of BP values or BP differences (between AOBP and an other  
9 BP measurement technique) obtained and reporting of a measure of variance as  
10 standard deviation (SD) or standard error (SE). Exclusion criteria were: I) incomplete  
11 or incorrect reporting data on BP values or differences; II) conference abstracts and  
12 other unpublished data; III) duplicate reporting (the manuscript with the largest  
13 sample of patients was selected); IV) AOBP readings not in agreement with the  
14 current recommendations<sup>3,15</sup> or using a not validated device.

#### 15 Clinical data extraction and end points

16 Titles and abstracts of retrieved publications were reviewed. Firstly, articles were  
17 selected by title and abstracts and divergences were solved after consensus of two  
18 investigators (MP and FR). Then all the identifies studies were evaluated as complete  
19 reports, assessing eligibility and computerizing the relevant information. The  
20 references of eligible manuscripts were also inspected to identify possible duplicate  
21 publications of the same data or missing information. The following relevant data  
22 were extracted: general study characteristics (sample size, study design, AOBP device  
23 used, AOBP technique description adopted, authors, journal and year of publication),  
24 baseline characteristics of the study sample (age, sex, diabetes, antihypertensive  
25 therapy), BP values or BP differences for each BP measurement technique used.

1 The co-primary endpoints of our meta-analysis were the BP difference between  
2 AOBP and office BP and between AOBP and daytime ABPM, while the difference  
3 between AOBP and home blood pressure monitoring and non-physician office blood  
4 pressure were evaluated as secondary end-points. When possible, we performed a  
5 subgroup analysis for studies using BpTRU or the other two AOBP devices (Omron  
6 907 XL and Microlife WatchBP Office).

### 7 Statistical analysis

8 Continuous variables were reported as median (IQR), while categorical variables were  
9 expressed as percentage (%). RevMan 5 (The Cochrane Collaboration, The Nordic  
10 Cochrane Centre, Copenhagen, Denmark) was used for the statistical main analysis,  
11 according to a random-effect (RE) model with generic inverse-variance weighting and  
12 results are expressed as mean change [95% confidence interval (C.I.)]. When studies  
13 did not report the BP difference and its SD, BP difference was calculated as the  
14 difference between AOBP and OBP/Non-physician OBP/daytime ABPM/HBPM  
15 readings, while the SD was calculated according to the following formula [ $\sigma(\text{AOBP} -$   
16  $\text{other BP technique}) = \sqrt{\sigma(\text{AOBP})^2 + \sigma(\text{other BP technique})^2}$ ]<sup>16</sup>. The proportion of  
17 variability explained by true heterogeneity (i.e. between-studies variability) was  
18 estimated by calculating the  $I^2$  for each analysis, with  $I^2$  values of 25% representing  
19 mild statistical inconsistency, 50% representing moderate statistical inconsistency,  
20 and 75% representing high statistical inconsistency. Assessment of publication bias  
21 was performed by inspection of funnel plots followed by the trim-and-fill procedure.  
22 Statistical significance of 0.05 was fixed for all hypothesis tests. We performed a  
23 meta-regression analysis using a random effect model to appraise the effect of age on  
24 the observed BP difference, using OpenMetaAnalyst for Sierra<sup>17</sup>.

1 Finally, we explored quality of included trials according to Cochrane statements  
2 selection bias (allocation and random sequence generation) and attrition bias  
3 (incomplete outcome data).

4

## 5 **Results**

### 6 Characteristic of the included studies

7 We identified 316 potential publications that were evaluated for eligibility at title and  
8 abstract level (Fig. 1). Of the 49 full text records assessed, 23 were excluded: eight  
9 were duplicate reports, five did not use a validated AOBP device, in three studies  
10 AOBP readings were not taken in agreement with recommendations, five did not  
11 report any comparison between unattended AOBP and at least one of the other BP  
12 measurement techniques mentioned above and finally two studies were excluded  
13 because of missing data (Table S1). 26 studies published between 2003 and 2018,  
14 including a total of 7,116 patients were eligible for the analysis<sup>4,8,10,12,15,18-38</sup>  
15 Characteristics of the included studies are reported in Table 1. The studies were both  
16 cross-sectional (n=4), prospective (n=4), retrospective (n=3) or randomized clinical  
17 trial (n=2); in thirteen reports the study design was not specified (Table S2). Only  
18 attrition bias was relevant in 7 studies due to missing data (BP readings missing,  
19 patients lost at follow-up). 16 studies compared AOBP with traditional OBP taken by  
20 physicians<sup>4,8,10,12,19,21-24,27,28,30,32-34,37</sup>; 16 studies compared AOBP with awake ABPM  
21<sup>4,8,10,18,19,20,22,24-26,29,33-35,37,38</sup>, AOBP was compared with HBPM in 7 studies  
22<sup>10,12,24,27,28,30,38</sup> and with non-physician OBP in 10 studies<sup>4,8,15,18-20,31,36-38</sup>.

