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Screening for High Blood Pressure in Adults: A Systematic Evidence Review for the U.S. Preventive Services Task Force

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Prepared by:
Kaiser Permanente Research Affiliates Evidence-based Practice Center
Kaiser Permanente Center for Health Research
Portland, OR

Investigators:
Margaret A. Piper, PhD, MPH
Corinne V. Evans, MPP
Brittany U. Burda, MPH
Karen L. Margolis, MD, MPH
Elizabeth O'Connor, PhD
Ning Smith, PhD
Elizabeth Webber, MS
Leslie A. Perdue, MPH
Keshia D. Bigler, BS
Evelyn P. Whitlock, MD, MPH

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Structured Abstract

Objective: We conducted this systematic review to support the U.S. Preventive Services Task Force (USPSTF) in updating its recommendation on screening for high blood pressure (BP) in nonpregnant adults.

Data Sources: We searched relevant databases and literature sources from 2003 to June 17, 2013 to identify existing systematic reviews. For Key Questions (KQs) 1 and 5, we searched MEDLINE, PubMed, Cochrane Central Register for Controlled Clinical Trials, and the Cumulative Index to Nursing and Allied Health Literature from 2003 to February 24, 2014 to locate relevant studies. For KQs 2 and 3, we searched MEDLINE, PubMed, and the Cochrane Central Register for Controlled Clinical Trials from January 1, 1992 to February 24, 2014 for relevant studies. For KQ 4, we searched MEDLINE and PubMed from January 1, 1966 to February 24, 2014 to identify longitudinal cohort studies of rescreening.

Study Selection: We conducted a dual independent review of 19,309 abstracts and 1,171 full-text articles against a priori inclusion and exclusion criteria. Two investigators also independently critically appraised each included article using criteria defined by the USPSTF and supplemented with criteria from the Quality Assessment of Studies of Diagnostic Accuracy II, the Quality in Prognosis Studies tool, and the Newcastle-Ottawa Scale for diagnostic accuracy (KQs 2 and 3), prognostic (KQ 3), and observational (KQs 4 and 5) studies, respectively. We resolved discrepancies through discussion and consultation with a third reviewer, when necessary. We included only fair- or good-quality studies.

Data Analysis: For KQs 1 and 5, we qualitatively summarized results because of the small number of included studies. For KQ 2, we calculated the diagnostic accuracy of office-based BP measurement (OBPM) devices and protocols using the result from the most commonly recommended device (i.e., manual mercury sphygmomanometer) or protocol component (e.g., no caffeine) as the reference standard. We qualitatively summarized the results. For the prognosis component of KQ 3, we grouped outcomes into the categories of cardiovascular (CV), stroke, and cardiac events. We combined fatal and nonfatal events within these outcome categories. Risk was consistently expressed as a hazard ratio per increment in BP measurement across all included studies. Risk results for CV outcomes by BP measurement method at baseline were visualized in forest plots of hazard ratios. For diagnostic accuracy calculations, we used the BP measurement method that best predicted CV outcomes (i.e., ambulatory BP monitoring [ABPM]) as the reference standard. We qualitatively evaluated how patient or study characteristics influenced diagnostic accuracy. For KQ 4, we pooled incidence rates for the overall populations in included studies to generate a weighted mean incidence at various rescreening intervals, which were categorized into 1, 2, 3, 4, and 5 years. We qualitatively examined direct evidence from subgroup results reported within studies to address the influence of patient characteristics.

Results: One randomized, controlled trial (39 clusters; n=140,642) of a Canadian BP screening program that targeted adults age 65 years or older reported 3.02 fewer annual hospital admissions for cardiovascular disease per 1,000 persons in the intervention group compared with the no screening group. When the trial data were analyzed by number of unique persons with hospital admissions, there was a significant relative reduction only in the individual outcome of

acute myocardial infarction (rate ratio, 0.89 [95% CI, 0.79 to 0.99]; p=0.03).

Few studies reported the necessary data to allow us to evaluate the diagnostic accuracy of specific BP measurement methods or protocols. In three studies, automated oscillometric office BP results showed a range of sensitivity (51%–68%) for elevated BP, defined by manual mercury sphygmomanometry, but more consistent specificity (97%–98%) and positive predictive value (PPV) (76%–84%). Three different diagnostic accuracy studies examined the impact of recommended protocols on OBPM. In one study, a single BP measurement had high sensitivity (0.95) but only moderate PPV (0.76) compared with the average of second and third BP measurements. Two small studies in normotensive subjects found that leg crossing elevated BP measurements within the normal range and caffeine ingestion falsely elevated BP measurements above the hypertensive threshold in 17% of normotensive participants.

We first evaluated the predictive value of home BP monitoring (HBPM) and ABPM methods for long-term CV events compared with OBPM. Eleven studies reported that daytime, nighttime, and 24-hour ABPM predicted stroke and other fatal and nonfatal CV events independently of OBPM. While the results of five studies suggest similar results for HBPM, too few studies are available to draw firm conclusions. Evidence from one study comparing HBPM with ABPM was insufficient to allow us to draw conclusions. Limited evidence suggested that cardiovascular disease outcomes for the patient subgroup with isolated clinic hypertension (elevated OBPM and normal ABPM) are more similar to those of normotensive subjects at baseline than those with sustained hypertension.

The proportion of participants with an elevated BP measurement who are normotensive upon confirmatory testing by ABPM (or HBPM) ranged from 5 to 65 percent across all studies. This population has false-positive results when screened by OBPM methods, or “isolated clinic hypertension.” Increasing baseline OBPM was associated with increasing PPV for ABPM-confirmed hypertension. As a result, the likelihood of misdiagnosis of hypertension based only on screening measurement is greater as measurements approach the threshold for a diagnosis of hypertension. We did not qualitatively detect any associations between reported race/ethnicity, sex, or smoking.

Estimates of the weighted mean incidence of hypertension at yearly intervals less than 6 years were derived from a small number of studies (except at 5 years) with highly variable results at each interval. The weighted mean incidence at 5 years of 14 percent, for example, actually ranged from 2 to 28 percent. In the small number of studies that used a separate confirmation step, a significant proportion of apparent incident hypertension cases were not confirmed. Thus, overall estimates at yearly intervals based on unconfirmed incident hypertension are likely to be falsely high. Variation in incidence estimates across studies also likely reflects differences in criteria for diagnosis, as well as differences in age, sex, baseline BP, and obesity status of the populations studied. Hypertension incidence increased as much as two- to four-fold between a younger (ages 18 to 40/45 years) and older (ages 40/45 to 60/65) age group, respectively. Within-study hypertension incidence consistently tripled when comparing participants with initial optimal versus normal BP, and was approximately doubled in those with initial normal versus high-normal BP. Incidence was generally higher in men than women, especially men in younger populations. While incidence was also two-fold higher in overweight persons and three-

fold higher in obese persons compared with those of normal weight, it was not increased in smokers compared with nonsmokers or former smokers. African Americans had a consistently higher incidence of hypertension at rescreening than white participants.

Four trials found no significant differences in psychological distress or quality of life after patients were labeled as hypertensive or prehypertensive. One cohort study reported significantly increased absenteeism up to 4 years after labeling compared with the year before. Three cohort studies reported significant sleep disturbances associated with ABPM use and one study reported that a significant proportion of ABPM users experienced pain, skin irritation, and overall discomfort. Discomfort and restrictions in daily activities were more frequently reported with ABPM than HBPM in one study.

Limitations: Despite recent emphasis on the instability of single BP measurements and the need for multiple valid measurements to assess a patient's actual elevated BP exposure, high-quality comparable diagnostic accuracy studies are not common. Given recent recognition of the impact of overdiagnosis in many diseases, the widespread availability of automated BP devices with variable performance, and the prevalence of essential hypertension in the United States, further research is needed to guide primary care clinicians and consumers.

Conclusions: ABPM (24-hour, daytime, or nighttime) is a better predictor of long-term CV outcomes than OBPM (usually manual sphygmomanometry) and should be considered the reference standard for evaluating noninvasive BP measurements. A small body of evidence suggests, but does not confirm, that HBPM can serve as a similar predictor of outcomes. Initial screening by office-based methods (manual sphygmomanometry or automated oscillometric devices) variably predicts hypertension as defined by ABPM, resulting in a significant population with isolated clinic hypertension. Limited evidence suggests that patients with isolated clinic hypertension have outcomes that are more similar to normotensive than hypertensive persons. Failure to confirm initial elevated OBPM results may result in misdiagnosis and overtreatment. Limited evidence suggests that repeated measurements and improved procedural control (e.g., by automation) may improve the diagnostic accuracy of OBPM when used to screen for high BP or confirm a diagnosis of hypertension. Studies of rescreening intervals at up to 6 years found a higher incidence of hypertension overall and at shorter intervals for persons with BP in the high-normal range, older adults, persons with an above normal BMI, and African Americans. These studies showed much lower incidence at longer rescreening intervals up to 6 years in persons without these risk factors.

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Chapter 1. Introduction

Condition Definition

Blood pressure (BP) is the pressure the blood exerts against arterial walls as it circulates through the body. It is regulated by a variety of physiological systems, including neural and hormonal signals from the heart, vasculature, brain, kidneys, and gastrointestinal organs.[1-5] BP is generally estimated by measuring systolic and diastolic components. Systolic blood pressure (SBP) is the maximal pressure in blood vessels during systole (heart contraction) and diastolic blood pressure (DBP) is the minimal pressure in blood vessels during diastole (heart relaxation between contractions). BP is most commonly measured peripherally in the upper arm.

Large prospective studies in diverse populations have demonstrated a strong positive association between BP and stroke, ischemic heart disease, and overall mortality. These studies have found no evidence of a threshold below which the association between BP and cardiovascular and stroke events and mortality is no longer evidence; this has been tested down to at least 115/75 mm Hg.[6] In the absence of a clear threshold, hypertension may be defined pragmatically as the level of BP at which there is either experimental or epidemiological evidence that therapeutic interventions reduce cardiovascular (CV) event rates.[7] Hypertension is most commonly defined as SBP of 140 mm Hg or greater and/or DBP of 90 mm Hg or greater (hereafter referred to as ≥140/90 mm Hg). Blood pressure classifications from the Seventh Report of the Joint National Committee on the Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC 7) are shown in **Table 1**.[1] The JNC 8 did not redefine the threshold for a diagnosis of high BP in its recently published 2014 guidelines, although it did raise the treatment threshold for persons with diabetes or chronic kidney disease and those age 60 years and older.[8]

Etiology and Natural History

Primary (or essential or idiopathic) hypertension is defined as high BP in the absence of a known secondary cause and accounts for 95 percent of all cases of hypertension.[9] The pathogenesis of primary hypertension is multifactorial and imprecisely understood. Risk factors include age, African American race, genetic factors, excess weight and obesity, excess alcohol intake, and dietary habits (especially high sodium intake).[10-12] Hypertension is common in persons with diabetes and dyslipidemia (including metabolic syndrome), but is still considered primary hypertension in these persons. Secondary causes of hypertension include chronic kidney disease, coarctation of the aorta, Cushing syndrome, use of certain drugs, obstructive uropathy, pheochromocytoma, primary aldosteronism, sleep apnea, and thyroid or parathyroid disease.[1] Secondary hypertension may be suggested by symptoms, clinical or laboratory findings, resistance to treatment, or onset of hypertension at an unexpected age.[13]

BP increases progressively with age[11] and hypertension develops in a high proportion of adults in the United States who survive into the eighth and ninth decades.[14] In a younger population, hypertension can develop over a relatively short period when BP is at the higher end of the normal range.

Untreated hypertension tends to progress and cause damage to multiple organs, including the heart (left ventricular hypertrophy, coronary atherosclerosis), brain (stroke, vascular dementia), kidneys (nephrosclerosis, albuminuria, proteinuria), arteries (peripheral artery disease, atherosclerosis), and eyes (retinopathy).[15,16] Damage to arteries and kidneys may culminate in a treatment resistant state.[2] Measuring long-term average BP may improve its prognostic utility for cardiovascular disease (CVD) risk beyond risk assessments based on current BP measurement.[17]

Age also modifies the association between high BP and health risks. In adults age 50 years or older who participated in the first National Health and Nutrition Examination Survey (NHANES) and had their BP measured, SBP of 140 mm Hg or greater was associated with increased mortality, regardless of DBP. DBP was a stronger predictor of mortality in those younger than age 50 years, with elevated risk at levels greater than 100 mm Hg.[18]

Prevalence and Burden of High BP

Based on 2009 to 2010 data, the overall age-adjusted prevalence of high BP (defined as ≥140/90 mm Hg or use of antihypertensive medication; or having been told at least twice by a health professional that one had high BP) among U.S. adults age 18 years or older was 28.6 percent.[19] As shown in **Table 2**, although the prevalence of high BP tends to be higher in men than women at younger ages, it is higher in women than men at ages older than 65 years. Thus, the overall prevalence of high BP is similar among men (33.6%) and women (33.2%),[19] but disparities are seen among different races and ethnicities. High BP is markedly more common in African Americans (42%) than whites (27.5%) or Hispanics (26.1%), and African American women have the highest prevalence of hypertension (47.0%) of any sex-specific race/ethnicity subgroup.[20] There are also sex, racial, and ethnic differences in high BP awareness, treatment, and control.

Hypertension is the most commonly diagnosed condition at physician office visits (3.9%).[21] In 2009, the estimated direct medical costs of treating hypertension in the United States was $47.5 billion, with prescription medications accounting for 45 percent of the costs ($21.4 billion).[22] In 2010, there were 280,000 hospitalizations with a first-listed diagnosis of essential hypertension and more than 55 million physician office, emergency department, and outpatient visits with essential hypertension as the primary diagnosis code.[19]

Elevated BP is the largest contributing risk factor to all-cause and CVD mortality.[23] Studies have shown that the excess proportion of mortality attributable to elevated BP is 40.6 percent (95% confidence interval [CI], 24.5 to 54.6) for CVD mortality and 30.4 percent for overall mortality (95% CI, 19.4 to 40.6).[23] High BP is a major contributor to heart attack, stroke, and congestive heart failure (CHF). In 2010, high BP was listed as a primary or contributing cause of death for more than 362,000 Americans.[19]

Rationale for Screening

There are generally no signs or symptoms associated with high BP.[24] As a result, high BP is usually found through screening. BP can be modified with lifestyle interventions,[25-27] and large

good-quality randomized, controlled trials (RCTs) demonstrate the effectiveness of antihypertensive pharmacological treatments to reduce CV and total mortality.[28,29] The same measurement techniques used for screening and confirmation are also used for BP monitoring after a diagnosis to monitor treatment effectiveness and BP control.

BP control rates remain low despite substantial improvements since the 1970s in the awareness, treatment, and control of hypertension.[1] Between 2009 and 2010, 81.9 percent of U.S. adults with hypertension were aware of their status and 76.4 percent were taking medication to lower their BP. Only 53.3 percent, however, had their BP controlled to less than 140/90 mm Hg.[20]

Screening/Measurement Modalities to Detect High BP

Intra-Arterial Monitoring

Direct intra-arterial measurement is considered the gold standard for BP measurement.[30] During intra-arterial BP monitoring, a catheter is inserted into an artery and pressure waves are displayed on a monitor. This method provides a beat-to-beat record of BP and is used in the intensive care unit and during surgery.[31] Because of its invasive nature, however, this technique is not suitable for use in screening or in noncritical care settings.[30,32]

Clinic Measurement

There are several methods and devices for measuring BP in routine clinic settings, which are briefly described below. Screening for high BP should be done by trained personnel. The standard method is to measure BP in the upper arm at the brachial artery, as devices and techniques for measuring BP at alternate sites like the wrist and finger are highly prone to error and are not recommended in guidelines. As such, we do not include these devices in this review.[33]

Auscultatory Method

The manual auscultatory method involves a trained observer using a stethoscope to detect Korotkoff sounds, which are made by the turbulent flow of blood past the restricted area created by the inflated cuff. The readings are made using a mercury or aneroid sphygmomanometer at the brachial artery. Sources of observer error and bias in the auscultatory method include differences in auditory acuity and terminal digit rounding.[5] Detailed guidelines outline recommendations for the positioning of the patient and arm, cuff size and placement, cuff inflation and deflation, number and timing of measurements, and distinguishing Korotkoff sounds. These guidelines, however, are not based on a systematic review of the literature.[33] Even considering these many potential sources of error, the auscultatory method using a mercury sphygmomanometer correlates well with simultaneous intra-arterial BP (r=0.94 to 0.98) when performed correctly and was considered the gold standard for clinic-based measurements for many years.[34] However, environmental concerns about the potential for mercury spillage and the banned use of mercury sphygmomanometers have diminished the role of this method. Aneroid sphygmomanometers use a lever and bellows system (as opposed to a mercury column) to

measure pressure and have been used as a mercury-free alternative. "Hybrid" sphygmomanometers are newer devices with an electronic pressure gauge in place of the mercury column, but BP is still determined using the auscultatory method.[5]

Oscillometric Method

Oscillometric sphygmomanometers use a pressure transducer to assess the oscillations of pressure in a cuff during gradual deflation. The point of maximum oscillation corresponds to the mean intra-arterial pressure. Systolic and diastolic measurements are then calculated based on an empirically derived algorithm.[5] Investigators have cited several advantages to these devices, especially when they are fully automated and can be programmed to complete several measurements after a period of rest at appropriate intervals without requiring the presence of medical personnel. The ability to obtain multiple readings while a patient rests alone in a quiet room may mitigate the increased BP seen in some persons only when in medical settings (isolated clinic hypertension).[33,35]

Measurement Modalities to Confirm a Diagnosis of Hypertension

In addition to the clinic-based measurement modalities discussed above, two additional nonclinic-based BP measurements may be used to confirm the diagnosis of hypertension: ambulatory BP monitoring (ABPM) and home BP monitoring (HBPM).

ABPM

ABPM devices are small portable machines connected to a BP cuff worn by patients that record BP at regular intervals over 24 to 48 hours while patients go about their normal activities, including sleep. Measurements are typically taken at 20- to 30-minute intervals.[5] Results may be reported for 24 hours, daytime (awake), and nighttime (asleep). Modern ambulatory devices use oscillometric techniques and have replaced use of a microphone to measure Korotkoff sounds.[1] Frequent indications for ABPM use is the evaluation of initial borderline office hypertension (25%) or suspected isolated clinic hypertension (24%), as well as monitoring of active antihypertensive treatment.[36]

HBPM

HBPM devices are typically fully automated oscillometric devices that record pressure from the brachial artery.[5] Many home measurement devices are commercially available, and some have undergone technical validation according to recommended protocols.[37] Indications for HBPM are similar to those for ABPM. In addition, self-monitoring may improve adherence to treatment and has been associated with small improvements in BP control, even in the absence of additional self-management support interventions.[37]

Limitations of Screening With Manual Methods

BP is affected by numerous short-term internal and environmental factors, such as emotions, pain, eating, voiding, mental activity, physical activity, temperature, and drugs (including caffeine and nicotine). It may vary markedly with posture and over the course of a 24-hour day. This within-person variability presents challenges when characterizing someone's usual BP.[38-40]

In addition to biological and temporal within-person variability, it is well documented that BP can increase substantially in the medical setting and in the presence of medical personnel, a phenomenon called the "white coat effect," or isolated clinic hypertension. Epidemiological data suggest that 15 to 30 percent of the population thought to have hypertension may have lower BP outside of the medical setting.[2] Such persons with isolated clinic hypertension may require different measurement methods to resolve apparently increased BP at screening.[2] Thus, the disadvantages of screening for high BP solely in the routine office setting include the limited number of measurements that can be performed conveniently, the high rate of observer error, and the potentially altering effects of the medical setting and medical personnel on BP.[33,41]

Limited evidence from small studies suggests that the white coat effect may have limited to moderate reproducibility. Studies examining isolated clinic hypertension continuously as a difference between BP measured in and out of the office show that the effect is significantly attenuated with repeat measurements.[42,43] Other reports examining isolated clinic hypertension dichotomously show a wide range of reproducibility, from 45 percent in a combination of treated and untreated participants[44] to 79 percent in highly-selected treatment-resistant participants.[45] Thus, while elevated BP in clinic settings and normal BP in nonclinic settings could reflect "true" isolated clinic hypertension, it could also reflect measurement error or regression to the mean.[42,44] For these reasons, we use the descriptive term isolated clinic hypertension rather than white coat hypertension in this report.

Potential Methods for Screening Confirmation

Simply repeating a manual office-based BP measurement (OBPM) at a separate office visit to confirm initial elevated BP is subject to the same limitations as described above. Office-based confirmation also does not capture BP variations over time. Newer methods of BP measurement have become available, including automated measurement methods for clinical settings and HBPM and ABPM for nonclinical settings. These methods have made it possible to investigate and discover additional information about BP and may overcome some of the limitations of manual OBPM.

Automated OBPM with a valid and reliable device has the advantage of avoiding observer error and bias. HBPM has some of the same advantages, with the ability to record BP measurements at various times of day over an extended period outside of the medical setting. Automated 24-hour BP measurement has the potential to increase the accuracy of hypertension diagnosis beyond that of HBPM by performing representative BP measurements outside of the office setting across the full course of a day and night's routine activities and sleep.

As assessed by 24-hour measurement, BP exhibits a diurnal pattern whereby pressure is generally the lowest during sleep, rises sharply and peaks after a person rises from bed, and then falls again during the day. Studies have shown that BP normally falls by 10 to 20 percent from daytime to nighttime, and this pattern may be more strongly related to physical activity than to a circadian rhythm.[30] In 1988, O'Brien and colleagues named this pattern "dipping" and reported a cross-sectional association with stroke in patients with a less marked decrease in nighttime BP ("nondipping").[46]

A recent 2011 meta-analysis by Hansen and colleagues concluded that nighttime BP is a stronger predictor of mortality and CV events than daytime BP.[47] These authors further concluded that dipping status contributed little to prognostic value over and above 24-hour BP. For this reason, and because dipping status may have poor reproducibility, we do not address this issue in this review.[48,49]

The reverse phenomenon to isolated clinic hypertension, sometimes called "masked hypertension," refers to persons with apparently nonhypertensive levels of BP at clinic visits who have elevated BP when it is measured outside of the medical setting.[4] This condition is of interest because it has been associated with increased CV risk.[50,51] We do not address masked hypertension further in this review, however, because it is not detectable using methods that begin with confirmation of elevated BP found by office-based screening. A practical method to detect masked hypertension at a population level remains to be established.[52]

Device Regulation, Validation, and Calibration

Noninvasive BP monitors that use a cuff with an inflatable bladder in conjunction with another device, such as electronic or automated sphygmomanometers or standard oscillometric measurement methods, are classified as Class II devices by the U.S. Food and Drug Administration (FDA). While there are no mandatory performance standards, the FDA provides guidance for the safety, performance, and clinical validation of automated and nonautomated noninvasive sphygmomanometers.[53-55] This guidance is equivalent to the SP10 standard developed by the Association for the Advancement of Medical Instrumentation (AAMI) for manual, electronic, or automated sphygmomanometers, including ABPM.[56] Although a BP measurement device can be marketed without evidence of meeting AAMI standards, no claims can be made about its accuracy.[57]

In general, validation of devices requires independent assessment of accuracy of the device compared with a reference standard (mercury sphygmomanometry). This is especially important for oscillometric automated monitors, which use proprietary algorithms to calculate SBP and DBP. The three most widely used protocols are the British Hypertension Society Protocol, the AAMI Standard, and the International Protocol of the European Society of Hypertension.[58-60] Many automated BP measuring devices intended for home use have not been independently validated. Even devices that have met validation standards in general populations may not provide similar measurements as a mercury sphygmomanometer in all patients, particularly in those with stiffness of the arteries (the elderly), advanced renal disease, and diabetes.[33] A list of devices of various types, results of validation testing, special populations included in validation

testing (children, pregnant women, the elderly), and recommendations can be found at www.dableducational.org.

All sphygmomanometers require regular calibration and maintenance to maintain accuracy, and devices randomly evaluated in clinical settings have often been found to be inaccurate.[2,33,61,62] One review recommends calibration at 3-year intervals for mercury sphygmomanometers, 6-month intervals for anaeroid sphygmomanometers, and 12-month intervals for oscillometric or hybrid devices.[63]

Current Clinical Practice

According to the 2010 National Ambulatory Medical Care Survey, BP was measured in 59.4 percent of clinic visits by patients age 18 years or older in the United States.[21] The American Heart Association recommends that BP be measured after a patient sits comfortably and quietly for at least 5 minutes in a chair with back supported, both feet flat on the floor (i.e., legs not crossed or dangling), and the unbent arm supported at heart level at mid-sternum.[64] The appropriate cuff size should be used on a bare arm (i.e., not over clothing) and the inflatable bladder should encircle 80 percent or more of the patient's arm circumference. The average of at least two measurements should be recorded as the patient's BP level for that visit. Other guidelines, such as those from JNC 8,[8] have recommended similar procedures. While these procedures are typically used in research studies, they are rarely followed in routine health care settings.[41,65-69] The reasons for not following recommended BP measurement guidelines are likely multifactorial and may include lack of information, training, and time.

Common clinical practice is to measure weight, BP, and pulse at every office visit and to record these measurements as "vital signs." While BP may not be measured at certain types of primary care visits (e.g., dental or eye examinations) or at ambulatory visits with some specialists, these exceptions tend to be the minority. This suggests that rescreening is occurring opportunistically at most visits rather than at specified intervals and that the rescreening interval is determined primarily by the frequency of office visits. As such, persons who make infrequent visits may not be screened.

When screening BP results are elevated above the threshold for the normal range, some organizations also recommend ABPM to confirm the diagnosis (and for management) of hypertension (**Table 3**), although this is infrequent. In the United Kingdom, for example, only about one in every 20 hypertension diagnoses is made with ABPM because of limited availability of devices.[70] Similarly, guidelines recommend the use of HBPM for diagnosis and management.[2,71-74]

Recommendations of Others

Recommendations of other organizations for high BP screening in clinical practice are presented in **Table 4** and methods for confirming a diagnosis of hypertension are listed in **Table 3**. In some cases this division is arbitrary, as few guidelines specifically separate the concepts of or

protocols for screening versus confirmation of hypertension.

Recommendations for rescreening intervals are also presented in **Table 4**. The Canadian Hypertension Education Program is the only organization that recommends screening for high BP at every clinical visit.[72] Other guidelines recommend 1- to 2-year rescreening intervals, with most recommending the shorter interval for persons with BP of 120–139/80–89 mm Hg.[1,75-77] However, these guidelines generally do not provide the basis for the interval recommended.[78]

Previous Recommendation

In 1996, the U.S. Preventive Services Task Force (USPSTF) recommended screening for hypertension in adults. While no rescreening interval was recommended, the USPSTF noted that measurement every 2 years in persons with previously normal BP levels and every year in those with borderline levels "may be prudent." In 2003, the evidence in support of screening for hypertension was again reviewed. There was high certainty that screening for high BP in adults has a substantial net benefit. Although no RCTs of screening were identified, the USPSTF concluded that substantial indirect evidence supported the effectiveness of screening adults to detect hypertension and treating them to reduce CVD. This recommendation was based on good evidence that BP measurement can identify adults at increased risk for CVD from high BP, that treatment of high BP substantially decreases the incidence of CV events, and that screening and treatment of high BP causes few serious harms. Rescreening was not addressed. In 2007, the USPSTF reaffirmed its 2003 recommendation supporting screening. The 2007 update also stated that evidence was lacking to recommend an optimal interval for screening, but referred to the JNC 7 recommendation of screening at 1- to 2-year intervals.

Rationale for the Current Review

This report systematically reviews newer evidence relevant to screening for hypertension in adults, including RCTs that may provide direct evidence on the effectiveness and harms of screening for prevention of CVD and mortality. Newer BP measurement methods are available that may reduce measurement error, simplify performance of repeated measurements, allow measurement of BP throughout the 24-hour day, and allow measurement in nonmedical settings. Previous recommendations did not separate initial screening and confirmation of hypertension. For these two diagnostic steps, different measurement methods or protocols may be needed to improve accuracy of long-term CV outcome prediction, minimize misdiagnosis, and avoid unnecessary treatment. While the 2003 review sought evidence on the accuracy of HBPM and ABPM for cost-effectively diagnosing hypertension and predicting future CV events, these topics were identified as evidence gaps to be addressed in future systematic reviews. Finally, previous reports noted the lack of a systematically reviewed evidence base to support recommendations for appropriate rescreening intervals and to reconcile the varying recommendations from other groups.

Chapter 2. Methods

Scope and Purpose

The Agency for Healthcare Research and Quality (AHRQ) requested an updated evidence review on screening for high BP in adults. The USPSTF will use this report to update the 2007 recommendation on screening for high BP in adults.[79] Questions on the role of confirming hypertension diagnoses, rescreening intervals, and ABPM and HBPM are central to this review and are addressed in new Key Questions (KQs). The USPSTF has not addressed ABPM and HBPM, confirmation of diagnosis, or rescreening interval in previous recommendations.

KQs and Analytic Framework

We developed an Analytic Framework (**Figure 1**) and five KQs in consultation with the AHRQ Medical Officer and USPSTF members. KQs 1 and 5 were adapted from questions addressed in the previous review.[80]

1. Does screening for high BP reduce CVD and mortality in adults age 18 years or older?
2. What is the best way to screen for high BP in adults in the primary care setting?
   a. How accurate (i.e., sensitivity, specificity, predictive value) are clinic-based BP measurement methods (e.g., manual vs. automated) in provisionally diagnosing hypertension within a single visit?
   b. What screening protocol characteristics within a single visit (e.g., sitting quietly for 5 minutes, number of readings) define the best diagnostic accuracy?
3. What is the best way to confirm hypertension in adults who initially screen positive for high BP?
   a. How well do ABPM and HBPM methods predict CV events compared with clinic-based methods? What confirmation protocol characteristics define the best prediction of CV events? Which methods and associated protocols best predict CV events[*]?
   b. How accurate are other noninvasive BP measurement methods in establishing or confirming the diagnosis of hypertension compared with these best methods and associated protocols? Does diagnostic accuracy vary by protocol characteristics (i.e., number of visits)?
   c. Does changing the measurement method from that used during the initial screening improve diagnostic accuracy for some specific patient subgroups (e.g., those with suspected white coat hypertension[†])?

[*]The BP measurement method that best predicts long-term CV outcomes will be used as the reference standard for KQs 3b and 3c.

[†]A key assumption underlying the Analytic Framework is that in the United States, BP screening occurs only in primary care settings and does not involve HBPM or ABPM. Thus, false-negatives, or "masked hypertension" (defined as normal office BP that is elevated only in out-of-office settings), is not addressed in this review, as patients with normal BP at screening would not proceed to the next step of confirmation through either additional office measures or home or ambulatory methods. Patients who have isolated clinic hypertension, however, may be detected by an initial elevated screen and would proceed to confirmation.

4. What is the clinically appropriate rescreening interval for patients who have previously been screened and found to have normal BP?
   a. What is the shortest interval in which clinically significant, diagnosed hypertension may develop?
   b. Does the rescreening interval vary by patient characteristics (e.g., age, sex, race/ethnicity, CV risk, BP level, screening history)?
5. What are the adverse effects of screening for high BP in adults?

Data Sources and Searches

We conducted a comprehensive literature search for existing systematic reviews in the following databases: MEDLINE, PubMed, the Database of Abstracts and Reviews of Effects, AHRQ, BMJ Clinical Evidence, the Canadian Agency for Drugs and Technologies in Health, Health Technology Assessment (Centre for Reviews and Dissemination), the Institute for Clinical Systems Improvement, the Institute of Medicine, the National Health Services Health Technology Assessment Programme, and the National Institute for Health and Clinical Excellence from January 1, 2005 to March 19, 2013.

For KQs 1 and 5, we searched the following databases from 2003 to February 24, 2014 to identify RCTs and controlled clinical trials (KQs 1 and 5) and cohort studies (KQ 5 only) to update evidence on benefits and harms of screening for high BP in adults: MEDLINE, PubMed, Cochrane Central Register for Controlled Clinical Trials, and Cumulative Index to Nursing and Allied Health. For KQs 2 and 3, we searched the following databases from January 1, 1992 (to allow for implementation of first guidelines for validation of BP monitoring devices[81]) to February 24, 2014 to identify diagnostic accuracy studies: MEDLINE, PubMed, and Cochrane Central Register for Controlled Clinical Trials. For KQ 4, we searched MEDLINE and PubMed from January 1, 1966 (beginning of MEDLINE) to February 24, 2014 to identify longitudinal cohort studies for high BP rescreening. We limited all searches to articles published in the English language and studies that enrolled human populations. All literature search strategies were designed by a research librarian. A second librarian reviewed each strategy (**Appendix A**).

We also reviewed reference lists of included studies, systematic reviews, and meta-analyses and the online publication lists of highly referenced studies (e.g., Framingham Heart Study) to identify potentially relevant studies that may not have been identified in our literature searches. We obtained additional references from bibliographies of other sources (e.g., guidelines). Literature search results were managed using Reference Manager® version 12.0 (Thomson Reuters, New York, NY), a bibliographic management software program.

Study Selection

Two investigators independently reviewed 19,309 titles and abstracts and 1,171 full-text articles (**Appendix A Figure 1**) against prespecified inclusion and exclusion criteria (**Appendix A Table 1**). We used Abstrackr, a Web application, to manage the title and abstract dual-review screening process.[82] Excluded studies and reasons for their exclusion are listed in **Appendix B**.

We required studies to be conducted in adult populations (i.e., >80% of the study population was age ≥18 years) or, if conducted in adults and children, we required results to be stratified by age group. Participants must not have been taking antihypertensive medications (except for KQ 3a). We excluded pregnant women, institutionalized persons, inpatients, and persons with an underlying cause of high BP. We excluded studies that enrolled a highly selected group of participants, such as renal transplant recipients or those with chronic kidney disease.

We required BP measurements to be taken on the upper arm (forearm cuffing was not acceptable). Although wrist devices can provide accurate BP results, their use is discouraged because the arm position may not be carefully controlled.[83,84] Measurements taken closer to the periphery of appendages may overestimate vascular resistance changes and BP.[33,85] Thus, we excluded wrist, ankle, finger, and toe BP monitors and measurements. We also excluded any BP measurement methods not commonly used in routine screening practices, such as invasive methods or noninvasive central BP measurements. Use of HBPM and ABPM was eligible for KQ 3 only, to confirm elevated BP detected by office-based methods.

We required that included studies be conducted in eligible primary care settings, which we defined as having personnel trained in BP measurement, established BP measurement protocols, and ongoing documentation procedures for each. These settings include (but are not limited to) primary care clinics, school-based health clinics, dental offices, retail and mobile clinics, and pharmacies. We excluded settings that were not likely to have the aforementioned criteria, as well as correctional and inpatient or residential facilities. We also restricted studies to those conducted in countries rated as "Very High" on the 2013 Human Development Index.[86]

KQs 1 and 5 (Benefits and Harms of Screening)

For KQ 1 (benefits of screening), we only included RCTs that reported changes in health outcomes as a result of screening for hypertension compared with no screening. Screening had to occur during a single encounter. Screening could have been conducted as part of a multicomponent CV risk assessment as long as the BP measurement was the initial and sole factor that determined whether a patient proceeded to additional assessment.

Acceptable health outcomes included mortality, CVD, and end-stage renal disease. For mortality, we accepted all-cause or CV-related death. We defined CVD by fatal and nonfatal CV events, including myocardial infarction (MI), sudden cardiac death, stroke, CHF, hospitalization for coronary heart disease, atrial fibrillation (AF), and transient ischemic attack (TIA). Composite outcomes were eligible if they did not contain any excluded health outcomes, such as CV symptoms (e.g., palpitations), angina pectoris, revascularization, carotid intima-media thickness, and left ventricular hypertrophy. Doubling of serum creatinine, halving of glomerular filtration rate, or transition to dialysis or transplant were also acceptable outcomes for end-stage renal disease.

For KQ 5 (harms of screening), we included RCTs and cohort studies that reported on the harms of screening, including any psychological effects, absenteeism, and changes in quality of life as a result of being labeled as hypertensive. We also included studies that examined the adverse effects of subsequent BP measurement methods to confirm the initial diagnosis (i.e., ABPM or

HBPM), such as sleep disturbance or discomfort in continuously wearing a BP monitor.

KQ 2 (Diagnostic Accuracy of OBPM)

For KQ 2, we included any study design that compared noninvasive OBPM methods differing either by device (KQ 2a) or protocol (KQ 2b). We excluded within-class comparison of devices (e.g., automated vs. automated) with identical screening protocols. We also excluded any validation or accuracy studies of devices compared with standards or using specific protocols (e.g., British Hypertension Society Protocol, AAMI).

We required that studies report the diagnostic accuracy (i.e., sensitivity, specificity, positive predictive value [PPV], negative predictive value [NPV], or comparable statistics) of the comparison. Concordance (e.g., kappa statistic) was also acceptable. We also required that studies report directionality with a change in hypertension diagnosis in order to calculate the diagnostic accuracy, if the latter was not directly reported. We excluded studies that did not provide diagnostic accuracy or comparable data, even if they compared the mean differences in BP levels between devices or protocols or other correlations based on numeric BP values.

KQ 3a (Prediction of CV Events)

Eligible studies followed a cohort of subjects over time and reported the association of each of two or more BP measurement methods at baseline with overall mortality or fatal or nonfatal CV events during followup. This was the only question for which participant treatment with antihypertensive medications was allowable at baseline. Inclusion of treated participants increased generalizability, recognizing that some proportion of adults followed over time will be treated for hypertension. This inclusion also expanded an otherwise severely limited evidence base.

In addition to our systematic bibliographic database search, we also examined the reference lists of relevant systematic reviews and individual patient data (IPD) meta-analyses to ensure we captured all relevant cohorts.[2,87-96] Several long-term cohort studies had multiple associated publications. For each study, we carefully examined the various articles to select the most current publication with the longest followup and largest cohort for each outcome to ensure that participants would not be counted more than once for the same outcome.

Fatal and nonfatal CV events considered to be acceptable indicators of CVD were MI, sudden cardiac death, stroke, CHF, AF, and transient ischemic attack. Composite measures were also accepted if they did not contain excluded outcomes, which were CV symptoms (e.g., palpitations), angina pectoris (chest pain), revascularization, carotid intima-media thickness, and left ventricular hypertrophy.

We required that estimates of association be reported as hazard ratios (HRs) or risk ratios, preferably in a model with adjustment for modifiable and nonmodifiable risk factors, such as age, smoking, use of antihypertensive medication, and personal history of CVD (if not a study participant exclusion criterion). We also required that BP be entered in the model as a continuous

variable. We excluded studies that categorized BP and reported individual risk estimates for each BP category compared with a reference category, as these studies could not be readily compared or combined with others. Although not an exclusion criterion, we preferentially abstracted data from models that estimated the independent predictive capacity of one method by also adjusting for its comparator BP measurement method (e.g., ABPM adjusted for OBPM). This direct comparison identified the method with predictive value "over and above" another. We also abstracted data when BP for each method was included in separate models. We excluded studies that included additional measures related to BP in a model with BP (e.g., adding pulse pressure to a model that already included SBP).

KQs 3b and 3c (Diagnostic Accuracy of Other BP Measurement Methods)

For these questions, we required that all patients have an initial elevated OBPM to represent potentially hypertensive patients needing confirmation. Patients could not, however, be treated with antihypertensive medications unless there was a wash-out period of at least 2 weeks. Included studies confirmed the initial elevated BP using a measurement method that differed from the screening method either by device or protocol. We required that studies report at minimum the proportion of participants diagnosed with hypertension by the confirmatory method. We also required the same diagnostic accuracy reporting characteristics as for KQ 2.

KQ 4 (Rescreening Interval)

Eligible studies followed a cohort of normotensive subjects over time and reported incidence of hypertension at rescreening intervals of less than 6 years. We considered 6 years a reasonable upper bound for a rescreening interval. We also accepted studies enrolling participants with BP that was high-normal—but below the accepted threshold for pharmacological therapy—and studies enrolling participants not previously confirmed as hypertensive (e.g., participants with isolated clinic hypertension).

We required that incident hypertension be identified through measured BP or physician diagnosis or prescription for antihypertensive medication (e.g., medical chart review). Studies were ineligible if they used only self-reported measures that were not verified, reported average change in BP without reporting change in diagnostic classification, or reported only incident antihypertensive drug use.