23 Clinical characteristics of the included patients are summarized in the Appendix  
24 (Table S3); the median age of our subjects was 60.5 years [IQR 55.8-64] and 48.5%

1 [IQR 44.8-53.2] were men, 23.2% [IQR 18.8-35.6] were diabetic and 86.4% [IQR  
2 54.3-99.2] were under antihypertensive therapy.

3

#### 4 Comparison between BP measurement techniques

5 The difference between unattended AOBP values and those measured with OBP,  
6 daytime ABPM, HBPM and non-physician OBP was assessed; when possible, a  
7 subgroup analysis to compare BP difference obtained by using the BpTRU device  
8 with the one measured by using the Microlife WatchBP Office and the Omron HEM  
9 907 XL instruments was performed.

10 Sixteen studies, for a total of 3,022 patients, compared AOBP with traditional OBP  
11 measurement. Both systolic and diastolic AOBP values were significantly lower in  
12 the AOBP group, by -10.48 mmHg [95% CI -13.15 to -7.81] and by -4.44 mmHg  
13 [95% CI -6.07 to -2.80] respectively (Figure 2). When the 4 studies, using the  
14 Microlife WhatchBP Office or the Omron HEM 907 XL (indicated as Other devices),  
15 were analysed separately, the results were comparable to those of the main analysis  
16 (SBP difference: -9.55 mmHg [95% CI -17.15 to -1.95]; DBP difference -4.70 mmHg  
17 [95% CI -8.03 to -1.38]).

18 Interestingly, the main pooled analysis of 16 studies comparing AOBP with daytime  
19 ABPM (with a total of 3,193 included patients) showed no significant differences  
20 between AOBP and daytime ABPM both for systolic (-1.85 mmHg [95% CI -4.50 to  
21 0.79;]) and diastolic values (0.12 mmHg [95% CI -1.42 to 1.66]) (Figure 3), that were  
22 consistent within the two subgroups analysed.

23 Seven studies were available for the comparison between AOBP and HBPM  
24 measurements. No significant differences were found for both systolic (-2.65 mmHg  
25 [95% CI -8.42 to 3.12]) and diastolic values (-1.67 mmHg [95% CI -4.20 to 0.87]) as

1 detailed in Supplemental Figure S1. When the 3 studies using the BpTRU device  
2 were analysed separately, both systolic (-7.84 mmHg [95% CI -12.50 to -3.18]) and  
3 diastolic (-4.21 mmHg [95% CI -5.45 to -2.96]) AOBP values were significantly  
4 lower than HBPM ones, while those taken with other devices did not differ  
5 significantly from home readings (4.83 mmHg [95% CI -2.16 to 11.82] and 1.24  
6 mmHg [95% CI -0.10 to 2.59]) for systolic and diastolic BP, respectively)  
7 (Supplemental Figure S1).

8 In the last analysis comparing AOBP with office BP taken by nurses or technicians  
9 (non-physician OBP), BP difference was similar to that obtained comparing AOBP  
10 with OBP measured by physicians (-6.89 mmHg [95% CI -8.75 to -5.04] and -3.82  
11 mmHg [95% CI -4.86 to -2.78], for systolic and diastolic BP respectively)  
12 (Supplemental Figure S2).

13 To explore a potential confounding effect of age on the results of the present meta-  
14 analysis we performed a meta-regression analysis for mean age, which did not show  
15 any significant effect on the evaluated outcomes (Supplemental Figure S3).

16 Visual inspection of the funnel plots did not show a skewed or asymmetrical  
17 distribution (Supplemental Figure S4 to S7).

18

## 19 **Discussion**

20 Auscultatory office BP measurement has been traditionally considered as the standard  
21 technique for hypertension diagnosis<sup>1</sup>. Although in a research setting the auscultatory  
22 method remains the standard approach for testing new BP measurement devices, it is  
23 now accepted that it can be relatively inaccurate in routine clinical practice<sup>39,40</sup>. In  
24 fact, the last ESH/ESC and ACC/AHA hypertension guidelines<sup>1,2</sup> acknowledge the  
25 importance of a new and fully automated oscillometric techniques, referred to as

1 AOBP, as useful mean to obtain accurate and reproducible BP readings in the office  
2 setting.

3 The main finding of this meta-analysis of 26 studies, is that AOBP technique  
4 measurement provides significantly lower BP values than the office one, whilst  
5 AOBP readings were not significantly different from the evaluated out-of-office  
6 techniques (daytime ABPM and HBPM). Furthermore, our data demonstrated  
7 discrepancies in terms of BP values among the different devices validated for AOBP.