Several cohort studies had multiple publications. To avoid double counting, we selected the publication with the most participants for each rescreening interval. We accepted supplemental publications if they additionally reported on subgroups of interest, as specified in KQ 4b.

We accepted diagnostic thresholds as defined in individual studies and accepted BP measurements conducted in any eligible primary care setting. While we captured both unadjusted and adjusted incidence rates, unadjusted rates were more commonly reported. As such, we used unadjusted rates to generate weighted mean incidence of hypertension at various rescreening intervals. We did not accept data that were derived or extrapolated (i.e., deriving 1-, 2-, and 3-

year incidence rates based on rescreening at 4 years).

For KQ 4b, we identified the following a priori subgroups of interest: age, sex, race/ethnicity, CV risk (e.g., body mass index [BMI]), BP level, and screening history. Where reported, incidence rates were captured for these groups in addition to those for the overall population.

Quality Assessment and Data Abstraction

Two investigators independently assessed the quality of included studies using predefined criteria from the USPSTF[97] and supplemented with criteria from the Quality Assessment of Studies of Diagnostic Accuracy II,[98] the Quality in Prognosis Studies tool,[99] and the Newcastle-Ottawa Scale[100] for diagnostic accuracy (KQs 2, 3b, and 3c), prognostic (KQ 3a), and observational (KQs 4 and 5) studies, respectively (**Appendix A Table 2**). We assigned each study a final quality rating of good, fair, or poor. All quality ratings were entered into a database that electronically compared the two ratings and reported discrepancies. We resolved disagreements through discussion.

We excluded studies rated as poor quality (i.e., attrition >40%, differential attrition >10%, other "fatal flaws," or the cumulative effects of multiple minor flaws and/or missing important information significant enough to limit our confidence in the validity of the results) from the review (**Appendix B**). Good-quality studies included blinding of outcome assessors, reliable outcome measures, comparable groups at baseline (with specified eligibility criteria) and followup, low attrition, adequate and faithful adherence to the intervention, and acceptable statistical methods. In addition, we also considered whether the study reported device calibration and maintenance protocols, as lack thereof can result in measurement inaccuracy. Studies were downgraded to fair quality if they did not meet the majority of the criteria for good-quality studies.

One investigator abstracted data from all included studies into a customized database. A second investigator checked the data for accuracy. We abstracted study design characteristics, population demographics, intervention details, health outcomes (e.g., mortality), diagnostic accuracy, and adverse events.

Data Synthesis and Analysis

KQs 1 and 5 (Benefits and Harms of Screening)

For KQs 1 and 5, we qualitatively described results because of the small number of included studies.

KQ 2 (Diagnostic Accuracy of OBPM)

We initially calculated the diagnostic accuracy of OBPM devices and protocols using the most standard office-based device (i.e., manual mercury sphygmomanometer) or protocol component

(e.g., no caffeine) as the reference standard. Subsequent to identification of ABPM as providing improved prediction of CV events and thus providing a better BP reference standard, we calculated OBPM diagnostic accuracy for a subset of included studies for KQ 3b that measured manual OBPM, automated OBPM, and ABPM in screening populations, using ABPM as the reference standard. Because of the small number of included studies, results are qualitatively described.

KQ 3a (Prediction of CV Events)

The outcome of interest was risk for CV outcomes, as predicted by different methods of measuring BP at baseline in prospective cohort studies. Because a stronger relationship has been reported between baseline BP and vascular mortality than with nonvascular mortality,[6] we grouped outcomes accordingly where possible. We combined fatal and nonfatal events within outcome categories (i.e., CV, stroke, and cardiac events).

Risk was consistently expressed as HRs, which were most often reported for each 10-mm Hg increase in SBP and 5-mm Hg increase in DBP. We converted results that were reported differently (e.g., 1 mm Hg, 1 standard deviation) to these common increments for consistency using the formula $HR_c=\exp(\ln(HR_o)/I_o*I_c)$, where HR_c is the converted HR, HR_o is the originally reported HR, I_o is the original increment for HR calculation, and I_c is the increment to which the HR was converted. The CIs were also converted accordingly using the formula $LB_c=\exp(\ln(LB_o)/I_o*I_c)$ and $UB_c=\exp(\ln(UB_o)/I_o*I_c)$, where LB_o and LB_c are the original and converted lower bounds of the CI and UB_o and UB_c are the original and converted upper bounds of the CI, respectively.

Risk for CV outcomes by BP measurement method at baseline was visualized in forest plots of HRs. We conducted meta-analyses to obtain risk estimates for each measurement method, separated by outcome. However, if within each method-outcome category there were less than 10 studies (particularly if <5), if there were important identifiable sources of heterogeneity across studies, and if sample sizes varied across a wide range, then no meta-analysis was conducted. We conducted exploratory meta-analyses to compare ABPM results across measurement protocols (24-hour, daytime, or nighttime). For this comparison, we used the DerSimonian and Laird[101] random-effects method to generate estimates of CV events or mortality risk per 10-mm Hg increase in SBP for each protocol. We used sensitivity analyses to compare these results with estimates generated using profile likelihood[102] and Knapp-Hartung methods.[102]

KQs 3b and 3c (Diagnostic Accuracy of Other BP Measurement Methods)

For diagnostic accuracy calculations, we used the BP measurement method identified in KQ 3a as best predicting CV outcomes as the reference standard. Since all study participants had an initial elevated BP, the 2x2 table was incomplete for most studies. Rather, a 1x2 table documenting true-positive results (sustained hypertension) and false-positive results (isolated clinic hypertension) according to the reference standard allowed calculation only of PPV. We qualitatively evaluated the influence of patient or study characteristics on PPV, as well as the

association of subpopulations with higher or lower PPV.

KQs 4a (Rescreening Interval) and 4b (Subgroups)

For KQ 4a, we pooled incidence rates for the overall populations in included studies to generate a weighted mean incidence at various rescreening intervals, which were categorized into 1, 2, 3, 4, and 5 years. Observations within 0.5 years were included for each time interval. For example, the 1-year interval includes observations from 0.5 to 1.5 years. We reported the ranges of incidence within each interval category from pooled studies.

We estimated incidence rates from figures using WebPlotDigitizer© version 2.6 when figures provided the only data source.[103] These estimates are reported in tables but were not pooled for weighted mean incidence because the number of participants at specified rescreening intervals was not available.

For KQ 4b, we focused on a qualitative examination of direct evidence of subgroup results reported within studies (e.g., men vs. women, smokers vs. nonsmokers). We also constructed a summary table of evidence across studies by calculating weighted mean incidence rates for subgroups of interest as identified in the KQ. For smoking status, we categorized participants into current and nonsmokers, where nonsmokers were a combination of never and previous smokers. We used three age categories: 10 to 40/45 years, 40/45 years to 60/65 years, and 60/65 years or older. Cut point boundaries had a 5-year margin to enable as many subgroup observations as possible, since there was substantial heterogeneity of subgroup definitions across trials. For BP level subgroups (high-normal vs. normal), we used the cut point identified by the authors. Most often, this was 130–139/85–89 mm Hg, but some used 120–139/80–89 mm Hg and one study reported diastolic values only (80–94 mm Hg).

To maximize the number of subgroup categories, we combined subgroups (where possible) to correspond to our categories and cut points. For example, we combined never and previous smokers to form "nonsmokers," combined ages younger than 30 and from 30 to 39 to form "age 39 years and younger," and combined optimal (<120/80 mm Hg) and normal BP (120–129/80–84 mm Hg), if reported, versus high-normal BP (130–139/85–89 mm Hg).

Expert Review and Public Comment

A draft version of the research plan was posted on the USPSTF Web site for public comment from June 20 to July 17, 2013. We received comments from 18 persons or organizations. All comments were reviewed and addressed as appropriate. The final research plan was posted on the USPSTF Web site on September 19, 2013. The full draft report was reviewed by invited experts and Federal partners in February 2014. We compiled and addressed (where appropriate) the comments received from the reviewers.

USPSTF Involvement

We worked with three USPSTF liaisons during development of the research plan. USPSTF members approved the final research plan after we incorporated the public comments. An AHRQ Medical Officer provided project oversight, reviewed the draft report, and assisted with external review.

Chapter 3. Results

Literature Search

We reviewed 19,309 abstracts and 1,171 full-text articles. This review included 96 studies that were reported in 152 publications (**Appendix A Figure 1**). We identified one trial examining the benefits of screening for high BP (KQ 1),[104] seven studies examining the diagnostic accuracy of clinic-based BP measurements and protocols (KQ 2),[105-111] 15 studies examining the predictive value of clinic-based and other BP measurements (i.e., ABPM and HBPM) (KQ 3a),[112-126] 27 studies examining the diagnostic accuracy of other BP measurement methods (KQs 3b and 3c),[114,127-152] 40 studies evaluating rescreening for high BP in adults (KQ 4),[144,153-191] and nine studies examining the harms of screening for high BP (KQ 5).[192-200]

KQ 1. Does Screening for High BP Reduce CVD and Mortality in Adults Age 18 Years or Older?

We identified one good-quality cluster RCT (39 clusters; n=140,642) of a BP screening program that reported eligible CV outcomes (**Appendix C Tables 1–3**).[104] Clusters were randomly assigned to the Cardiovascular Health Awareness Program (CHAP) or no intervention. The CHAP intervention was a Canadian community-based program for CV risk assessment and education targeted at adults age 65 years or older. Although CHAP included other elements of risk assessment, BP was the primary component of the intervention and was the only measured biological characteristic, which makes this study eligible for inclusion.

The CHAP intervention involved community pharmacy-based BP screenings using an automated instrument (BpTRU®, VSM MedTech, Coquitlam, BC) and risk profiles conducted by interview over a period of 10 weeks. Results from screenings were rank-ordered by SBP within diagnostic groups and provided to family physicians. An on-call nurse reassessed participants identified as high-risk (i.e., SBP of 180 or DBP of 110 mm Hg). Trained volunteer health educators also provided participants with educational materials and resources to support self-management. This study was conducted in community residents age 65 years or older (mean age, 74.8 years), of whom 57.2 percent were women. Twelve percent of the participants had a previous history of CHF and 22 percent had diabetes. Although the latter slightly exceeded the acceptability limit of our inclusion criteria (20%), the deviation was minor.

This study's primary outcome was a composite of hospital admissions for acute MI, CHF, or stroke in all community residents age 65 years or older in the year before versus after implementation of the intervention. CHAP resulted in a statistically significant 9-percent relative reduction in the number of hospital admissions for composite events (rate ratio, 0.91 [95% CI, 0.86 to 0.97]; p=0.002). In absolute terms, there were 3.02 fewer annual hospital admissions for CVD per 1,000 persons in the intervention group compared with the group that did not receive the intervention. When analyzed by number of unique persons admitted to the hospital (not counting additional admissions for more than one event per person), there were fewer composite

events, acute MIs, and CHF admissions in the intervention group. The reduction in acute MI was marginally statistically significant (rate ratio, 0.89 [95% CI, 0.79 to 0.99]; p=0.03). While the secondary outcomes—all-cause mortality (33.98 vs. 34.55) and in-hospital CV mortality (3.88 vs. 4.66)—showed lower rates per 1,000 in the intervention group, the reductions were not significant (p=0.38 and 0.06, respectively). The number of participants who initiated antihypertensive treatment was 10 percent higher in the intervention group than in the group that did not receive the intervention (95% CI, 1.02 to 1.20; p=0.02).

KQ 2. What Is the Best Way to Screen for High BP in Adults in the Primary Care Setting?

We identified seven fair- to good-quality studies examining the diagnostic accuracy of OBPM devices (k=4; n=2,528)[105,107-109] or protocols (k=3; n=20,253) (**Appendix C Tables 4–9**).[106,110,111]

KQ 2a. How Accurate Are Clinic-Based BP Measurement Methods in Provisionally Diagnosing Hypertension Within a Single Visit?

Initially, we only included studies comparing manual versus automated OBPM for diagnosing hypertension in adult screening populations. The manual device was chosen as the reference standard. Studies were required to provide diagnostic accuracy data or characteristics rather than mean BP comparisons. We found four fair- to good-quality studies providing evidence on sensitivity, specificity, and predictive value (**Table 5**).[105,107-109] Three of the four studies used a threshold of 140/90 mm Hg or greater to define hypertension; the other study used a higher threshold (≥160/95 mm Hg). Studies did not use a consistent reference standard for hypertension diagnosis and used different comparator devices. Sensitivity ranged from 51 to 91 percent, although specificity and predictive value were in closer agreement.

One good-quality study compared a manual anaeroid sphygmomanometer with an automated oscillometric device in 399 middle-aged men and women from the population-based European Prospective Investigation into Cancer and Nutrition-Potsdam Study.[107] Participants were randomly selected, with oversampling of those with higher BP. One trained observer performed three auscultatory measurements 2 minutes apart using the aneroid device; these measurements were performed simultaneously with the oscillometric measurement by connecting both devices to a single cuff with a T-tube. Cuff inflation and deflation were controlled by the automated device. Using the anaeroid measurement as the reference, sensitivity of the oscillometric device was 91 percent, specificity 96 percent, PPV 88 percent, and NPV 97 percent. This study's limitations include the use of a higher than usual threshold for classifying hypertension (SBP ≥160 mm Hg or DBP ≥ 95 mm Hg) and automated inflation and deflation of the (usually) manual sphygmomanometer cuff by the oscillometric device. This unique feature of the study design may have minimized human error in the manual anaeroid measurement.

Two good-quality studies compared a manual mercury sphygmomanometer with an automated oscillometric device in 454 Korean men and women ages 20 to 95 years[108] and 509 adults recruited from the 2006 and 2007 NHANES.[105] Diagnostic accuracy results were somewhat similar (sensitivity, 59% and 68%; specificity, 98% and 96%; PPV, 84% and 79%; NPV, 94% and 93%, respectively). These studies also provided similar kappa results for manual versus automated methods (0.68 for the NHANES study[105] and 0.65 for the Korean study[108] [95% CI, 0.5436 to 0.7641]; $p<0.0015$).

A fourth fair-quality study compared a mercury sphygmomanometer with an automated oscillometric device in the emergency room and general medicine clinic at an urban hospital.[109] Sensitivity of the oscillometric device was 51 percent, specificity 97 percent, PPV 76 percent, and NPV 92 percent. Although this study used three different oscillometric devices with no attempt to ensure comparability or validity among them, the results may be generalizable to a typical practice setting.

The results of KQ 3a indicate that ABPM is a better reference standard than manual sphygmomanometry. Thus, a better study design would compare manual versus automated OBPM using ABPM as the reference standard. We found three studies with this design[132,141,150] among those included for KQ 3b and evaluated them for KQ 2a. Results were limited since all enrollees had an elevated OBPM per inclusion criteria. One study only presented kappa statistics, reporting a kappa of 0.44 for the comparison of systolic manual OBPM versus ABPM and 0.25 for systolic automated OBPM versus ABPM.[132] Calculated PPV was 0.78 and 0.93 for the two comparisons, respectively, in the second study,[141] and 0.39 and 0.58 in the third.[150] Thus, reference to ABPM does not clearly favor either manual or automated OBPM in these few studies.

KQ 2b. What Screening Protocol Characteristics Within a Single Visit Define the Best Diagnostic Accuracy?

Although we searched for evidence on any aspect of BP measurement protocol (e.g., resting time before measurement, number of measurements, time between measurements, body position, setting), the stringency of our predefined criteria, which limited studies to those enrolling untreated screening populations, resulted in few included studies. Only three fair- to good-quality studies provided evidence on using variations in office-based screening protocols for diagnosing hypertension in adults not on antihypertensive treatment (**Table 6**).[106,110,111] All included studies used a threshold of SBP ≥140 mm Hg or DBP ≥ 90 mm Hg to define hypertension.

One very large good-quality study compared the effect of one versus multiple BP measurements on the diagnostic accuracy of auscultatory BP measurement performed by trained physicians using mercury sphygmomanometers in the NHANES population in 1999 to 2008.[106] Three measurements were performed according to a standardized protocol in 20,155 adults. Among 3,454 participants with Stage I hypertension according to the first BP measurement, 20.0 percent were reclassified as normal when the mean of the first two BP measurements was used to diagnose participants, 27.5 percent were reclassified using the mean of all three BP measurements for diagnosis, and 35.5 percent were reclassified using the mean of the second and

third BP measurements for diagnosis. A limitation of the results is potential bias due to lack of observer blinding. In addition, because BP measurement was performed using a carefully controlled protocol, the results may not apply in ordinary practice settings.

A fair-quality study examined the effect of leg crossing on the accuracy of BP measurement in 50 normotensive men and women with baseline BP far from the diagnostic threshold.[110] A blinded observer recorded BP measured 5 minutes after subjects assumed three leg positions in random order: feet flat on the floor, legs crossed at the knee, and ankle resting on the opposite knee. None of the subjects were reclassified as hypertensive. This study's primary limitations were low power and the potential selection of a sample that does not represent a typical screening population.

A fair-quality study compared BP following double-blind administration of oral caffeine (3.3 mg/kg, equivalent to two or three cups of coffee) or placebo in 47 healthy male volunteers who habitually consumed caffeine.[111] After overnight caffeine abstinence, three BP measurements were taken with an automated oscillometric device at 2-minute intervals before and 40 minutes after ingestion of placebo or caffeine. Baseline BP was less than 140/90 mm Hg in all participants, but eight (17%) had BP in the hypertensive range (SBP ≥140 mm Hg or DBP ≥ 90 mm Hg) after administration of caffeine. These eight participants constituted 33 percent of the 24 subjects who had baseline BP of 135/85 to less than 140/90 mm Hg. Participants who received placebo remained normotensive. This study's key limitation was that it included only a homogeneous population of young Caucasian men and, as such, does not represent the range of responses that might be seen in a screening population.

KQ 3. What Is the Best Way to Confirm Hypertension in Adults Who Initially Screen Positive for High BP?

We identified 40 fair- to good-quality studies examining the prognostic value (k=15; n=29,142)[112-126] and/or the diagnostic accuracy of BP measurement methods used to confirm the diagnosis of hypertension (k=27; n=17,233).[114,127-152] Study details and results are provided in **Appendix C Tables 10–34**.

KQ 3a. How Well Do HBPM and ABPM Methods Predict CV Events Compared With Clinic-Based Methods? What Confirmation Protocol Characteristics Define the Best Prediction of CV Events? Which Methods and Associated Protocols Best Predict CV Events?

For KQ 3a we sought to identify the BP measurement method category that best predicts long-term CV, stroke, cardiac, and all-cause mortality events. We then used the method identified as the best predictor as the reference method for consistent evaluation of diagnostic accuracy studies of BP measurement methods in KQs 3b and 3c.

Ten good-quality[112,113,115,117,120,121,123-126] and five fair-quality[114,116,118,119,122] studies met the inclusion criteria for this KQ (**Appendix C Tables 10–12**). None were conducted in the United States; most were conducted in Europe and some in Japan. Spacelabs ABPM devices (Spacelabs Healthcare, Snoqualmie, WA) were the most commonly used and cited models and are still available in the United States. Studies used other ABPM devices that have subsequently been discontinued, but at the time of use appear to have been validated against at least one of the recognized protocols. Studies used HBPM devices exclusively manufactured by Omron (Omron Healthcare, Lake Forest, IL). While some models have been discontinued, similar Omron devices are currently available in the United States.

One included study was conducted in countries in western and eastern Europe.[126] Studies used a prospective cohort design, and one study followed a cohort of participants in a placebo-controlled RCT taking a calcium channel blocker as an antihypertensive to compare the prognostic significance of OBPM and ABPM.[126] For this study, we abstracted combined (placebo and treatment arms) results, as these are more representative of a general population, a significant proportion of which would be treated over time.

A total of 26,132 participants were characterized at baseline. The percentage of participants diagnosed with hypertension at baseline ranged from 15 percent[124] to 100 percent[113-116,122,126] and was not reported in four studies.[119,120,123,124] The percentage of participants treated with antihypertensive medication at baseline ranged from 0 to 100 percent, with one study not reporting.[120]

Included studies compared the prognostic value of different methods of measuring BP at baseline by following patients over time for major CV, stroke, cardiac events, and all-cause mortality events and reported HRs by measurement method. HRs were adjusted for relevant covariates in regression models and preferably included the comparative method as a covariate to determine if one method had additional prognostic value beyond its comparator. Items reported as covariates tended to be similar across studies, always including age, sex, and smoking and usually including BMI, diabetes, cholesterol levels, and previous history of CVD.