8 The white coat effect (defined as rise of office BP values in a clinical setting induced  
9 by an alerting reaction to physicians or nurses<sup>1</sup> can, at least partly account for the  
10 observed difference in BP values between AOBP and OBP. Several factors have been  
11 shown to affect the occurrence of the white coat effect such as age, female sex and  
12 non-smoking habit<sup>1,41</sup>. To evaluate a possible confounding effect of age on the  
13 observed difference between OBP and AOBP we performed a meta-regression  
14 analysis, which did not show any significant impact of age on the evaluated outcomes.  
15 Significant evidence, including a recent meta-analysis<sup>42</sup>, indicates that BP values  
16 taken by physicians are systematically higher than those recorded by nurses<sup>43,44</sup>. In  
17 our meta-analysis we found that Office BP values, even when measured by nurses (or  
18 technicians), were significantly higher than AOBP ones, making it possible to assume  
19 that the BP rise induced by nurses is enough to overestimate BP in many patients. to  
20 consider the OBP measured by nurses as overestimating BP values in a majority of  
21 the patients.

22 Furthermore, AOBP allows to overcome some important limitations of OBP  
23 measurements, including the absence of a period of rest before the readings,  
24 conversation with patient and the “Hawthorne Effect”. Finally, OBP does not allow to

1 detect masked hypertension and requires confirmation by out-of-office techniques for  
2 hypertension diagnosis or treatment titrating.

3 By integrating the results of previous studies<sup>8-10,33</sup>, our results showed that AOBP  
4 values are not statistically different to those measured with out-of-office techniques  
5 (ABPM and HBPM), strongly recommended by all the international hypertension  
6 guidelines<sup>1,2</sup>. In particular, no significant differences were found between AOBP and  
7 both HBPM and daytime ABPM values in the overall cohort of patients.

8 Evidence demonstrated that both AOBP and daytime ABPM correlate better than  
9 office BP with cardiovascular outcomes<sup>45</sup> and intermediate measures of target organ  
10 damage including intima media thickness<sup>46</sup> and left ventricular mass index<sup>47</sup>.

11 Furthermore, AOBP is less expensive than ABPM and can overcome some limitations  
12 of HBPM, that can be affected by technical inaccuracies and by mistakes in under-  
13 reporting or over-reporting data<sup>48,49</sup>, with HBPM readings reported by patients  
14 markedly different from those stored in the device memory.

15 In the comparison between AOBP and out-of-office techniques, subgroup analysis  
16 showed that AOBP systolic BP values, measured with Omron HEM 907 XL and  
17 WatchBP Office, were between 10 to 5 mmHg higher than those measured by using  
18 BpTRU; on the other hand, differences in diastolic BP were smaller. These findings  
19 are in agreement with previous reports. In fact, some studies and a meta-analysis, all  
20 reporting AOBP values obtained by using the BpTRU, showed significant differences  
21 in terms of BP values between AOBP and daytime ABPM, in particular with systolic  
22 AOBP levels being lower than ABPM<sup>50-52</sup>. Another study<sup>53</sup> compared BpTRU  
23 readings with those taken by using the WatchBP Office in a severely obese  
24 population: the mean BpTRU values were 9.4 (11.6)/3(7.7) mmHg lower than  
25 WatchBP Office measurements, underlying a marked difference and “the need for

1 formal validation of the devices”. On the contrary, Myers et al.<sup>54</sup> showed no  
2 significant differences for systolic BP by using the BpTRU or Omron HEM 907 XL  
3 devices, but only 50 subjects were recruited for the analysis.

4 Various factors could be responsible for this discrepancy, such as differences in the  
5 devices internal algorithm and differences in threshold values for small cuffs between  
6 BpTRU and Omron HEM 907 XL<sup>55,56</sup>, and lower mean BP values<sup>31</sup>. We acknowledge  
7 that, even if the results of the subgroup analysis confirmed previous reports, it is  
8 difficult to make robust conclusions due to the small number of included studies. It  
9 appears reasonable to suggest the constant use of the same device while readings  
10 translation or comparison between different AOBP devices should be done with  
11 extreme caution.

12 In conclusion, the routine use of AOBP could reduce the risk of hypertension over-  
13 diagnosis and over-treatment<sup>57,58</sup> and allow to overcome several OBP technique  
14 limitations as mentioned above. The results of this meta-analysis, indicating that  
15 AOBP readings did not differ significantly from out-of-office measurements, provide  
16 further evidence to establish the cut-off for hypertension diagnosis with AOBP  
17 technique, thereby contributing to the diffusion and implementation of its routinely  
18 use into clinical practice.

19

## 20 **Perspectives**

21 AOBP is an emerging BP measurement technique and may improve hypertension  
22 diagnosis by overcoming some of Office BP limitations, mostly through the  
23 elimination of white-coat effect. The differences in BP values across different AOBP  
24 devices, the absence of an accepted AOBP threshold for hypertension diagnosis limit  
25 its use. Based on the data of the present meta-analysis, AOBP threshold for the

1 diagnosis of hypertension should be considered the same as for daytime ABPM and  
2 HBPM. This will allow the diffusion of this technique and facilitate the interpretation  
3 and generalization of the findings of the clinical trials in which this BP measurement  
4 technique is adopted.

5

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7 All the authors contributed extensively to the work presented in this article. F.R. and  
8 F.V. conceived the study; M.P., S.M. and F.R. did the literature search and analysed  
9 the data; E.P., F.R., J.B. and F.D.A. contributed to study protocol and key data  
10 interpretation; M.P., S.M. and F.R. wrote the manuscript; F.D.A., F.R. and F.V.  
11 critically revised the manuscript. The corresponding author had full access to all of  
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16 None.

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1 **Novelty and Significance**

2 **What Is New?**

- 3 • This is the first meta-analysis comparing AOBP with office and out-of-  
4 office blood pressure measurement techniques.
- 5 • Office blood pressure values measured both by physicians and nurses  
6 are significantly higher than AOBP ones;
- 7 • There are no differences between AOBP values and day-time ABPM  
8 or HBPM

9 **What Is Relevant**

- 10 • AOBP allows to overcome the white-coat effect on the diagnosis of  
11 hypertension and is less expensive than ABPM
- 12 • AOBP values are comparable with those measured with out-of-office  
13 techniques and therefore the threshold for the diagnosis of  
14 hypertension should be considered the same;
- 15 • The use of the same AOBP device should be preferable and readings  
16 translation or comparison between different AOBP devices should be  
17 done with extreme caution.

18 **Summary**

19 Automated Office Blood Pressure (AOBP) is a fully automated unattended  
20 blood pressure technique, which records multiple BP readings with the patient  
21 resting alone in a quiet room. Despite the obvious advantage of eliminating the  
22 white coat effect, the lack of a universally accepted cut-off for hypertension  
23 diagnosis limits its use. The results of the present meta-analysis indicating that  
24 AOBP readings are not significantly different from out of office values,

1 contribute to expanding our knowledge on this technique and provide strong  
2 evidence for establishing a cut-off for hypertension diagnosis.

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4

1 **Figure Legends**

2 **Figure 1. Flow chart of literature search and study selection.**

3

4 **Figure 2. Comparison between AOBP and Office BP. A) SBP difference between**  
5 **AOBP and Office BP. B) DBP difference between AOBP and Office BP.**

6 Forest plot of the BP difference between AOBP and Office BP. Central squares of  
7 each horizontal line represent the mean BP difference for each study. Horizontal lines  
8 indicate the range of the 95% CI and the vertical line indicates a BP mean difference  
9 of 0 (which indicates no differences in BP values between the two measurement  
10 techniques).

11

12 **Figure 3. Comparison between AOBP and daytime ABPM. A) SBP difference**  
13 **between AOBP and daytime ABPM. 2) DBP difference between AOBP and**  
14 **daytime ABPM.**

15 Forest plot of the BP difference between AOBP and daytime ABPM. Central squares  
16 of each horizontal line represent the mean BP difference for each study. Horizontal  
17 lines indicate the range of the 95% CI and the vertical line indicates a BP mean  
18 difference of 0 (which indicates no differences in BP values between the two  
19 measurement techniques). DT\_ABPM = daytime ABPM.

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## 1 Tables

Studies	AOBP Device	Sample size	Type of comparison	AOBP Description
Myers M.G., <i>Am J Hypertens.</i> 2003 <sup>4</sup>	BpTRU	22	AOBP vs. Office BP AOBP vs. daytime ABPM AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 3 readings with 2-min interval. Average obtained using the three measurements.
Culleton B.F., <i>Blood Press Monit.</i> 2006 <sup>19</sup>	BpTRU	107	AOBP vs. Office BP AOBP vs. daytime ABPM AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 5 readings over 25 min with 5-min interval.
Myers M.G., <i>Blood Press Monit.</i> 2009* <sup>21</sup>	BpTRU	62	AOBP vs. Office BP	AOBP undertaken in the absence of a healthcare professional; 5 readings with 1 or 2-min interval. Average obtained using the five measurements.
Myers M.G., <i>J Hypertens.</i> 2009 <sup>8</sup>	BpTRU	309	AOBP vs. Office BP AOBP vs. daytime ABPM AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 5 readings with 1 or 2-min interval.
Myers M.G., <i>Blood Press Monit.</i> 2010 <sup>10</sup>	BpTRU	300	AOBP vs. Office BP AOBP vs. daytime ABPM AOBP vs. HBPM	AOBP undertaken in the absence of a healthcare professional; 5 readings with 1-min interval.
O'shaughnessy M.M., <i>Blood Press Monit.</i> 2011 <sup>23</sup>	BpTRU	80	AOBP vs. Office BP	AOBP undertaken in the absence of a healthcare professional; 6 readings with 2-min interval. Average obtained discarding the first and using the remaining five.
Godwin M. <i>Fam Pract.</i> 2011 <sup>33</sup>	BpTRU	654	AOBP vs. Office BP AOBP vs. daytime ABPM	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1 or 2-min interval. Average obtained discarding the first and using the remaining five.
Myers M.G., <i>BMJ</i> 2011† <sup>22</sup>	BpTRU	555 (total) 299 vs 249	AOBP vs. Office BP AOBP vs. daytime ABPM	AOBP undertaken in the absence of a healthcare professional; 5 readings with 2-min interval.
Lamarre-Clichè M. <i>Can J Cardiol.</i> 2011 <sup>24</sup>	BpTRU	99	AOBP vs. Office BP AOBP vs. daytime ABPM AOBP vs. HBPM	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval. Average obtained discarding the first and using the remaining five.