Table 7 shows the number of studies reporting various BP measurement method comparisons and the outcomes these studies addressed. It does not include the two studies reporting the cardiac end points of fatal/nonfatal CHF, fatal/nonfatal MI, and sudden death, which were grouped together.[116,126] It also does not show one study that reported CHF outcomes.[121]

ABPM vs. OBPM

Summary of Findings

Eleven studies compared ABPM with OBPM (**Appendix C Tables 10–12**).[114-122,125,126] Studies used various ABPM protocols, including 24-hour ABPM,[115,116,118,119,121,122,125,126] 48-hour ABPM (one study, combined with 24-hour ABPM for analysis),[120] daytime ABPM,[115-117,119-122, 125,126] and nighttime ABPM.[115-117,119-122,125,126] These time periods were either specifically derived from patient diaries or were predetermined in each study protocol. Twenty-four-hour ABPM, daytime ABPM, and nighttime ABPM were considered separate measurement protocols for comparison

with OBPM and for analysis.

Each 10-mm Hg increase in systolic ABPM at baseline, controlling for OBPM, was associated with a moderately increased risk (in most cases statistically significant) for fatal and nonfatal stroke or CV events in 11 good- or fair-quality studies. No summary meta-analysis estimates of risk were generated because of the small number of studies for each outcome (two to seven studies), variability in how outcomes were reported across studies (e.g., fatal vs. fatal or nonfatal stroke), and variability in study size by as much as a factor of six. Nevertheless, these results are consistent and within a small range of HR values. An exploratory meta-analysis to compare ABPM protocols showed that estimates for CV events or mortality are very similar whether ABPM is 24-hour, daytime, or nighttime. The results were consistent despite enrollment of participants from different geographic regions and who had different baseline characteristics. Thus, ABPM methods add additional and significant predictive information to OBPM methods for CV and cerebrovascular outcomes. For this reason, ABPM was chosen as the reference standard for KQs 3b and 3c in this review.

Risk estimates were lower and less consistent for outcomes that were limited to cardiac end points (i.e., CHF, MI, sudden death) and all-cause mortality. Diastolic ABPM results followed a similar pattern to that of systolic results for all outcomes, although the HR estimates were lower. Thus, diastolic ABPM appears to contribute less predictive information.

Each 10-mm Hg increase in systolic ABPM, not controlling for OBPM, was also consistently and significantly associated with an increased risk for stroke and CV outcomes. The parallel results for OBPM, on the other hand, showed generally lower predictive risks. These results support the conclusion that ABPM provides predictive information in addition to OBPM.

Study Details

24-Hour ABPM vs. OBPM. Nine studies (including one study of 48-hour ABPM) compared baseline 24-hour systolic ABPM and OBPM for predicting long-term outcomes. The number of participants at baseline ranged from 808 to 5,292 and mean followup ranged from 4.4 to 13 years. Mean/median age of participants at baseline ranged from approximately 50 to 60 years, except for two studies that had mean participant ages of about 70 years.[121,126] Details can be found in **Tables 8 to 12**, where the data are arranged by major outcome category. **Appendix Tables 13 to 17** display the original data.

Unadjusted HRs for systolic OPBM were not consistently significant and ranged from 1.07 to 1.29 for stroke and 1.06 to 1.32 for CV events or mortality (**Figure 2**). These results are similar to those of the Prospective Studies Collaboration IPD meta-analysis, which reported a range of risk estimates, from 1.22 to 1.41 for CV mortality and 1.22 to 1.62 for fatal stroke[‡], across age categories.[6] This pattern of results for OBPM is similar across all ABPM versus OBPM comparisons and outcomes. Because of this similarity, we do not discuss OBPM results in the following sections. Details of results can be found in **Tables 8 to 12**.

[‡]Results of the IPD analysis were originally reported as HRs per 20-mm Hg decrease in SBP and were converted to HRs per 10-mm Hg increase in SBP for consistency and comparability.

Each 10-mm Hg increase in 24-hour systolic ABPM, adjusting for OPBM, was consistently associated with increased risk for fatal and nonfatal stroke events in four studies (**Figure 3**).[116, 122,125,126] The number of reported events per study ranged from 30 in the smallest study with the shortest followup[126] to 112 in the study with the longest followup.[125] Risk estimates ranged from an HR of 1.28 to 1.40 and were all statistically significant, indicating that systolic ABPM predicts stroke events significantly and independently of OBPM. The largest risk estimate (HR, 1.40 [95% CI, 1.21 to 1.62]) was reported for a community-based study in rural Japan, which enrolled 1,332 participants who were followed for a mean of 10.2 years.[125] This study was the only study of the four that did not limit participation to those with hypertension and had by far the lowest mean baseline OBPM (131/74 mm Hg). One study reported nonsignificant results for OBPM-adjusted ABPM without reporting an estimate. The number of events analyzed in this study was small at 36 out of a total population of 1,963, and analysis of stroke outcomes alone was not prespecified.[115] Unadjusted risk estimates for systolic 24-hour ABPM were reported in two studies and both were significant (HR, 1.27 [95% CI, 1.15 to 1.40] and 1.40 [95% CI, 1.12 to 1.76]) (**Figure 4**).[116,126]

While risk estimates for fatal and nonfatal stroke were slightly lower for each 5-mm Hg increase in diastolic 24-hour ABPM, adjusted for OBPM, they were significant in three studies.[116,122,124] Results for diastolic ABPM are provided in **Table 8**; forest plots are not shown because fewer studies reported diastolic APBM and because results were similar to those of systolic ABPM, although more attenuated.

One study also estimated risk for stroke events for systolic OPBM, adjusted for 24-hour ABPM (**Figure 5**). This result was a nonsignificant HR of 1.04 (95% CI, 0.94 to 1.15), which indicates that OBPM adds no significant predictive capacity for stroke events when 24-hour ABPM is in the model.[125]

Each 10-mm Hg increase in 24-hour systolic ABPM, adjusted for OBPM, was associated with an increased risk for fatal and nonfatal CV events (**Table 9**). Six studies reported an elevated risk, with five studies reporting statistically significant results[115,116,118,120,125] (**Figure 3**).[126] The number of CV events per study ranged from 36 in the smallest study with the shortest followup[126] to 389 in the largest study.[116] HRs ranged from 1.11 to 1.42. Only the lowest estimate was not statistically significant and was reported for the smallest and oldest cohort with the highest baseline BP (173/86 mm Hg; n=808; mean age, 70 years), who were participants in a trial of antihypertensive medication.[126] One additional study only reported ABPM as a significant predictor of CV mortality when entered in a model with OBPM (p=0.0003).[119] Results for studies reporting only CV mortality were not different from those reporting a combination of fatal and nonfatal CV events, with the one exception already described.[126] Unadjusted risk estimates were all statistically significant, with the same exception (**Figure 2**).[126] In five studies reporting this outcome, estimates of CV-related risks for 24-hour diastolic ABPM, adjusted for OBPM, tended to be smaller than for systolic ABPM but remained statistically significant, except for one study (**Table 9**).[125]

Two studies reported risk estimates for fatal and nonfatal cardiac events (**Table 10**).[116,126] Each 10-mm Hg increase in 24-hour systolic ABPM, adjusted for OBPM, was associated with increased risk (HR, 1.11 [95% CI, 0.93 to 1.31] and 1.16 [95% CI, 1.07 to 1.25]), but did not

consistently reach conventional statistical significance (**Figure 3**). One study evaluated CHF outcomes (70 events in 951 participants) and found a nonsignificant increase in risk (HR, 1.01 [95% CI, 0.85 to 1.19]) (**Table 11**).[121]

Finally, four studies evaluated risk for all-cause mortality (**Table 12**).[115,116,119,126] The number of events per study ranged from 68 in the smallest study (which had the shortest followup)[126] to 646 in the largest study.[116] Risk for all-cause mortality tended to modestly increase (2% to 13%) in three studies with each 10-mm Hg increase in 24-hour ABPM, controlling for OBPM. A fourth study provided no estimate, only reporting that ABPM independently predicted risk after controlling for OBPM (p=0.001).[119]

Nighttime ABPM vs. OBPM. Nine studies compared baseline nighttime systolic ABPM and OBPM for predicting long-term outcomes.[115-117,119-122,125,126] The number of participants at baseline ranged from 391 to 5,292. The mean followup ranged from 4.4 to 10.9 years. Mean/median age of study participants at baseline ranged from approximately 50 to 70 years.[117, 121,126] Additional study details can be found in **Tables 13 to 17**, where the results are arranged by major outcome category. **Appendix Tables 18 to 22** display the original data.

Four studies reported risk for fatal and nonfatal stroke events for nighttime systolic ABPM, adjusted for systolic OBPM (**Table 13**).[116,122,125,126] The number of events per study ranged from 30 to 112. Only the study by Ohkubo and colleagues was not restricted to participants who were hypertensive at baseline.[125] Each 10-mm Hg increase in ABPM was statistically significantly associated with increased risk for a stroke event (HR, 1.26 to 1.43), similar to the results for 24-hour ABPM (**Figure 6**). Results for each 5-mm Hg increase in nighttime diastolic ABPM, adjusted for OBPM, showed a consistently and significantly elevated risk in three studies (**Table 13**), although this increase was less pronounced than for systolic results.[116,122,125]

Six studies evaluated nighttime systolic ABPM, adjusted for systolic OBPM, and reported risk estimates for CV event or mortality (**Table 14**).[115-117,120,125,126] The number of events per study ranged from 36 to 389. In four of six studies, each 10-mm Hg increase in ABPM was statistically significantly associated with increased risk;[116,117,120,125] two studies reporting nonsignificant increased risk had shorter followup times and smaller numbers of events.[115,126] Overall, estimates ranged from an HR of 1.13 to 1.37. One additional study reported only unadjusted HRs for ABPM (1.41 [95% CI, 1.23 to 1.62]) and OPBM (1.25 [95% CI, 1.10 to 1.42]).[119]

For the combined fatal and nonfatal cardiac endpoints, each 10-mm Hg increase in nighttime systolic ABPM was significantly associated with increased risk (HR, 1.16 [95% CI, 1.02 to 1.33] and 1.15 [95% CI, 1.04 to 1.23]) (**Table 15**).[116,126] For CHF outcomes, each 10-mm Hg increase in nighttime systolic ABPM suggested slightly increased risk (HR, 1.08 [95% CI, 0.94 to 1.22]) (**Table 16**).[121] For all-cause mortality, each 10-mm Hg increase in nighttime ABPM was associated with increased risk.[115,116,126] While HRs ranged from 1.03 to 1.15, results were statistically significant in only the largest study (**Table 17**).[116]

Daytime ABPM vs. OBPM. Ten studies compared daytime systolic ABPM and systolic OBPM results at baseline for predicting long-term outcomes.[114-117,119-122,125,126] The number of participants at baseline ranged from 391 to 5,292. Mean followup ranged from 4.4 to 10.9 years.

Mean/median age of study participants at baseline ranged from approximately 50 to 70 years.[117, 121,126] Details can be found in **Tables 18 to 22**, arranged by major outcome category. **Appendix Tables 23 to 27** display original data. The pattern of results for all outcomes was very similar to that described for nighttime ABPM versus OBPM. Results are presented in **Figure 7**.

24-Hour vs. daytime vs. nighttime ABPM. In order to compare ABPM measurement protocols, we conducted exploratory meta-analyses for the outcome of CV events or mortality. Using the DerSimonian and Laird random-effects method, HRs for each 10-mm Hg increase in SBP were 1.24 (95% CI, 1.17 to 1.30; I^2=8.7%) for 24-hour ABPM, 1.20 (95% CI, 1.12 to 1.28; I^2=33.3%) for daytime ABPM, and 1.24 (95% CI, 1.17 to 1.31; I^2=25.6%) for nighttime ABPM, all controlled for OBPM. Sensitivity analyses using profile likelihood and Knapp-Hartung meta-analysis methods resulted in nearly or exactly the same estimates with slightly wider confidence limits (data not shown). While the narrower CIs for the DerSimonian and Laird estimates make it more likely that differences in estimates will be detected, no differences were detected. As such, it appears that there are no measurement differences among the three protocols.

HBPM vs. OBPM

Five studies examined HBPM (**Appendix C Tables 10–12**) results at baseline as a predictor of CV events or mortality (**Table 23**), fatal and nonfatal stroke (**Table 24**), or all-cause mortality (**Table 25**) (see **Appendix Tables 28–30** for original data).[112,113,117,123,124] Studies enrolled 391 to 4,939 participants whose mean ages ranged from about 50 to 70 years. Where reported, studies enrolled a significant proportion of participants (if not all) with hypertension at baseline, of whom at least half were being treated with antihypertensive medications. The number of events per study ranged from 85 to 160. In four studies, systolic HBPM, adjusted for OBPM, was consistently associated with increased risk,[112,117,123,124] ranging from an HR of 1.17 (95% CI, 1.02 to 1.33) to 1.39 (95% CI, 1.22 to 1.59) (**Figure 8**).[112,117,123] Results for a slightly different set of four studies reporting systolic HBPM, not controlled for OBPM, showed smaller, less consistent effects (**Figure 9**).[113,117,123,124] These results suggest that HBPM, like ABPM, may contribute predictive information that is significant and independent of that contributed by OBPM. Too few studies, however, were available for each category of outcomes to confidently reach conclusions.

ABPM vs. HBPM

Only one study compared ABPM with HBPM and OBPM for predicting CV outcomes (stroke, MI, and CV death).[117] Each increase in daytime and nighttime ABPM, controlled for HBPM, was associated with increased risk (HR, 1.13 [95% CI, 0.93 to 1.38] and 1.16 [95% CI, 1.01 to 1.34], respectively). The magnitude of increase was somewhat smaller when ABPM was compared with OBPM in the same study (daytime ABPM, adjusted for OBPM: HR, 1.27 [95% CI, 1.05 to 1.54]; nighttime ABPM, adjusted for OBPM: HR, 1.23 [95% CI, 1.07 to 1.40]).

ABPM or HBPM for Predicting Isolated Clinic Hypertension Outcomes

Six studies reporting ABPM or HBPM predictive value for long-term CV outcomes in general

populations also reported risk specifically for the subgroup of participants with isolated clinic hypertension, which was most often defined as OBPM of 140/90 mm Hg or greater and ABPM or HBPM of less than 135/85 mm Hg at baseline (**Appendix D Table 1**).[113,114,117,121,125] One additional study, which we excluded from the main body of evidence for KQ 3a because it did not report risk estimates, is also reviewed here.[201] Participants with isolated clinic hypertension were compared with either normotensive participants or those with sustained hypertension.

In three studies, risk for CV disease, mortality, or CHF in participants with isolated clinic hypertension at baseline was elevated, but not statistically significantly different compared with normotensive participants (HR for CVD mortality, 1.54 [95% CI, 0.73 to 3.21]; HR for stroke, 1.07 [95% CI, 0.58 to 2.07];[125] HR for CHF, 2.01 [95% CI, 0.82 to 4.91];[121] p=0.85 for CV events [no estimate reported]).[117] Five studies reported on comparisons between participants with sustained hypertension and those with isolated clinic hypertension.[113-115,117,201] The method of reporting results varied across studies.

In general, all studies reported lower event rates or risk estimates for participants with isolated clinic hypertension than for those with sustained hypertension. One study reported a higher risk for sustained hypertension versus isolated clinic hypertension (HR, 2.16 [95% CI, 1.16 to 4.01]); results were similar whether or not treated participants were included in the analysis.[117] In one study, all 22 major CV events occurred in participants with sustained hypertension, while no events occurred in those with isolated clinic hypertension.[114] Similarly, a different study reported smaller numbers of events in participants with isolated clinic hypertension (1.32 per 100 patient-years) than those with sustained hypertension (2.56 per 100 patient-years; p<0.001).[201] Another study reported similar numbers of CV events in participants with isolated clinic hypertension (12.1 per 1,000 patient-years) or controlled hypertension (11.1 per 1,000 patient-years), but a larger number of events in those with uncontrolled hypertension (25.6 per 1,000 patient-years).[113] Finally, one study reported ABPM results for participants with baseline systolic OBPM greater than 140 mm Hg. For SBP of 140–159 mm Hg, the adjusted risk for an event among those with sustained hypertension compared with normotensive ABPM was 1.82 (95% CI, 0.92 to 3.56); for SBP of 160 mm Hg or greater, the risk was 2.31 (95% CI, 1.26 to 4.22).[115]

KQ 3b. How Accurate Are Other Noninvasive BP Measurement Methods in Establishing or Confirming the Diagnosis of Hypertension Compared With These Best Methods and Associated Protocols? Does Diagnostic Accuracy Vary by Protocol Characteristics?

We included 27 good- and fair-quality diagnostic accuracy studies (seven good-quality and 20 fair-quality) evaluating a total of 17,233 participants (87 to 4,263 enrolled per study) for KQ 3b (**Appendix C Tables 31–33**).[114,127-151] Studies were conducted in North America (four studies), western Europe (18 studies), Israel (one study), and Japan (four studies).

We required that all study participants had elevated, untreated OBPM. Screening results were confirmed with ABPM (24 studies),[114,127-143,145,148-152] HBPM (seven studies),[127,128,134,136,142,146,147]

or repeat OBPM at a second visit (three studies).[130,144,152] Selected study characteristics are summarized in **Table 26**.

We used ABPM, where measured, as the reference standard (i.e., "true" BP classification). Because all study participants screened positive for elevated BP at baseline, only the PPV of each screening-confirmatory combination could be calculated for diagnostic accuracy (**Table 26**). It is important to note that in this scenario, persons with false-positive results are referred to as having isolated clinic hypertension, although this category could also include measurement error and regression to the mean.

Five studies measured 24-hour ABPM in 131 to 255 participants per study.[127,135-137,143] The PPV of elevated OBPM for elevated ABPM ranged from 0.35 (95% CI, 0.27 to 0.42) to 0.89 (95% CI, 0.85 to 0.93) (**Figure 10**). That is, the proportion of participants with elevated OBPM and true hypertension (according to the ABPM reference standard) ranged from 35 to 89 percent. Factors that may have influenced the prevalence of true hypertension in the population, and thus PPV, were an older population in the study with the highest PPV[136] and higher baseline OBPM in the three studies with the higher PPVs (**Table 26**).[135,136,143] The study with the lowest PPV of 0.35 was a community-based study in rural Japan with a higher percentage of female participants (68%) than the other four studies (47% to 53%).[127]

Daytime ABPM was measured in 18 nonoverlapping studies that evaluated diagnostic accuracy in 69 to 1,466 participants per study.[114,128,130-134,138-142,145,148-152] The proportion of participants with elevated OBPM and true hypertension (as measured by daytime ABPM) ranged from 0.47 (95% CI, 0.40 to 0.55) to 0.93 (95% CI, 0.87 to 0.99) (**Figure 10**). Two other studies reported diagnostic comparisons of OBPM and ABPM, but are not included in **Table 26** or **Figure 10**. Licitra and colleagues used an unusually low OBPM threshold of 120/80 mm Hg, but a standard ABPM threshold of 135/85 mm Hg. Not surprisingly, the resulting PPV was low (0.20).[138] Andreadis and colleagues reported only a kappa result of 0.32, but did not report results that could be used to calculate PPV.[128] In general, no qualitatively examined factors clearly influenced hypertension prevalence in the population (**Table 26**). However, OBPM that was repeated within a single visit and/or across more than one visit before referral to ABPM appeared to be more frequently associated with higher ABPM PPVs. The study with the lowest PPV (0.47 [95% CI, 0.40 to 0.55]) also had the highest percentage of women in the study population (67%).[150]

Cuspidi and colleagues confirmed 658 participants with elevated OBPM using nighttime ABPM, reporting 95 percent as hypertensive (95% CI, 93% to 97%).[129] These patients had been diagnosed and confirmed using office-based methods during two visits in the previous 12 months, which may have helped select for likely true hypertension. Additionally, the threshold for nighttime ABPM confirmation was low at 120/70 mm Hg, which may have allowed more patients to be confirmed and helped to increase the PPV.