Myers M.G. <i>Blood Press Monit.</i> 2012 <sup>25</sup>	Microlife WatchBP Office	100	AOBP vs. daytime ABPM	AOBP undertaken in the absence of a healthcare professional; 3 readings with 1-min interval.
Andreadis E.A. <i>Am J Hypertens.</i> 2012 <sup>‡</sup> <sub>26</sub>	Microlife WatchBP Office	162	AOBP vs. daytime ABPM	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval.
Edwards C., <i>J Am Soc Hypertens.</i> 2013 <sub>18</sub>	BpTRU	329	AOBP vs. daytime ABPM AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval. Average obtained discarding the first and using the remaining five.
O'shaughnessy M.M., <i>Perit Dial Int.</i> 2013 <sup>38</sup>	BpTRU	17	AOBP vs. non-physician BP AOBP vs. daytime ABPM AOBP vs. HBPM	AOBP undertaken in the absence of a healthcare professional; 5 readings with 2-min interval.
Armstrong D., <i>Blood Press Monit.</i> 2015 <sup>20</sup>	BpTRU	422	AOBP vs. daytime ABPM AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 5 readings with 2-min interval.
Padwal R.S. <i>J Am Soc Hypertens.</i> 2015 <sub>35</sub>	Microlife WatchBP Office	100	AOBP vs. daytime ABPM	AOBP undertaken in the absence of a healthcare professional; 5 min of rest, 3 readings with 1-min interval.
Filipovský J. <i>Blood Press.</i> 2016 <sup>§</sup> <sub>12</sub>	BpTRU	353 (total) 114	AOBP vs. Office BP ( <i>n</i> = 353) AOBP vs. HBPM ( <i>n</i> = 114)	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval. Average obtained discarding the first and using the remaining five.
Wohlfahrt P. <i>J Hypertens.</i> 2016 <sup>15</sup>	BpTRU	2145	AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval. Average obtained discarding the first and using the remaining five.
Rinfret F <i>Can J Cardio.</i> 2017a   <sup>31</sup>	BpTRU <sup>c</sup> ; Omron HEM 907 XL <sup>d</sup>	65 <sup>c</sup> 64 <sup>d</sup>	AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 5 min of rest, 3 readings with 1-min interval for Omron HEM 907 XL device; 6 readings with 1-min interval, average obtained discarding the first and using the remaining five, for the BpTRU device.
Andreadis E.A. <i>J Am Soc Hypertens.</i> 2017 <sup>27</sup>	Microlife WatchBP Office	211	AOBP vs. Office BP AOBP vs. HBPM	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval.
Rinfret F. <i>Can J</i>	BpTRU	288	AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 6 readings

<i>Cardiol.</i> 2017b <sup>6</sup>				with 1-min interval. Average obtained discarding the first and using the remaining five.
Siddiqui M. <i>Hypertension</i> 2017 <sup>34</sup>	BpTRU	31	AOBP vs. Office BP AOBP vs. daytime ABPM	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval. Average obtained discarding the first and using the remaining five.
Bauer F. <i>Hypertension</i> 2018# <sup>30</sup>	Omron HEM 907 XL	107	AOBP vs. Office BP AOBP vs. HBPM	AOBP undertaken in the absence of a healthcare professional; 5 min of rest, 3 readings with 1-min interval.
Filipovský J. <i>Blood Press.</i> 2018** <sup>32</sup>	BpTRU	172	AOBP vs. Office BP	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval. Average obtained discarding the first and using the remaining five.
Bhatnagar A. <i>Kidney Blood Press. Res</i> 2018 <sup>28</sup>	Omron HEM 907 XL	120	AOBP vs. Office BP AOBP vs. HBPM	AOBP undertaken in the absence of a healthcare professional; 5 min of rest, 3 readings with 1-min interval.
Ringrose J.S. <i>Can J Cardiol.</i> 2018 <sup>29</sup>	BpTRU	96	AOBP vs. daytime ABPM	AOBP undertaken in the absence of a healthcare professional; 6 readings with 1-min interval. Average obtained discarding the first and using the remaining five.
Andreadis E.A. <i>J Am Heart Assoc.</i> 2018*** <sup>37</sup>	Omron HEM 907 XL	146	AOBP vs. Office BP AOBP vs. daytime ABPM AOBP vs. non-physician BP	AOBP undertaken in the absence of a healthcare professional; 5 min of rest, 3 readings with 1-min interval.

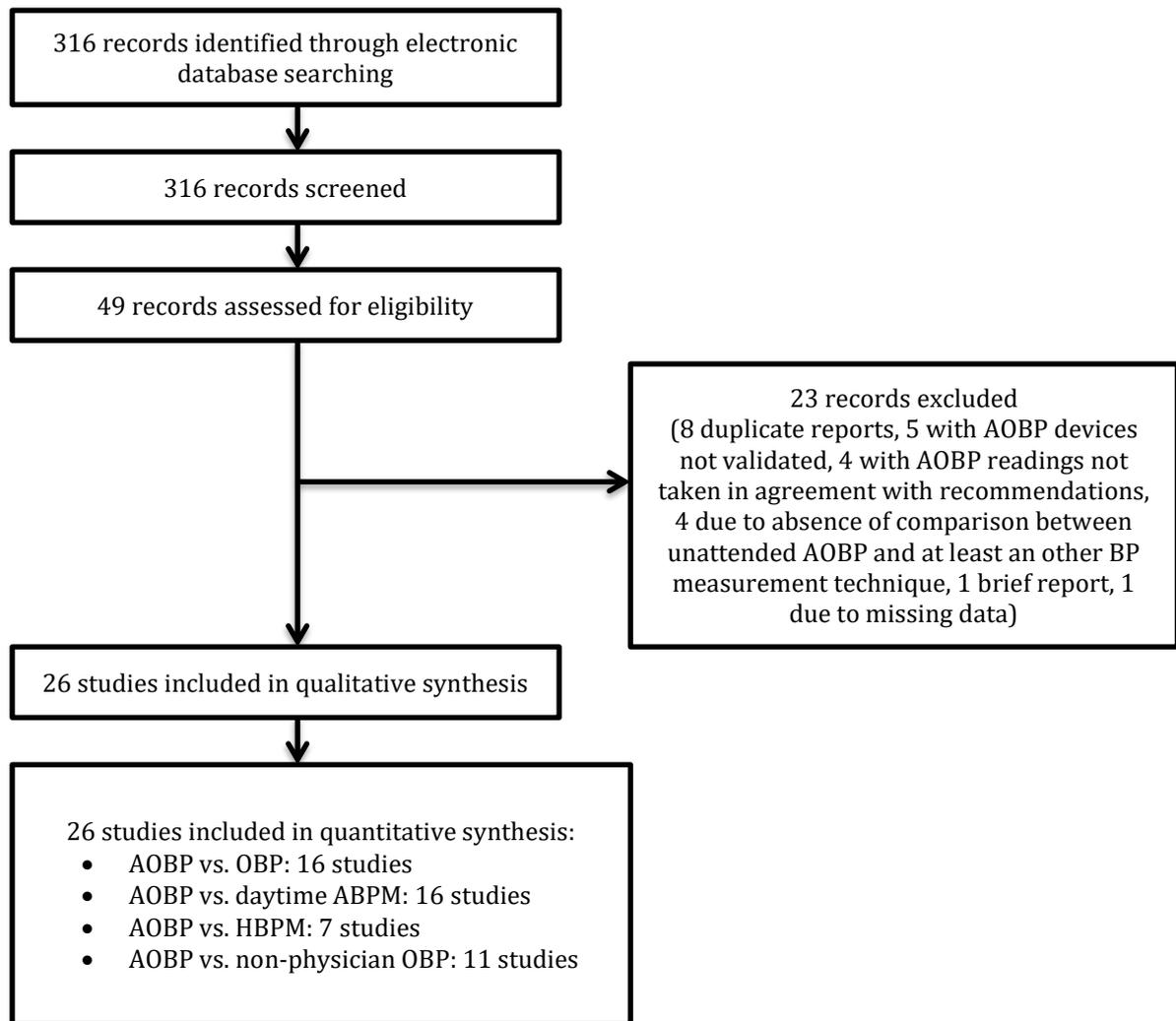
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2 1. Main characteristics of the 24 studies meeting inclusion criteria.

3 \*Overlap population with Myers M.G., *J Hypertens* 2009<sup>8</sup>. The reported OBP measurement was performed by a specialist during follow-up visit, while in  
4 Myers M.G., *J Hypertens* 2009<sup>8</sup>, it was performed by the family physician and was therefore included; data on nonphysician-OBP and daytime ABPM were  
5 excluded. In this study, office BP was measured twice by the hypertension specialist: during the first visit, and on a follow-up visit, with an interval between  
6 the first and second consultant of 61 days. Considering the long interval time, only the first office BP measurement was considered in the analysis. †In this  
7 study, OBP was measured twice, before and after the enrollment. Only BP values measured after the enrolment were included in the analysis. ‡Overlap  
8 population with *Andreadis EA J Am Soc Hypertens* 2017 [27], only the comparison between AOBP and daytime ABPM was included in the analysis. §In this  
9 study, mean HBPM values were available only in 114 of 353 patients. ||Prospective randomized factorial parallel 4-group study comparing AOBP estimated  
10 by BpTRU and Omron HEM 907 devices in closed vs. open areas. Only data comparing non-physicians OBP with AOBP taken in closed areas with either