Seven studies conducted HBPM after OBPM in 100 to 361 participants per study.[127,128,134,136,142,146,147] Participants whose elevated OBPM was confirmed with HBPM represented 45 (95% CI, 37 to 53) to 84 percent (95% CI, 80 to 89) of the population (**Figure 11**; **Table 26**). One additional study reported only a kappa result of 0.32.[128] Three of four studies with higher PPV

results measured OBPM on more than one visit, and two of these studies repeated measurements at each visit.[134,142,147] The fourth study only measured OBPM once, but the study population was noticeably older than in other studies, which could have increased hypertension prevalence.[136] Finally, four studies formally confirmed participants with initial elevated BP (range, 221 to 3,464 participants) using the same office-based methods at a second visit[137,144,152] or during multiple visits.[130] Of those participants with initial elevated BP, 58 to 96 percent were confirmed using the BP measurement results of the additional visit(s).Three other studies also confirmed participants with initial elevated BP; however, it was unclear if the same office-based methods were used at the second visit.[142,148,150] Study participants whose elevated OBPM was confirmed by a second OBPM comprised 67 to 82 percent of the population.

In summary, initial screening using OBPM methods variably predicted true hypertension, as defined by ABPM or confirmation with HBPM. Factors influencing this variability may include population characteristics that influence hypertension prevalence, such as age or baseline BP, but these characteristics do not appear to explain all variability. These results suggest that repeating initial screening BP measurements over more than one visit may improve PPV, but this is not clearly demonstrated. Finally, the proportion of study participants who had initial elevated OBPM but were diagnosed as normotensive using the reference method varied, ranging from 5 to 65 percent across all studies. We further investigate this variability in the next section of this report.

KQ 3c. Does Changing the Measurement Method From That Used During the Initial Screening Improve Diagnostic Accuracy for Some Specific Patient Subgroups?

The study design necessary to answer this question would enroll participants with elevated BP detected by an office-based screening method. Followup BP measurements would include both ABPM and repeat OBPM at a separate visit (and ideally HBPM as well). This design allows direct comparison of confirmatory measurement methods and results within the same population. While we found five studies that used this design,[130,137,142,148,150] only two studies clearly reported use of the same OBPM method for the prestudy and first OBPM visits (**Table 27**; **Appendix C Tables 31–33**).[130,137] One study used only one additional OBPM visit; the prestudy OBPM predicted the first OBPM visit result with a PPV of 76 percent, but the prestudy and first OBPM visit measurements predicted the reference ABPM result with PPVs of only 52 and 56 percent, respectively, suggesting that changing the measurement method to ABPM improved diagnostic accuracy in this study.[137] The other study included four additional OBPM visits using the same method.[130] The prestudy OBPM predicted the first OBPM visit result with a PPV of 96 percent; the PPV for the final OBPM visit decreased to 82 percent. The prestudy OBPM predicted the reference ABPM result with a PPV of 74 percent. Again, although the percentage of patients with confirmed elevated BP decreased with repeat OBPM, the percentage was lowest with followup ABPM.

While one other study found a similar pattern of results,[150] the PPVs in two other studies were much more similar to each other.[142,148] However, we cannot draw conclusions from these three additional studies without knowing the office methods used at each visit. The results from KQ 3b

indicate that use of a confirmatory BP measurement method can identify a subpopulation of persons with isolated clinic hypertension. These results, however, do not conclusively show whether the use of a different confirmatory measurement from the screening method improves diagnostic accuracy.

We also examined the same studies from KQ 3b by subpopulations, where available, to determine any qualitatively consistent association with higher versus lower PPV (**Appendix C Table 34**). There did not appear to be any association between reported age, race/ethnicity, sex, or smoking and PPV. Increasing stage of hypertension was clearly associated with increasing PPV. In one study, for example, hypertension classified as JNC 5 stages I, II, III, and IV was associated with PPVs of 0.74, 0.88, 0.97, and 1.0, respectively.[149] Thus, the likelihood of confirmation is greater when the initial elevated BP is well above the threshold for a diagnosis of hypertension than when it is closer to the threshold.

KQ 4. What Is the Clinically Appropriate Rescreening Interval for Patients Who Have Previously Been Screened and Found to Have Normal BP?

We identified 40 fair- to good-quality studies for KQ 4 (**Appendix C Tables 35–37**).[144,153-191] Thirty-nine studies were relevant to KQ 4a and 39 were relevant to KQ 4b. Some studies contributed to both subquestions and some contributed to just one. Details are addressed in each subquestion below.

KQ 4a. What Is the Shortest Interval in Which Clinically Significant, Diagnosed Hypertension May Develop?

We identified 43 articles (17 good-quality and 26 fair-quality) reporting results from 39 individual studies that provided evidence for this KQ.[144,153-168,170-191]

Study enrollment at baseline ranged from 275 to 115,736 participants. We evaluated screening intervals of less than 6 years. Most studies (k=16) reported results for a 5-year interval. Two studies provided data at more than one rescreening interval.[155,174] Most studies used a diagnostic threshold of 140/90 mm Hg or greater, but some used thresholds of 160/95 mm Hg or greater,[154, 161,162,171,173,184] and two studies used diastolic-only thresholds of 95 mm Hg or greater or greater than 100 mm Hg.[153,155] Many studies considered the use of antihypertensive medications equivalent to a BP level exceeding the diagnostic threshold. One study defined incident hypertension by self-report with physician confirmation of diagnosis or use of antihypertensive treatment.[180] Studies were conducted in Asia (19 studies), the United States (eight studies), Europe (10 studies), the United Kingdom, and Australia. Of the Asian studies, 12 were conducted in Japan, primarily in workplace settings. Twenty-one studies were community-based, 12 were employment-based, and six were clinic-based. Two clinics were specialized—one was an outpatient cardiology department[160] and another was a women's health clinic.[164]

Table 28 shows the weighted mean incidence of hypertension at intervals of less than 6 years; results were 2.5 percent at 1 year (range, 2.5% to 4.4%; k=2; n=17,740), 7.7 percent at 2 years (range, 1.2% to 12.3%; k=6; n=76,753), and 16.6 percent at 3 years (range, 6.6% to 24.9%; k=7; n=20,822). At 4 years, the weighted mean incidence of 34.4 percent (range, 2.1% to 39.2%; k=6; n=141,514) was strongly influenced by one study, which reported an unusually high incidence of 39.2 percent and contributed the vast majority of observations (n=115,736). We could find no characteristics of this study or its enrolled population to clearly explain the high incidence.[189] In a sensitivity analysis excluding this study, the annual incidence plateaued at 12.4 percent at 4 years (range, 2.1% to 23.7%; k=5; n=25,778) and 13.7 percent at 5 years (range, 2.1% to 28.4%; k=16; n=54,964).

Characteristics of the included studies are presented in **Table 29**. **Figure 12** shows a plot of hypertension incidence by rescreening interval. Notably, at each interval there was a wide range of incidence estimates among studies, showing that weighted mean incidence values are not sufficiently informative. Each of the six studies indicated by the circular symbols based hypertension incidence on multiple visits, either by use of a confirmation visit or by averaging BP measurements across two or more visits. Only one study, however, actually reported hypertension incidence based on one versus two visits per screening.[144] Hypertension incidence decreased by about half when incidence was based on two visits versus one (2.5% vs. 5.4%).[144] It is important to note that the confirmed incidence from this study was used for calculating weighted mean incidence at 1 year (**Table 28**) and considerably affected that estimate.

Another study examining hypertension incidence at a 3-year rescreening interval found that only 44 percent of apparent incident hypertension cases based on one screening (14.9%) were confirmed in a second visit.[153] We included only the incidence based on one screening in our analysis because of incomplete data reporting. Five other studies defined incident hypertension based on measurements taken at more than one visit or required confirmation.[157,158,160,173,184] One study, for example, required both elevated office and home BP measurements (1-year incidence, 4.4%),[158] another required elevated BP or use of antihypertensive medications at more than one annual checkup (5-year incidence, 10.5%),[173] and another required confirmation of elevated BP using the average of three or four subsequent visits (5-year incidence, 2.1%).[184] Except for the study by Dernellis and colleagues, studies defining hypertension based on multiple visits or confirmation generally showed lower incidence than studies using just one visit. This may be confounded, however, by varying population characteristics across studies, and the direct evidence is limited to one study.[144] The study by Dernellis and colleagues evaluated an older population attending the cardiology outpatient department of a hospital.

In summary, a substantial proportion of incident hypertension cases were not confirmed in a small number of studies that used a separate confirmation step. Therefore, estimates of the weighted mean incidence of hypertension are likely to be overestimates since most studies did not include a confirmation step. Estimates of the weighted mean incidence of hypertension at yearly intervals less than 6 years (**Table 28**) were derived from a small number of studies (except at 5 years) and showed highly variable results. For example, while the weighted mean incidence at 5 years was about 14 percent, there was a wide range of results—from as low as 2 percent to as high as 28 percent. Some of this variation is related to the criteria used to diagnose and, in some studies, confirm incident hypertension. Some variation likely also arises from differences

in the study populations. The wide variation in hypertension incidence highlights the importance of identifying subpopulations with a higher risk for incident hypertension that may benefit from targeted or more intensive rescreening. The following subquestion investigates this further.

KQ 4b. Does the Rescreening Interval Vary by Patient Characteristics?

Evidence for this KQ was provided by 44 articles reporting results from 39 individual studies.[144, 153-180,182-191,202] There were 18 good-quality and 26 fair-quality articles. All but one article evaluated for KQ 4a provided information on subgroups for this KQ.[181] Two additional articles completed the evidence base.[169,202]

Table 30 shows weighted mean hypertension incidence across studies at rescreening intervals of 1 to 5 years stratified by a priori subgroups (age, BP level, sex, BMI category, smoking status, and race/ethnicity). While this provides an overall summary and suggests some trends (e.g., increased incidence with age and BP level within the normal range at longer rescreening intervals), we focused our detailed evaluation on those studies that provided within-study comparisons directly addressing each subgroup category of interest.

Four studies reported incidence by age strata (**Table 31**).[144,171,172,176] In each study, incidence increased as much as two- to four-fold from the younger to older age categories. In three studies, hypertension incidence in the youngest stratum (18 to 40/45 years) ranged from 1.0 percent at 1 year to 5.5 percent at 5 years.[144,171,176] The fourth study reporting age strata reported a high incidence of 17.9 percent in participants ages 20 to 45 years at 5 years. Incidence may be higher in this community-based study in rural Korea because of a smaller number of participants and a high proportion of prehypertensive participants (41%) enrolled in this age category.[172]

Five studies reported hypertension incidence for three categories of normal BP—optimal (<120/80 mm Hg), normal (120–129/80–84 mm Hg), and high-normal (130–139/85–89 mm Hg) (**Table 32**).[166,167,177,183,185] Hypertension incidence consistently tripled between optimal and normal BP categories within each study and approximately doubled between normal and high-normal categories (**Figure 13**). Participants with optimal BP had a very low probability (2% to 9%) of developing hypertension over a 5-year period.

Hypertension incidence was reported separately by sex in 21 studies (**Table 33**). In general, incidence tended to be higher in men than women. In six studies, however, the ratio of hypertension incidence for men versus women was especially high at 1.7 or higher.[144,160,167,174, 186,203] In five of six studies, this elevated ratio was associated with a population mean age of about 40 years or younger, whereas all other studies with more similar hypertension incidence between men and women had population mean ages of about 45 years or older. One study with a high male-to-female hypertension incidence ratio enrolled a much older population with a mean age of 64.6 years. This study was conducted in the cardiology outpatient department of a hospital.[160]

Two studies reported hypertension incidence data by BMI category—one study at a 1-year

rescreening interval and another study at a 3-year rescreening interval.[144,175] Within each study, incidence nearly doubled between normal weight and overweight participants, and increased again for the obese category (**Figure 14**). In each study reporting on BMI, a significant proportion of participants were current smokers. Twelve studies reported hypertension incidence by smoking status. Interestingly, the incidence of hypertension appeared to be similar or lower in current smokers than nonsmokers and former smokers at all rescreening intervals (**Table 34**).

Six studies reported hypertension incidence at rescreening intervals by race/ethnicity. All were conducted in the United States (**Table 35**).[153,163,165,170,174] Only one study reported results for more than two categories.[170] Lakoski and colleagues reported higher incidence rates for African Americans at 5 years (27.5%) than for Asians, whites, or Hispanics (16.2% to 21.2%). One U.S. study conducted in Hispanic women ages 50 to 79 years reported a 3-year incidence of 19.8 percent, but within-study comparisons with other racial/ethnic subgroups were not reported.[190] The remaining studies only reported results for African Americans and whites at 2, 3, and 5 years. Hypertension incidence in African Americans was nearly two or more times higher than in whites at all intervals. This was true even for a very young population with a mean age of 25 years (range, 18 to 30 years) that reported hypertension incidence at 2 and 5 years.[174]

KQ 5. What Are the Adverse Effects of Screening for High BP in Adults?

We identified nine fair- to good-quality studies—four RCTs[192,194,195,197] and five prospective cohort studies[193,196,198-200] (n=4,634)—examining the adverse effects of screening for high BP in adults (**Appendix C Tables 38–41**). Four trials examined the quality of life of patients after being labeled as hypertensive[192,194] or prehypertensive.[195,197] One good-quality trial[195] and three fair-quality trials[192,194,197] found no significant differences in psychological distress (General Health Questionnaire)[192,194] or quality of life (Short-Form Health Survey) over short-term followup (2 weeks to 3 months) (**Appendix C Table 41**).[192,195,197] Another fair-quality cohort study examined absenteeism from work before and after labeling as hypertensive over 1 to 4 years.[193] The number of days absent per year, the number of days absent because of illness, the number of illness episodes, and the duration of illness episodes significantly increased from the year before compared with the year after labeling in those previously unaware of their hypertension status[193] and remained significant up to 4 years of followup ($p<0.01$).[204] Absenteeism increased the most among those who were least compliant with treatment for their hypertension. The reasons for this association cannot be determined from the study; one possibility suggested by the authors is an inappropriate response to diagnosis and labeling in a portion of the study population.[204]

Three fair-quality cohort studies reported significant sleep disturbances attributed to an ABPM device used for diagnosis confirmation, including less than usual sleep duration,[196] poor sleep quality,[199] frequent arousal from sleep, and subsequent removal of the device (**Appendix C Table 41**).[198] Only one fair-quality study considered the physical consequences of ABPM, reporting that a third of the participants experienced pain (32%) or skin irritation (37%) when wearing an ABPM device, and the overall comfort of the monitor was rated poorly.[198] Moderate to severe discomfort was more frequently reported during the use of an ABPM device than a

HBPM device ($p<0.0001$), as well as greater restriction in daily activities ($p<0.0001$) in one fair-quality cohort study.[200] Of the 104 participants, 41 and 70 percent had previously undergone ABPM or HBPM, respectively, which could have biased their opinion of the devices.

Chapter 4. Discussion

Context for This Review

This evidence review for the USPSTF addresses the overall benefits and harms of screening for high BP. This review also examines evidence gaps identified by the authors of the previous report regarding the optimal methods and protocols for initial BP screening, the predictive capacity for CV and mortality outcomes and the diagnostic accuracy of ABPM and HBPM, and optimal rescreening intervals.[79,205]

The 2003 and 2007 USPSTF recommendation statements affirmed and reaffirmed, respectively, that treatment of high BP in adults substantially decreases the incidence of CV events, thus completing the chain of evidence for BP screening.[206,207] Therefore, this review did not address questions regarding approaches or thresholds for treatment of hypertension.

The JNC 8 panel recently updated its guidelines for hypertension treatment.[8] It used a modified Delphi technique to identify the three highest-ranked questions that addressed BP thresholds and goals for pharmacological treatment of patients with hypertension. It also addressed whether particular antihypertensive drugs or drug classes improve important health outcomes compared with others. These guidelines were developed to meet the needs of the primary care clinician and were based on a rigorous assessment of the available RCT evidence on treatment of high BP.

The JNC 7 guidelines were published in 2003.[208] The main difference between the JNC 7 and JNC 8 recommendations is whether BP treatment thresholds and targets should be more conservative (i.e., set higher) in older populations, persons with diabetes, and persons with nondiabetic chronic kidney disease. In addition, JNC 7 addressed multiple issues, including BP measurement methods, that JNC 8 elected not to readdress so as to limit their systematic review to only the highest-priority questions.

The topics considered in the current review update and expand on similar sections of the JNC 7 guidelines. This review provides information complementary to the JNC 8 guidelines. In particular, current recommendations advise treating patients in order to reach specific BP target levels.[8] If goals are not reached within 1 month, additional medications are recommended. Thus, accurate BP measurement at appropriate intervals is necessary to identify and ensure timely treatment of patients with sustained BP elevation, while avoiding unnecessary treatment of those who may not actually benefit. **Table 36** provides a summary of the evidence.

Discussion of Findings

BP Screening, CVD, and Mortality (KQ 1)

We found one trial addressing the overarching issue of whether BP screening reduces CVD and mortality in adults (KQ 1). This good-quality cluster RCT, conducted primarily in Canadians age 65 years and older, was a pharmacy-based screening program (CHAP) that included an on-call

nurse to reassess high-risk participants and trained volunteer health educators to support self-management. The trial demonstrated that screening was associated with significant reductions in hospital admissions for acute MI. Moreover, a recent study has shown that CHAP can significantly reduce BP levels in participants with high BP at enrollment.[209] While direct evidence of benefit is reassuring, the evidence is not clearly applicable to all age groups. Additionally, this trial employed support interventions that may confound the results of simple screening.

The Franklin County study conducted in rural Maine, although not included in this review (not an RCT), also screened for BP in the context of a community program integrated with primary medical care and educational, counseling, and tracking support.[210] During the screening phase of the program, heart, coronary, and stroke death rates in Franklin County were significantly less than in one of two comparison counties not administering the program, and significantly less than in the state of Maine. Overall, while evidence addressing the overarching question is insufficient, it appears to be supportive of BP screening programs.

Diagnostic Accuracy of Clinic-Based Measurement (KQ 2)

Evidence addressing the diagnostic accuracy of clinic-based BP measurements in a single visit was surprisingly sparse, due in part to our predefined requirement of an enrolled screening population. In addition, few studies reported necessary data to evaluate the diagnostic accuracy of specific BP measurement methods or protocols. Excluded studies either enrolled a predominantly hypertensive population undergoing treatment or only compared mean BP values obtained for cohorts measured with different methods or protocols. In the few included studies, oscillometric office BP measurements showed a range of sensitivity (51% to 68%) for elevated BP, defined by manual mercury sphygmomanometry, but more consistent specificity (97% to 98%) and PPV (76% to 84%). These data omit one study for which the manual reference standard was automated in a manner not routinely used in the clinic.[107] Variation in sensitivity could reflect reference standard protocols and their effects on the patient and use of different oscillometric devices without clear documentation of their validity or calibration. Variable performance in automated BP devices is widely recognized, and reference listings of minimally valid instruments are in the public domain (www.dableducational.org).

Studies that also incorporated ABPM, which could be used as the better reference standard instead of auscultatory sphygmomanometry, did not clearly show advantage to either manual or automated OBPM, mainly because of the lack of sufficient studies and data.

We found only three diagnostic accuracy studies that examined the effects of all aspects of recommended protocols for OBPM. Again, this yield was likely limited by our requirement for enrollment of screening populations. In one study, a single BP measurement performed by a trained observer using a strict protocol had high sensitivity (0.95) but only moderate PPV (0.76) compared with the average of second and third measurements, which suggests that the main value of repeated measurements is in confirming initial elevated results.[106] This study did not include a separate reference standard and all measurements were conducted by the same unblinded observer, according to protocol. Two small studies in normotensive subjects found that leg crossing elevated SBP and DBP measurements within the normal range and that caffeine

ingestion falsely elevated BP measurements above the hypertensive threshold in 17 percent of participants. Although not extensive, these data confirm several recommended protocol approaches for accurate BP measurement.

Another recent systematic review examining the relative effectiveness of OBPM and HBPM compared with ABPM in the diagnosis of hypertension also found relatively few diagnostic accuracy studies (20 total) despite accepting nonprimary care settings, addressing high-risk populations in primary care, and not explicitly distinguishing initial screening studies from those confirming the diagnosis.[211] Similar to our review, it had stringent criteria for quality and reporting data to allow calculation of diagnostic accuracy measures (i.e., sensitivity, PPV, specificity, NPV). It also found considerable clinical and methodological variability among studies, and each study was also limited by methodological weaknesses or poor reporting. Nonetheless, it similarly reported that OBPM was variably sensitive (38% to 80% for two or three measurements in a primary care/general population) and specific (84% to 98%), concluding that OBPM was not sufficiently sensitive and specific to perform as a single diagnostic test.[212]

We excluded a much larger body of evidence that compared different BP measurement methods or protocols by calculating mean BP values for a cohort measured with both methods, but did not provide information regarding diagnostic reclassification. Although these studies did not provide information on diagnostic accuracy, we discuss them briefly in order to ground the included studies in the larger body of available evidence.

While mean BP values varied between measurement methods when both automated oscillometric device and mercury sphygmomanometer measurements were taken in the same cohorts, these variations did not occur in a consistent pattern. Among 11 studies comparing mean BP values using different measurement methods, six reported lower mean levels of BP when measured by automated oscillometric devices compared with mercury sphygmomanometers.[141, 213-217] Several studies, however, reported higher mean levels of BP[132,218-220] or comparable BP[221] when measured with automated versus mercury devices. Some of this variability may be related to variations in the algorithms oscillometric devices use to estimate SBP and DBP and lack of consistent validation. Because these devices are automated and can take several successive measurements without attendant medical personnel, they have the potential to reduce misclassification due to isolated clinic hypertension, correct errors in measurement technique such as rapid cuff deflation, and eliminate observer bias. However, it is important to base selection of oscillometric devices on rigorous independent validation and testing for accuracy in the widest possible variety of patients and practice settings.

Among excluded studies, several examined how the number of BP measurements conducted within a single session affected mean BP levels.[132,222-225] Most studies of automated oscillometric devices found that the first BP measurement was higher than subsequent measurements, which suggests that the simple procedure of automatic cuff inflation may induce an initial increase in BP that subsides with longer duration of rest before measurement and as the subject becomes accustomed to the device. The moderately low PPV of a single measurement suggests that the same may be true of manual BP measurement.[106] Two other studies of manual auscultatory measurement reported either higher first measurements[213] or no difference between first and subsequent measurements.[132] The duration of time required for BP to stop decreasing with

subsequent measurements ranged from 6.5 minutes to 1 hour.[226-228] BP was lower when measured in a nonclinical versus clinical setting,[229,230] in a waiting versus examination room,[229] and by a nurse versus physician.[231,232]

Among three studies that examined the mean BP effect of placing the cuff over a sleeve up to the thickness of a sweatshirt versus a bare arm, none showed a significant difference in BP.[225,233,234] Fast cuff deflation was found to underestimate SBP and overestimate DBP.[235] Higher BP was observed when small cuffs were used compared with larger cuffs,[236-238] but studies disagreed about whether cuff looseness affected BP.[225,239]

There was disagreement about the prevalence of within-group BP differences in studies providing only cohort-level mean BP analyses, with two studies showing a high frequency of differences greater than 10 mm Hg[240,241] and two studies showing little difference.[242,243] Studies of arm position showed that BP taken in the upper arm was lower when the arm was supported at the level of the heart in about 50 degrees of shoulder flexion (at about the mid-sternum or the fourth intercostal space) than when the shoulder was in a neutral nonflexed position and the arm was resting alongside the body in a dependent position or supported by the arm of a chair.[221,225,244] In terms of the measuring environment, one study found higher BP when it was measured during talking versus no talking.[225]

Thus, included diagnostic accuracy studies of BP measurement protocols, supported by excluded mean BP comparisons from cohort analyses, support many aspects of the recommended protocol for BP measurement,[245] except the requirement to place the cuff over a bare arm. The aspects of the recommended protocol for which evidence supports effectiveness include: 1) avoidance of caffeine ingestion before BP screening is performed, 2) seating the patient in a chair with the back supported and with both feet placed flat on the floor, 3) using a cuff that is properly sized for the patient's arm circumference, 4) avoiding rapid cuff deflation, 5) avoiding talking during measurement, 6) positioning the arm so that the shoulder is flexed and the outstretched upper arm is supported at the level of the mid-sternum, rather than resting alongside the body or supported by a chair arm, and, to some extent, 7) resting prior to BP measurement.

Measurement Methods and Prediction of CV Outcomes (KQ 3a)

Mercury sphygmomanometers, followed by aneroid sphygmomanometers, have long been the standard method for measuring BP in a clinical setting. Higher BP results measured with mercury sphygmomanometers are associated with increased vascular and overall mortality.[6] More recently, nonoffice-based methods, such as ABPM, have been considered to provide more accurate prediction of long-term CV outcomes; ABPM has been identified in many clinical studies as the reference standard for BP measurement. To answer KQ 3, we addressed the ability of ABPM and HBPM results to predict long-term CV outcomes compared with standard office-based results. Based on the available evidence, we found that ABPM predicts long-term outcomes better than OBPM in comparative studies. As such, ABPM is the most accurate reference standard for confirming an initial elevated BP measurement.

Included studies approximately reproduced the previously reported association between OBPM (e.g., using a sphygmomanometer) and CV outcomes, although these studies were relatively

small and risk estimates were low. Twenty-four-hour systolic ABPM, however, consistently and significantly predicted stroke and other CV outcomes independent of OBPM. Additionally, ABPM apparently has greater predictive value compared with OBPM. Diastolic results were similar although predictive value was attenuated. Because too few studies were available for each outcome category to conduct a meta-analysis, data synthesis was qualitative. While there were fewer data for cardiac, CHF, and all-cause mortality outcomes, 24-hour ABPM appeared to be less consistently predictive for these outcomes.

Results for daytime and nighttime ABPM appeared to follow the same prediction patterns as 24-hour ABPM, and an exploratory meta-analysis comparing these three protocols found no differences. One additional study, which we excluded because results were reported for categories of baseline BP level, also reported that daytime systolic ABPM was more predictive of all-cause mortality than OBPM, although only at higher levels of baseline BP.[246] The available evidence does not permit any qualitative distinctions among the three ABPM protocols (24-hour, daytime, or nighttime).

While available data suggest that HBPM predicts outcomes similarly to ABPM and independently of OBPM, there were few studies reporting this data. We excluded an additional study because the results were reported for categories of baseline BP level. This study also identified HBPM as a better predictor of stroke and MI at lower baseline levels of BP compared with OBPM, but these differences were not significant.[247] In general, data on HBPM were insufficient for firm conclusions regarding prediction of CV outcomes.[248,249] Only one study compared ABPM with HBPM, which is insufficient for conclusions regarding the direct comparison of HBPM and ABPM for prediction of long-term CV outcomes.

The National Institute for Health and Care Excellence (NICE) previously compared ABPM, HBPM, and OBPM in an analysis of prognosis.[250] We included seven of the 14 studies included in the NICE review in our review of prognosis, as well as eight additional studies, for a total of 15 studies. The NICE review included both meta-analyses and individual studies, with some overlapping populations. Our evidence review was limited to original studies, which we closely reviewed to avoid double counting for each outcome category. We also restricted the use of composite outcomes, which resulted in some study exclusions that were included in the NICE review. In addition, studies that reported predictive results only by categorized BP levels were not included in this review because of lack of comparability, but were included in the NICE review. Finally, we converted all HR results to consistent increments of expression for the BP predictor variable, which allowed direct comparison among studies. Despite some methodological differences between our reviews, the NICE report concluded that ABPM was most often the best predictor of clinical outcomes. With no clear data distinguishing among 24-hour, daytime, or nighttime ABPM, daytime ABPM was chosen pragmatically because it allowed for easy comparison with office-based or home BP measures. The report further stated that obtaining multiple BP measurements away from the clinic setting (potentially including HBPM, despite sparse data) is the best predictor of BP-related clinical outcomes. It also recommends offering ABPM (or HBPM if ABPM is declined or not tolerated) following an elevated BP measurement (≥140/90 to <180/110 mm Hg; any result above the latter threshold requires immediate medical attention),[2] and recommended additional prospective studies comparing OBPM, HBPM, and ABPM.

Numerous IPD meta-analyses have addressed the predictive value of BP measurement methods. Five IPD meta-analyses reported that ABPM is a significant predictor of CV death.[88-90, 95,96] Of these studies, three reported that ABPM was a better predictor than OBPM.[89,90,95] In two of these IPD meta-analyses, nighttime ABPM was a better predictor of CV death than daytime ABPM in persons with or without a history of CVD.[95,96] Another IPD meta-analysis, however, reported that whether daytime or nighttime ABPM was the better predictor depended on the outcome studied.[87] One study reported a significantly greater risk for CV mortality in women than men using 24-hour ABPM,[88] and daytime and 24-hour ABPM were better predictors of CV death in two studies using the same database.[89,90] In general, these studies support the choice of ABPM (no specific protocol) as an appropriate reference standard for measurement of BP.[251]

Diagnostic Accuracy of Confirming a Hypertension Diagnosis (KQ 3b)

We found that OBPM variably predicted true hypertension, as defined by the reference standard of ABPM (not distinguishing among 24-hour, daytime, or nighttime), and that ABPM confirmatory testing identified a significant proportion of persons with isolated clinic hypertension, ranging from as low as 5 percent to as high as 65 percent. When HBPM was used for confirmatory testing, the proportion ranged from 16 to 55 percent. For either confirmatory method, the high variability may be based on population characteristics that predict likely hypertension (older age, higher baseline BP) and the stringency of the protocol for initial office-based measurement. Several studies indicated that screening BP was based on repeat measurements taken at each visit and at more than one visit prior to confirmatory testing. Studies based on multiple initial screening measurements appeared to better confirm an initial elevated OBPM. However, this was contradicted by one study that formally evaluated multiple office-based measurements at two separate screenings, in which the second visit confirmed the initial elevation with a predictive value of only 58 percent.

The importance of confirmatory measurements depends on the long-term outcomes in persons whose initial elevated BP results are not confirmed (i.e., patients with isolated clinic hypertension). Therefore, we examined studies reporting long-term CV outcomes for results limited to this subpopulation. Although the evidence from seven studies is not consistently presented or directly comparable, it suggests that patients with isolated clinic hypertension have long-term outcomes more similar to those with normotensive BP than sustained hypertension. These limited data are generally consistent with other authoritative conclusions that persons with isolated clinic hypertension or normotensive BP have more similar CV prognoses than those with isolated clinic hypertension or sustained hypertension.[252] Nonetheless, persons with isolated clinic hypertension have a higher risk for developing sustained elevated BP and should be monitored. We could make no distinction between using ABPM and HBPM to identify persons with isolated clinic hypertension and risk for long-term outcomes because only one study used HBPM.

Given the high degree of variability of OBPM to predict hypertension and the importance of distinguishing between persons with higher and lower risk for long-term CV outcomes, confirmatory measurement is needed for persons with initial elevated BP. This appears to be particularly true for those with screening BP levels nearer the threshold for diagnosing hypertension. ABPM has the largest evidence base supporting prediction of long-term CV

outcomes and, thus, the most supportive evidence as a confirmatory test. HBPM may also be a satisfactory confirmatory test, but its evidence base for predicting long-term CV outcomes is much smaller, with too few studies for each type of outcome. ABPM provides multiple measurements over time in a nonmedical setting, potentially avoiding the white coat effect. In the absence of ABPM for confirmation, additional OBPM may improve diagnostic accuracy, especially if repeated within a single visit and across multiple visits. As noted, automated OBPM, using a valid device, can provide multiple accurate measurements without the need for attendant health care personnel, which may mitigate the white coat effect. This is consistent with JNC 8 recommendations on the use of oscillometric methods (when properly calibrated and validated) or two to three carefully performed manual measurements.[8]

The overall clinical value of confirmatory testing is avoiding misdiagnosis in normotensive persons who have isolated clinic hypertension in medical settings, which would avoid the harms of unnecessary treatment. In a large cohort of Spanish patients, for example, resistant hypertension (defined as persistent OBPM >140/90 mm Hg and treatment with three or more antihypertensives, including a diuretic) was fairly common (12.2%). Based on ABPM, more than one third (37.5%) of these patients were found to have isolated clinic hypertension.[253]

Rescreening Interval (KQ 4)

As shown in the Analytic Framework, persons who are screened and found to have BP levels within normal limits cycle back to the beginning of the screening process. The appropriate interval for the next screening visit (rescreening), however, is not clearly evidence-based. We summarized studies that followed screened, normotensive persons over time and reported incident hypertension at rescreening intervals up to 6 years (KQ 4). We found that estimates of hypertension incidence following a normal BP level were highly variable, ranging from 2.5 to 4.4 percent at 1 year, 1.2 to 12.3 percent at 2 years, and 6.6 to 24.9 percent at 3 years. Point estimates and ranges were similar at 3, 4, and 5 years. Studies that required confirmation of elevated BP measurements at rescreening confirmed fewer than half of initial cases, suggesting that confirmatory measurement at rescreening may reduce misdiagnosis and overtreatment.

Risk for incident hypertension varies by population subgroups as well as rescreening interval. A recent meta-analysis of risk prediction models for hypertension found that age, sex, BMI, baseline BP, and cigarette smoking were the most common predictors.[254] In general, our findings on incident hypertension rates at rescreening identified similar subgroups and are consistent with data showing that hypertension is more prevalent in older adults, men, and African Americans.[19] It is important to recognize that hypertension is more prevalent in men than women before age 65 years. In older age groups, however, it is more prevalent in women.[19] Included studies likely do not reflect this because the mean age was typically well below 65 years and study age ranges often did not include participants older than 69 years, where reported. While our review included only one study reporting on the incidence of hypertension in Hispanics, U.S. population data suggest that the prevalence is similar to that of non-Hispanic whites.[255]

Our findings are consistent with international prevalence data that BMI has a strong influence on the incidence of hypertension.[256] Our finding of lower incidence of hypertension in current smokers, who tend to have lower weight and BMI than nonsmokers or former smokers,[257] is also

consistent with a cross-sectional study conducted in the German general population on the epidemiological relationship between smoking and hypertension. The authors reported no association between never or former smokers and hypertension among persons of normal weight, but reported strong associations between obese former smokers and normal weight current smokers.[258]

Our data also confirm that any BP above the optimal level of less than 120/80 mm Hg conferred a graded risk, with those closest to the threshold for a diagnosis of hypertension (i.e., those with high-normal BP of 130–139/85–89 mm Hg) having the highest incidence. These findings are supported by incidence rates in the untreated group of the Trial of Preventing Hypertension study, which found that about 40 percent of participants with high-normal BP progressed to hypertension at 2 years and 63 percent at 4 years.[259] This was a placebo-controlled trial investigating whether pharmacological treatment of high-normal BP prevents or postpones hypertension. It was not included in our review because we did not consider hypertension intervention trials.

Based on higher incidence of hypertension in subpopulations at high risk for incident hypertension, ensuring rescreening at short-term intervals in particular groups is prudent, especially in older adults (particularly if age ≥60 years), persons with BP greater than 120/80 mm Hg (particularly if >130/85 mm Hg), overweight persons (particularly if obese), and African Americans. Adults ages 18 to 40 years with no other risk factors have a low incidence of hypertension (e.g., about 1% to 6% at 2 years, without confirmation of initial BP). We found only one study that examined a rescreening interval shorter than 1 year.[155] Although only two organizations recommend screening for high BP at all health care visits (one in ages 18 to 21 years and one in all adults),[260,261] national data show that BP is measured at nearly 60 percent of all adult clinic visits in the United States.[21] With an average of 1.8 primary care visits per person per year in the United States and an average of 90.8 percent of all adult primary care provider visits recording BP, overscreening is clearly possible, particularly in low-risk persons.[21] If this is the case, then available time and resources might be better directed toward improved measurement accuracy in higher-risk persons.

Clinic-based BP measurements must be taken accurately to avoid misclassification and potential overtreatment or undertreatment at any visit.[41] Newer methods of BP measurement are available that may improve current levels of diagnostic accuracy by reducing observer error, reducing the white coat effect, and increasing the aggregate number of measurements. These include automated methods for clinical settings, such as HBPM and ABPM.

Harms of Screening (KQ 5)

Evidence from four studies indicated no changes in psychological distress or quality of life before versus after persons were labeled as hypertensive or prehypertensive. One study documented increased absenteeism due to illness after persons were labeled as hypertensive that remained significant for up to 4 years. Four studies addressed the comfort and convenience of ABPM devices, consistently reporting poor sleep quality and minor physical reactions. Tolerability of the device was correlated with an overall health assessment in one study. In general, the direct evidence on harms of screening is inconsistent, and any harms appear to be

relatively minor.

As noted in the discussion of KQ 3b, some persons with an elevated BP measurement who are not confirmed with an additional BP measurement may be misdiagnosed and could suffer the more serious harms of unnecessary treatment. Therefore, we emphasize the need for confirmatory testing to avoid such harms.

Limitations of the Review

We excluded revascularization and angina from individual or composite prognostic outcomes. Angina alone, as opposed to hospitalization for angina, is not included in the Clinical Trials Initiative "Standardized Definitions for End Point Events in Cardiovascular Trials."[262] Revascularization outcomes are subject to numerous limitations, including variation in procedures, substantial practice variation, and mixed evidence on the appropriate use of these procedures. Reports have shown a five-fold variability in population-based rates of coronary artery bypass grafts in the Medicare population,[263] as well as hospital-to-hospital variation in percutaneous coronary interventions.[264] There are also concerns regarding the appropriate use of these interventions in nonacute settings.[264-266] Leape and colleagues have noted substantial variation in the interpretation of coronary angiography; such disparities can lead to overuse of coronary artery bypass grafts and percutaneous transluminal coronary angioplasty.[267] Both outcomes were included in many study composite outcomes, however, making those studies ineligible for this review (**Appendix Table 1**). As a result, many of our remaining eligible composite outcomes included only fatal events. This does not affect the value of the prognostic outcome assessments, primarily for KQ 3a, but likely enhances their precision and validity by removing outcome measurement variability. This requirement, however, limited the number of studies we could include, and our findings do not represent the full range of nonfatal CV events.

For KQ 3a, we did not conduct a new literature search specific for the prognosis of persons with isolated clinic hypertension. As noted in the discussion, our findings are generally consistent with other recent evidence-based guidance.

For KQ 3b, we did not address the reproducibility of isolated clinic hypertension (either by home or office methods) over a short time frame following the initial diagnosis. Studies included for KQ 3b enrolled some patients who may have been treated with antihypertensive medications and who had stopped treatment for a washout period of at least 2 weeks prior to BP measurement. It is possible, however, that the lingering effects of the medication could have altered results. We determined that only six of 26 included studies allowed treated patients with a washout period. Of these, one study stipulated a washout period of 2 weeks, another study stipulated 3 weeks, three studies required 4 weeks or longer, and another study required 24 weeks. Thus, any effect is likely to be minimal.

For KQ 4, the best evidence on rescreening intervals came from studies that evaluated participants at specific time intervals and reported incidence of new hypertension cases at that interval (e.g., the study by Dernellis and colleagues[160]). Some studies evaluated patients across a range of time, but reported only the mean or median followup without reporting the range. For

these studies, it is not clear where along the spectrum of followup the incident cases actually occurred, and the interval assignment is somewhat inaccurate.

Some experts consider dipping versus nondipping status to be an important predictor of CV events.[268] Others have reported that it adds little to the prognostic value of 24-hour BP.[47] Moreover, it is not clear that dipping is a stable characteristic.[48] We did not systematically review this literature.

Limitations of the Body of Evidence

Despite recent emphasis on the instability of single BP measurements and the need for multiple, valid measurements to assess a patient's actual elevated BP exposure, high-quality comparable diagnostic accuracy studies are not common. Given recent recognition of the impact of overdiagnosis in many diseases, the widespread availability of automated BP devices with variable performance, and the prevalence of essential hypertension in the United States, further research to guide primary care clinicians and consumers would be beneficial.