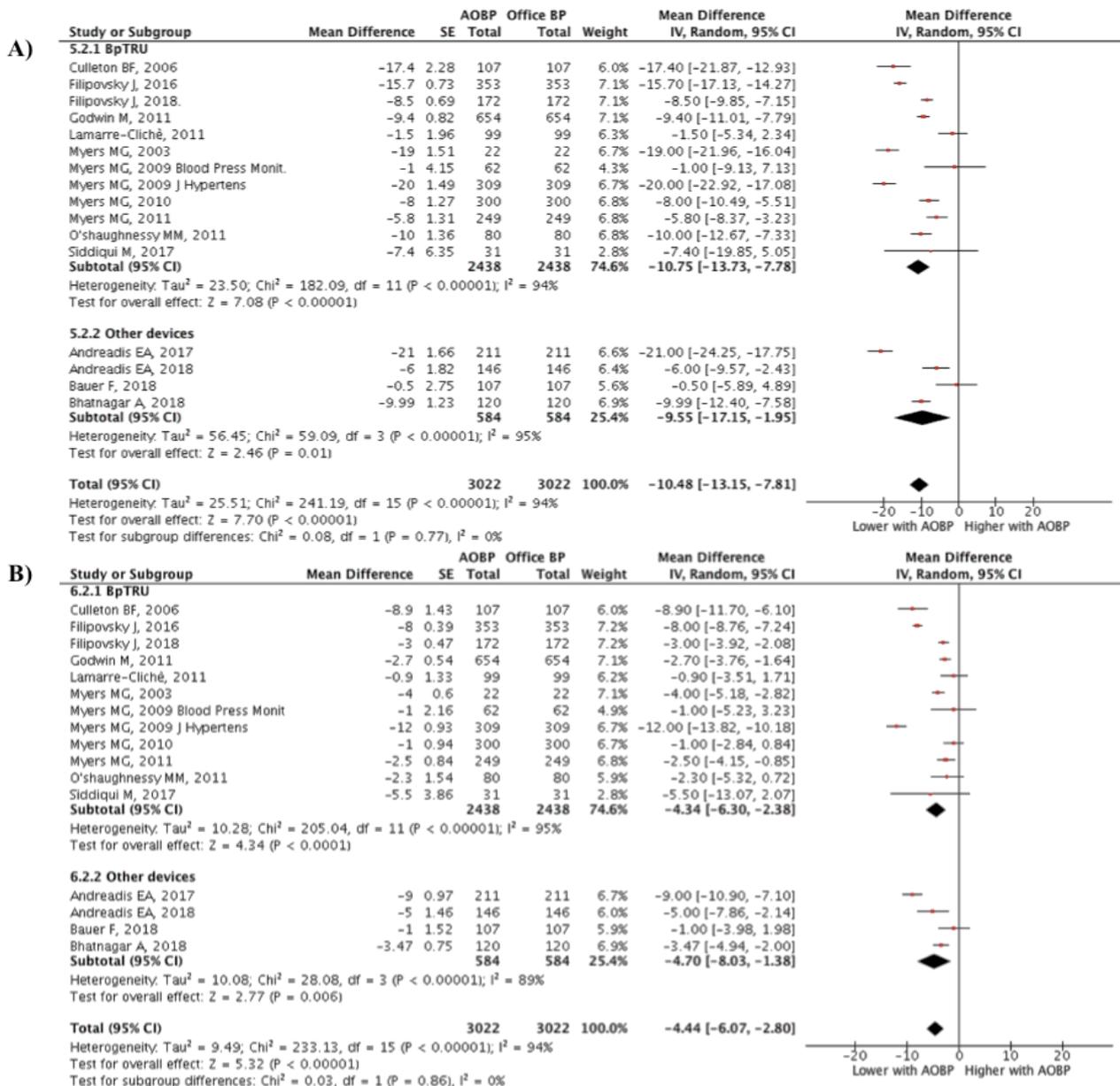
1 BpTRU or Omron HEM 907 devices were included in the analysis. ¶AOBP vs. OBP taken by trained nurse in both research and clinical settings were  
2 compared. Only data about the clinical setting were considered. #Patients were divided into two groups: group 1 comparing unattended AOBP with OBP and  
3 HBPM, while group 2 comparing unattendend AOBP with attendend AOBP and HBPM. Only data regarding Group 1 were included in our analysis. \*\*The  
4 study evaluates the relationship between unattended AOBP, attended OBP and ABPM. Attended OBP was performed with both auscultatory method ( $n=172$ )  
5 and oscillometric devices ( $n=102$ ), therefore only auscultatory data were considered (larger sample of patient). \*\*\*Tthe study reported both auscultatory and  
6 oscillometric OBP readings for all patients. We only considered oscillometric data (to avoid rounding off of readings to the nearest zero value).