Future Research Needs

Self-use BP kiosks placed in community settings, such as pharmacies and grocery stores, are frequently used by the general public. Kiosks are not regulated by the FDA, and a recent survey of seven leading North American manufacturers of BP kiosks reported that only one had satisfactory validation data.[269] A report by the Canadian Agency for Drugs and Technologies in Health found no systematic reviews, meta-analyses, or RCTs of BP kiosks and only one North American guideline that incorporated information on BP kiosks.[270] The report concluded that very little data were available to support the use of BP kiosks and their results are considered too variable and insufficiently researched to be incorporated into guidelines. One validation study reported results within the AAMI SP10 accuracy and reproducibility standards,[271] while another validation study of a different device reported acceptable reproducibility but unacceptable SBP accuracy.[272] A third study found acceptable accuracy only in persons with medium arm sizes. Persons with small or large arm sizes had BP results that were overestimated or underestimated, respectively.[273] One study addressed the characteristics of kiosk users by conducting a cross-sectional survey of adult patients seen in a primary practice network of clinics within a 4-week period.[274] The questionnaire response rate was 76 percent out of a random sample of 700. Sixty-three percent of respondents checked their BP at locations other than their physician's office or at home. Of these, about two thirds used pharmacy kiosks. Respondents ages 45 to 65 years were more likely to use kiosks than those older than 65 years, and were more likely to have a high school education but no advanced education. Persons with diabetes, heart disease, or a history of stroke were not more likely to use kiosks. Results were similar for persons taking antihypertensive medications. Finally, one study reported the results of a community-based program for hypertension detection using open-access kiosks placed in low socioeconomic areas of Exeter, Devon, United Kingdom.[275] Authors followed up with all users with an Exeter address and, if permission was granted, accessed their medical records. Overall, the program detected new hypertension cases in 1.4 percent of 58 responders (out of 122 with an Exeter address).

Contrary to the intent of the program, the study found that there was preferential use of the kiosks by persons with an existing diagnosis of hypertension.

The availability of protocols other than lengthy confirmatory BP measurement (e.g., ABPM) for identifying patients who are likely to have isolated clinic hypertension would be helpful for primary care and BP screening programs. One study reported on the development and testing of a screening tool to identify rural and nonrural patients at risk for the white coat effect.[276] The development cohort included 36 hypertensive or borderline hypertensive adults and the testing cohort included a sample of 104 patients. The screening tool was not predictive of systolic or diastolic white coat effect. No other tools for identifying isolated clinic hypertension were noted for this report.

High-quality studies are needed to confirm the best office-based protocols for initial screening and the most applicable and efficient postscreening confirmatory diagnostic methods for different levels of elevated BP and patient subgroups. Ideally, all studies would use ABPM as a reference standard.

In lieu of prospective diagnostic accuracy studies to compare office-based protocols for initial screening, consideration of published diagnostic accuracy studies and protocol comparison studies that enrolled treated hypertensive patients is needed. If deemed appropriate, these may substantially augment the evidence for KQ 2, which was limited in this review to screening populations only.

Identification of an ABPM standard allows investigation of literature comparing HBPM and ABPM and defining the characteristics of the best HBPM protocol—for example, whether there is any advantage to measuring BP in both the morning and evening versus one or the other, the optimal number of days to measure BP, or whether the first day of measurements should be discarded.

Further research is needed to predict future hypertension and CVD, including among the treatment-resistant segment of the hypertensive population. Standardized reporting of these outcomes is also needed.

Research is also needed on alternative methods to validly confirm hypertension diagnosis in screen-detected patients.

This review focused on brachial measures of central BP, as these are most commonly used in primary care settings. There are new devices and techniques available to noninvasively measure BP (e.g., central vascular pressure by applanation tonometry, pulse wave analysis), and some evidence suggests that these provide better prognostic data.[277] However, accuracy and reproducibility may need improvement.[278] These methods can also be used to calculate arterial stiffness, which may also improve predictive value.[279,280] High BP variability has also been associated with poorer CV outcomes.[281,282] Another form of new technology is conventional BP measurement using a wireless brachial BP monitor that connects to a smart phone via the Internet to save results for trend analysis and/or export to health care providers. Whether and how to incorporate these new devices and measurements into primary prevention requires further

analysis.

AF occurs in 1 to 2 percent of the general population, particularly the elderly, and often coexists with hypertension, both of which are strong risk factors for stroke. Single BP measurements in patients with AF are prone to systematic error due to increased beat-to-beat variability. Automated measurement methods, including ABPM, may address this problem, but evidence is scarce because patients with AF are usually excluded from studies.[283] Current guidelines recommend repeated auscultatory measurements in patients with AF, but question the accuracy of automated oscillometric devices, although without evidence-based review.[284] A recent meta-analysis of the small number of studies of automated BP measurement in patients with AF suggests that oscillometric methods may in fact be accurate, particularly for SBP (but may overestimate DBP), and be acceptable for home and ambulatory use, although not recommended for clinical settings.[285] More information is needed on the accuracy and reproducibility of both manual and automated devices, including ABPM, in patients with AF.

Recently, embedded algorithms for detecting asymptomatic AF have been developed for some automated BP devices for use in general screening, including ABPM devices. At least five studies have evaluated the diagnostic accuracy of automated BP devices for home use with the AF detection algorithm—four by testing the device in a clinical setting and one at home. Results have been evaluated as satisfactory.[284] The NICE Medical Technology Guidance Committee evaluated the WatchBP® Home A device (Microlife, Tampa, FL), an oscillometric BP monitor that also detects pulse irregularity by means of an embedded algorithm. The device may also be used for 24-hour ABPM. Clinical evidence was based on five studies conducted in a hospital setting and focused mainly on the diagnostic accuracy of the device in detecting AF. Evidence that the device could detect AF in persons undergoing 24-hour ABPM was limited to a small case-series and an unpublished study. The NICE Committee recommended AF screening with the device in a primary care setting under the supervision of a clinician in patients with suspected hypertension or those being screened or monitored for hypertension. The Committee considered potential benefits to be an increase in the rate of detection and a reduction in stroke incidence, although there were limited data to support clinical utility. The totality of the available evidence for automated devices requires evaluation, including use of ABPM for screening for AF.

Finally, BP trajectories throughout young adulthood may better predict risk for coronary artery disease in middle age and potentially long-term CV outcomes.[286]

Conclusion

ABPM (24-hour, daytime, or nighttime) is a better predictor of long-term CV outcomes than OBPM (manual sphygmomanometry) and should be considered the reference standard for evaluating noninvasive BP measurements. A small body of evidence suggests, but does not confirm, that HBPM can similarly predict outcomes. Initial screening with office-based methods (manual sphygmomanometry or automated oscillometric methods) variably predicts hypertension, as defined by ABPM, resulting in a significant population with isolated clinic hypertension. Limited evidence suggests that persons with isolated clinic hypertension have outcomes more similar to normotensive than hypertensive persons. Failure to confirm initial

elevated OBPM results may result in misdiagnosis and overtreatment. Limited evidence suggests that repeated measurements and improved procedural control (e.g., automation) may improve the diagnostic accuracy of OBPM when used to screen for high BP or confirm hypertension. Studies of rescreening intervals at up to 6 years found a higher incidence of hypertension overall and at shorter intervals for persons with BP in the high-normal range, older adults, persons with an above normal BMI, and African Americans. These studies showed much lower incidence at longer rescreening intervals (up to 6 years) in persons without these risk factors.

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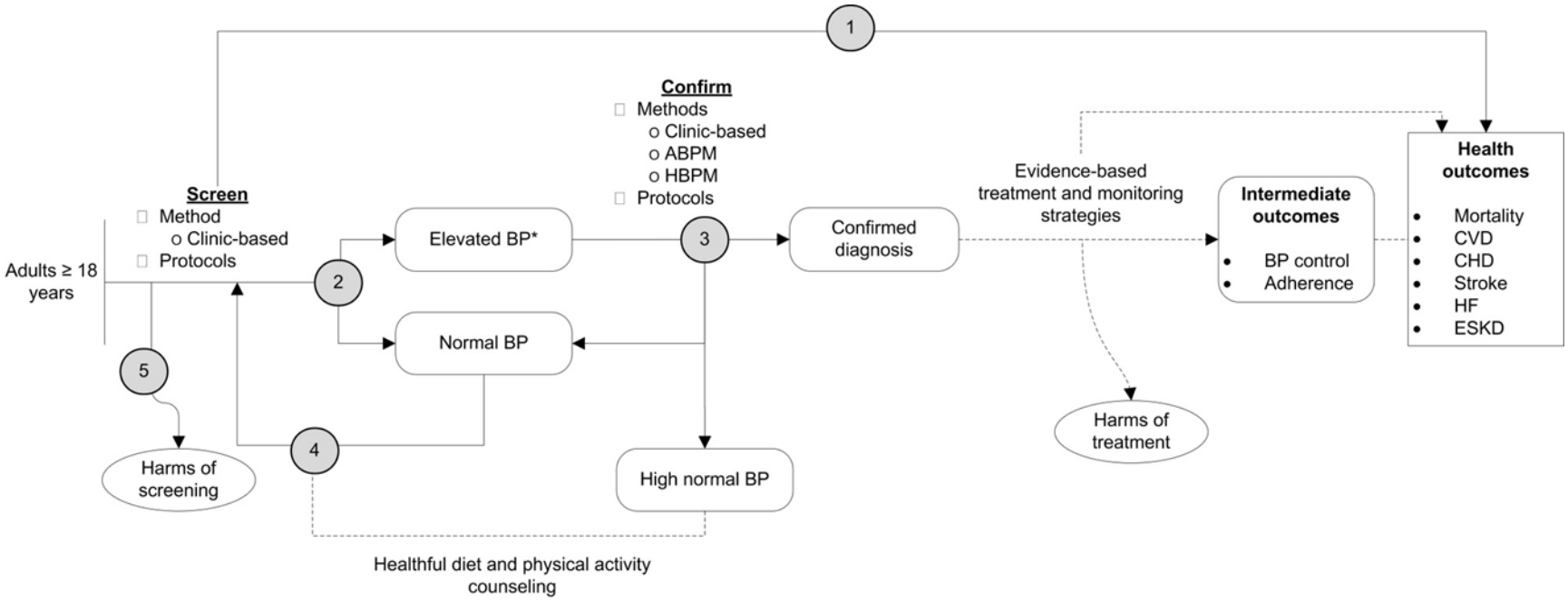
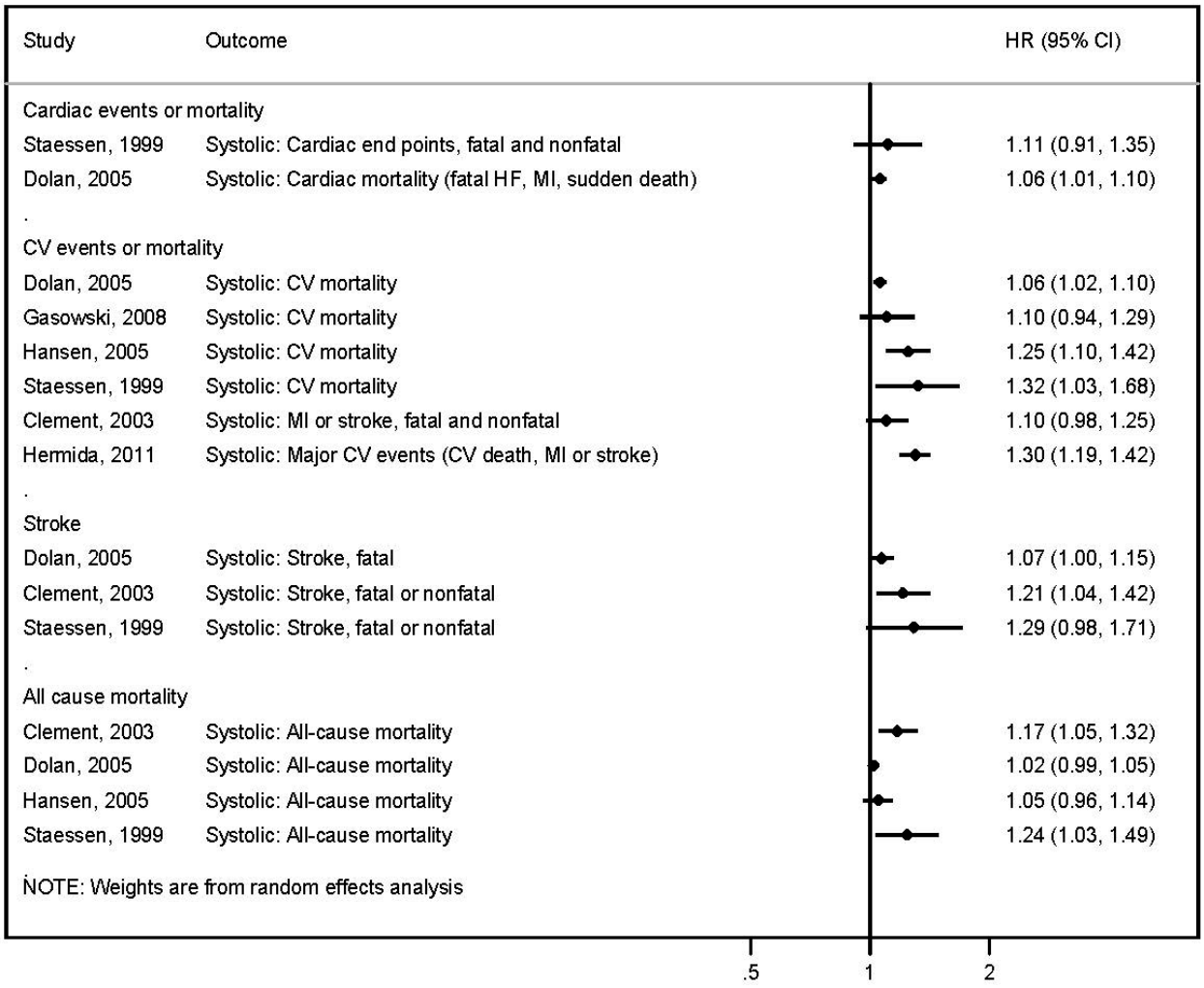
Figure 1. Analytic Framework



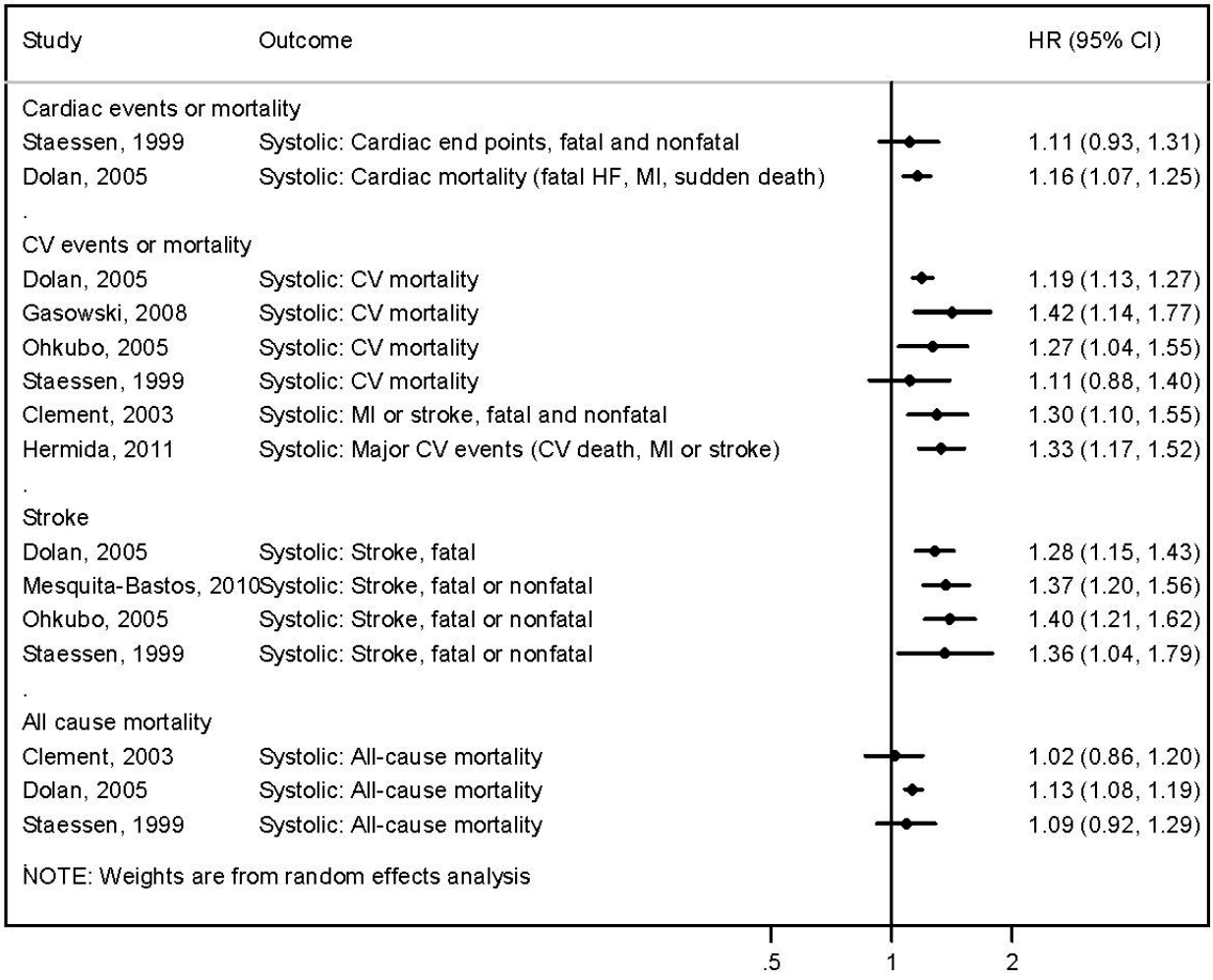
Abbreviations: ABPM = ambulatory blood pressure monitoring; BP = blood pressure; CHD = coronary heart disease; CVD = cardiovascular disease; ESKD = end-stage kidney disease; HBPM = home blood pressure monitoring; HF = heart failure.

Figure 2. Risk for Cardiovascular and Mortality Outcomes: OBPM, Not Adjusted for 24-hr ABPM



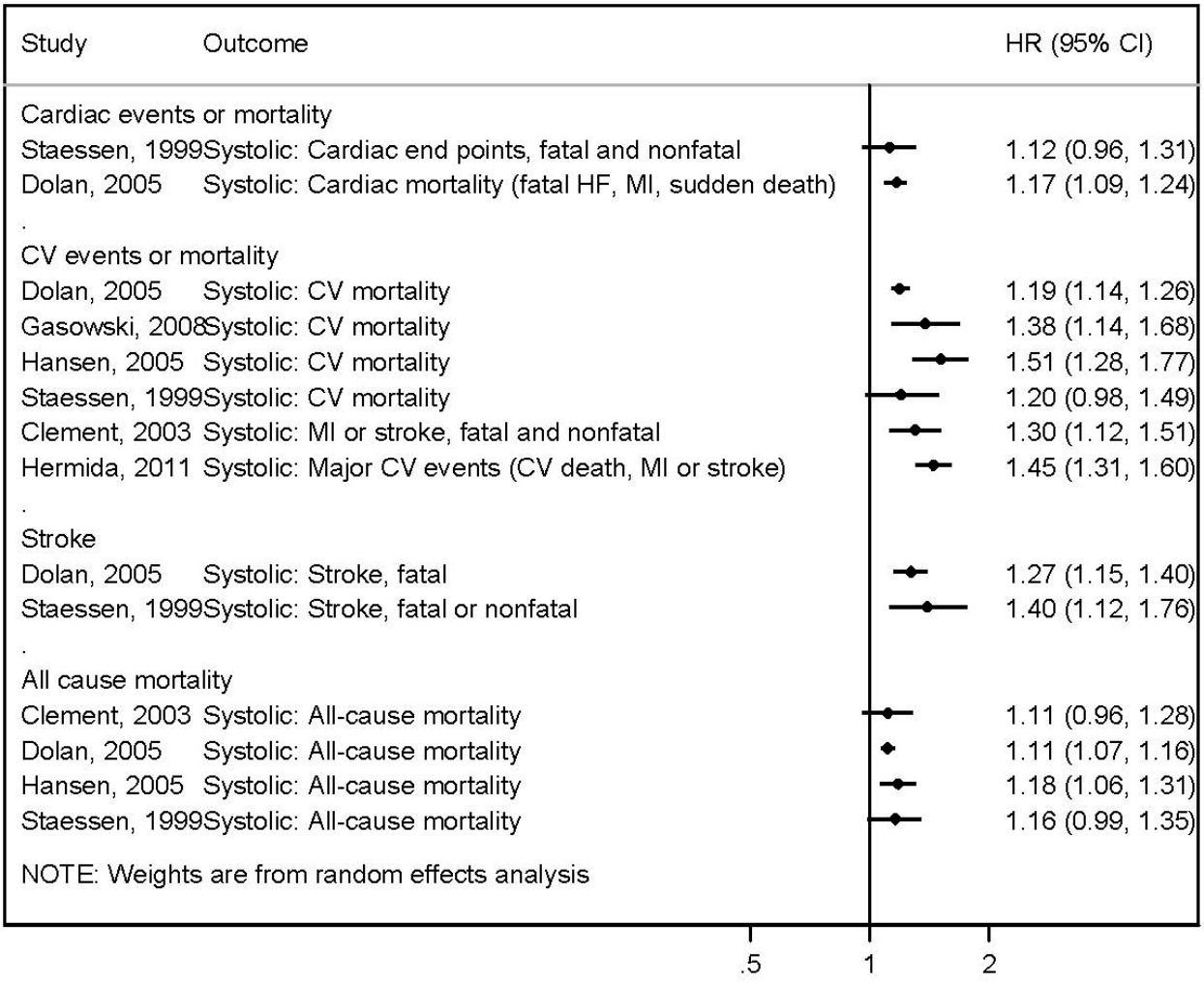
Abbreviations: CI = confidence interval; CV = cardiovascular; HF = heart failure; HR = hazard ratio; MI = myocardial infarction.