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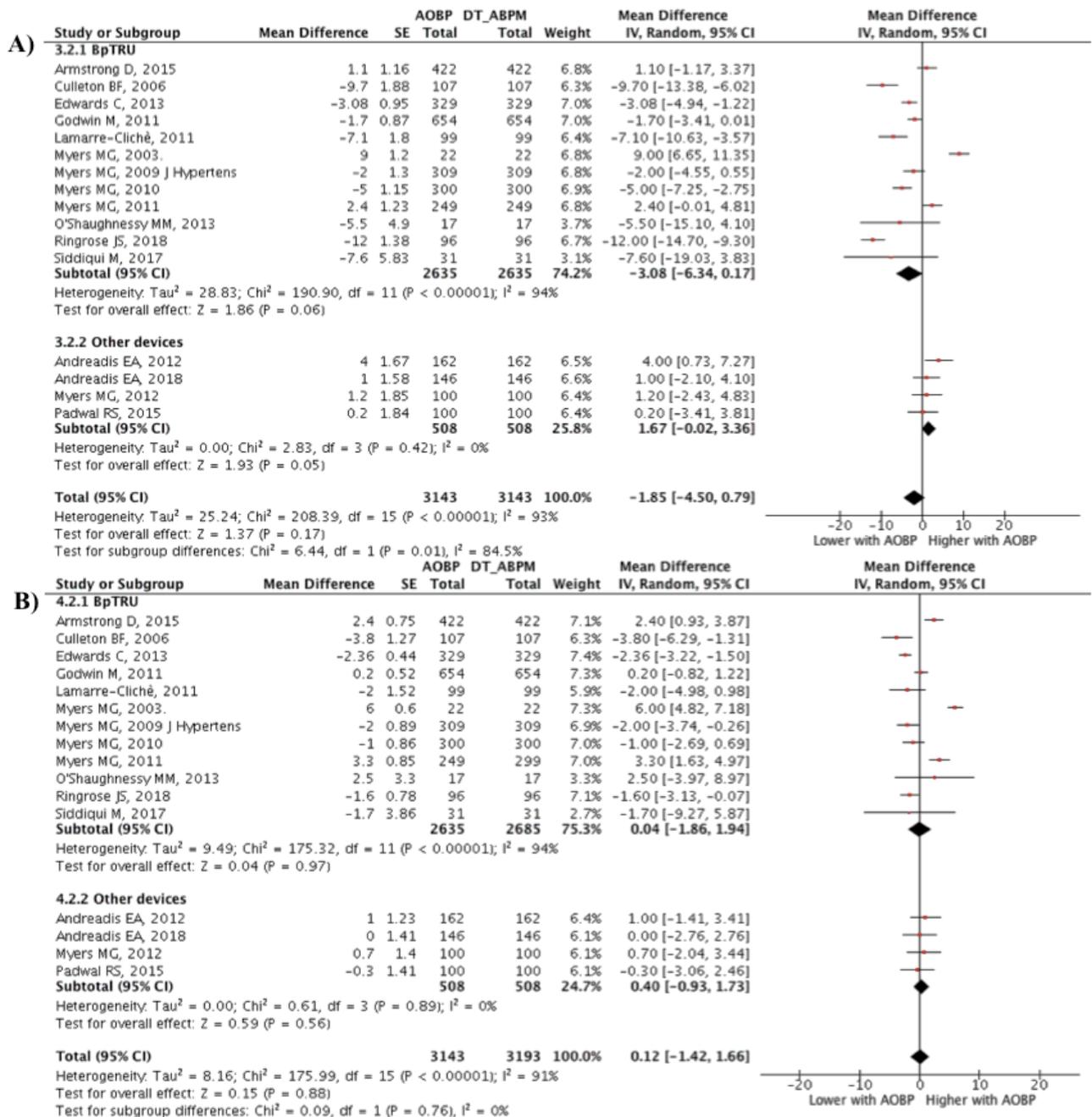


**Figure 1.** Flow chart of literature search and study selection.

ABPM indicates ambulatory BP monitoring; AOBP, automated OBP; BP, blood pressure; HBPM, home BP monitoring; and OBP, office BP.



**Figure 2.** Comparison between automated office BP (AOBP) and office BP (OBP). **A**, Systolic BP difference between AOBP and OBP. **B**, Diastolic BP difference between AOBP and OBP. Forest plot of the BP difference between AOBP and OBP. Central squares of each horizontal line represent the mean BP difference for each study. Horizontal lines indicate the range of the 95% CI, and the vertical line indicates a BP mean difference of 0 (which indicates no differences in BP values between the 2 measurement techniques).



**Figure 3.** Comparison between automated office BP (AOBP) and daytime ambulatory BP monitoring (ABPM). **A,** Systolic BP difference between AOBP and daytime ABPM (DT\_ABPM). **2)** Diastolic BP difference between AOBP and DT\_ABPM. Forest plot of the BP difference between AOBP and DT\_ABPM. Central squares of each horizontal line represent the mean BP difference for each study. Horizontal lines indicate the range of the 95% CI, and the vertical line indicates a BP mean difference of 0 (which indicates no differences in BP values between the 2 measurement techniques).