Figure 3. Risk for Cardiovascular and Mortality Outcomes: Systolic 24-hr ABPM, Adjusted for OBPM



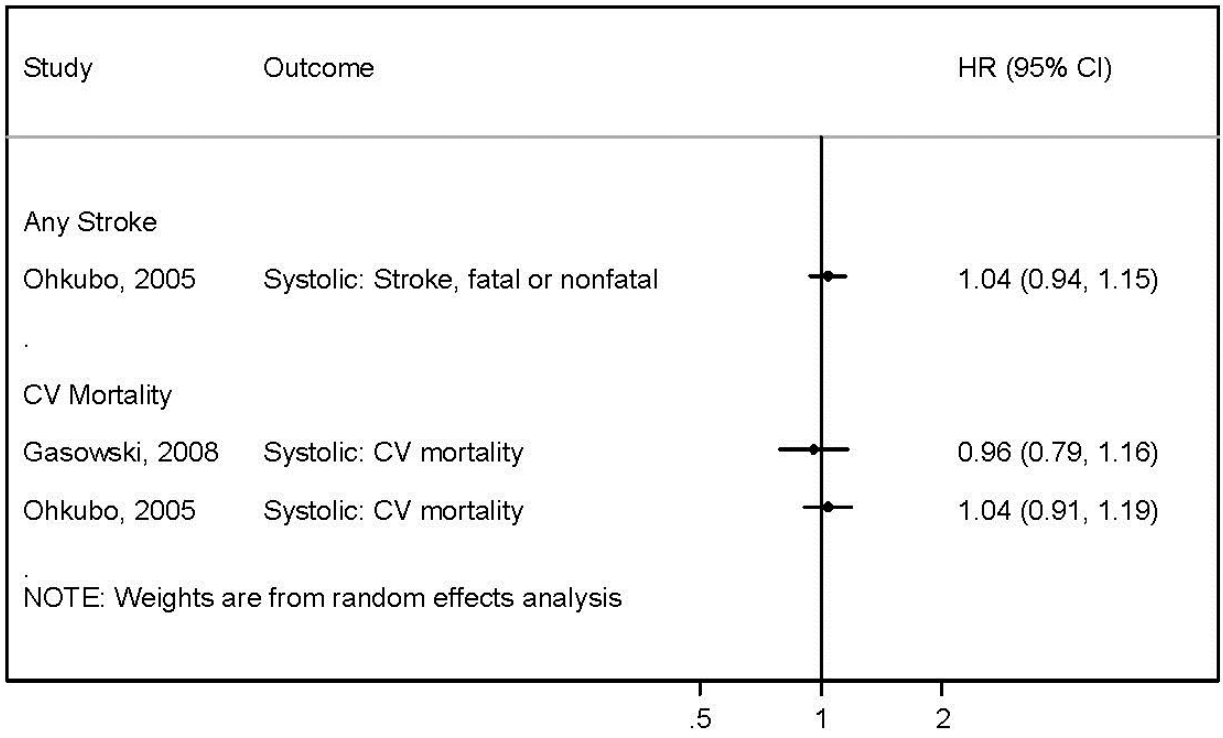
Abbreviations: CI = confidence interval; CV = cardiovascular; HF = heart failure; HR = hazard ratio; MI = myocardial infarction.

Figure 4. Risk for Cardiovascular and Mortality Outcomes: Systolic 24-hr ABPM, Not Adjusted for OBPM



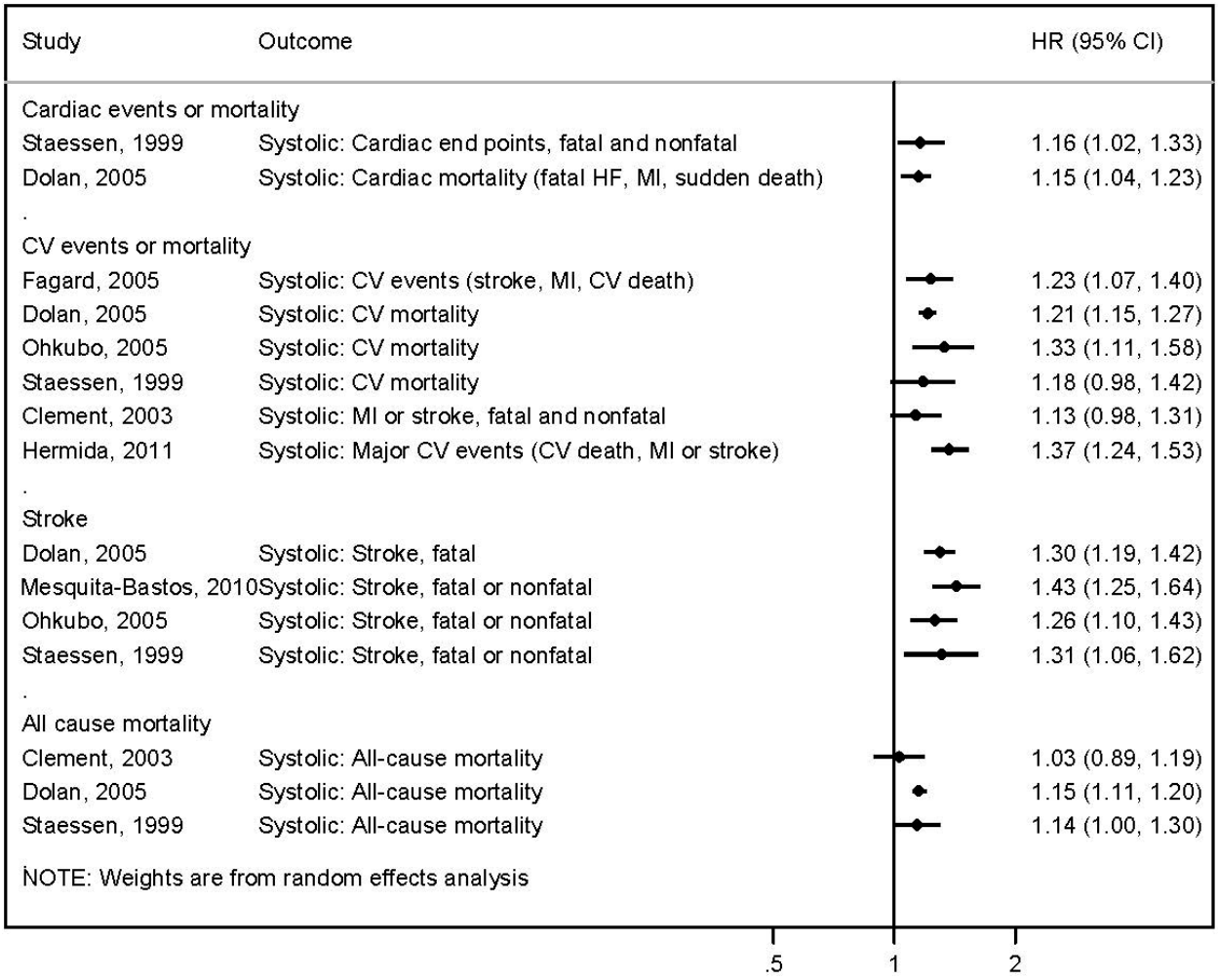
Abbreviations: CI = confidence interval; CV = cardiovascular; HF = heart failure; HR = hazard ratio; MI = myocardial infarction.

Figure 5. Risk for Cardiovascular and Mortality Outcomes: Systolic OBPM, Adjusted for 24-hr ABPM



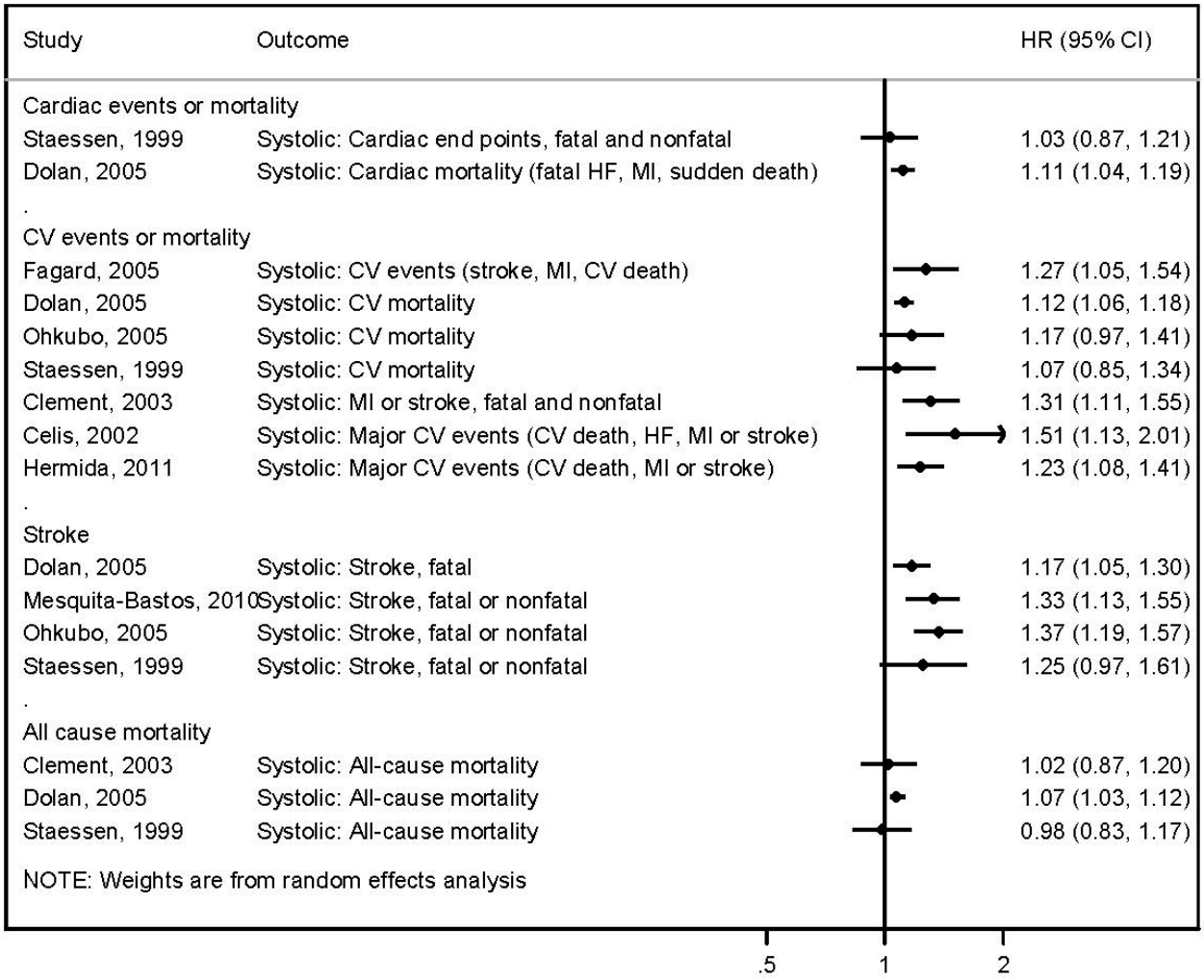
Abbreviations: CI = confidence interval; CV = cardiovascular; HF = heart failure; HR = hazard ratio; MI = myocardial infarction.

Figure 6. Risk for Cardiovascular and Mortality Outcomes: Systolic Nighttime ABPM, Adjusted for OBPM



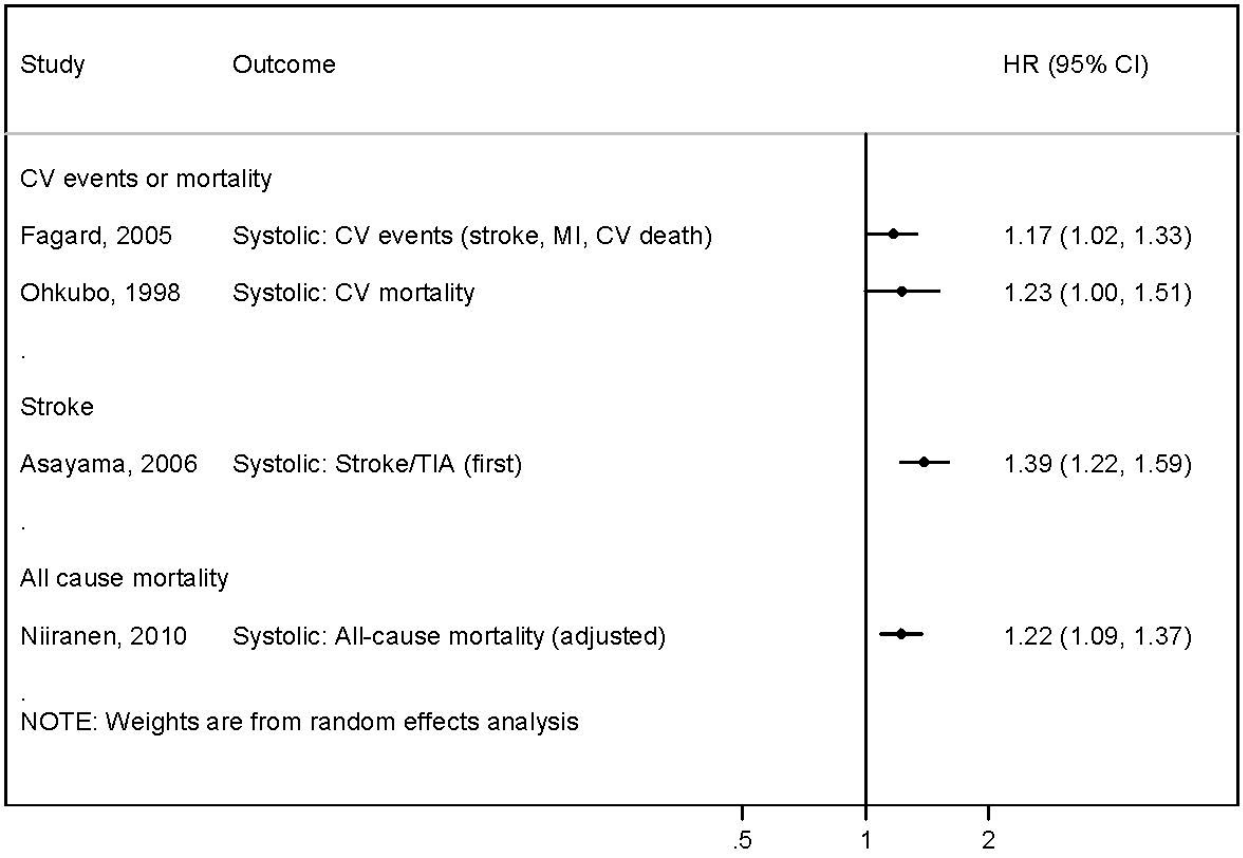
Abbreviations: CI = confidence interval; CV = cardiovascular; HF = heart failure; HR = hazard ratio; MI = myocardial infarction.

Figure 7. Risk for Cardiovascular and Mortality Outcomes: Systolic Daytime ABPM, Adjusted for OBPM



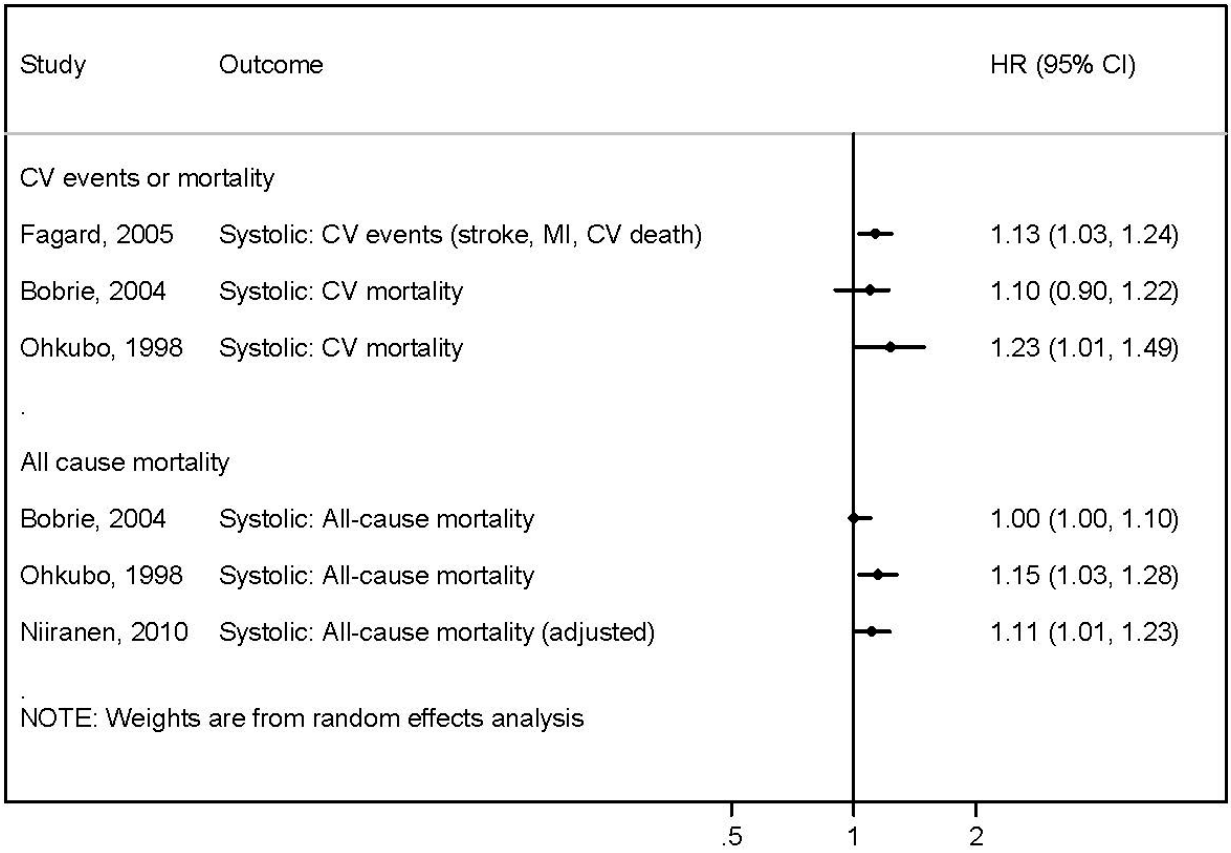
Abbreviations: CI = confidence interval; CV = cardiovascular; HF = heart failure; HR = hazard ratio; MI = myocardial infarction.

Figure 8. Risk for Cardiovascular and Mortality Outcomes: Systolic HBPM, Adjusted for OBPM



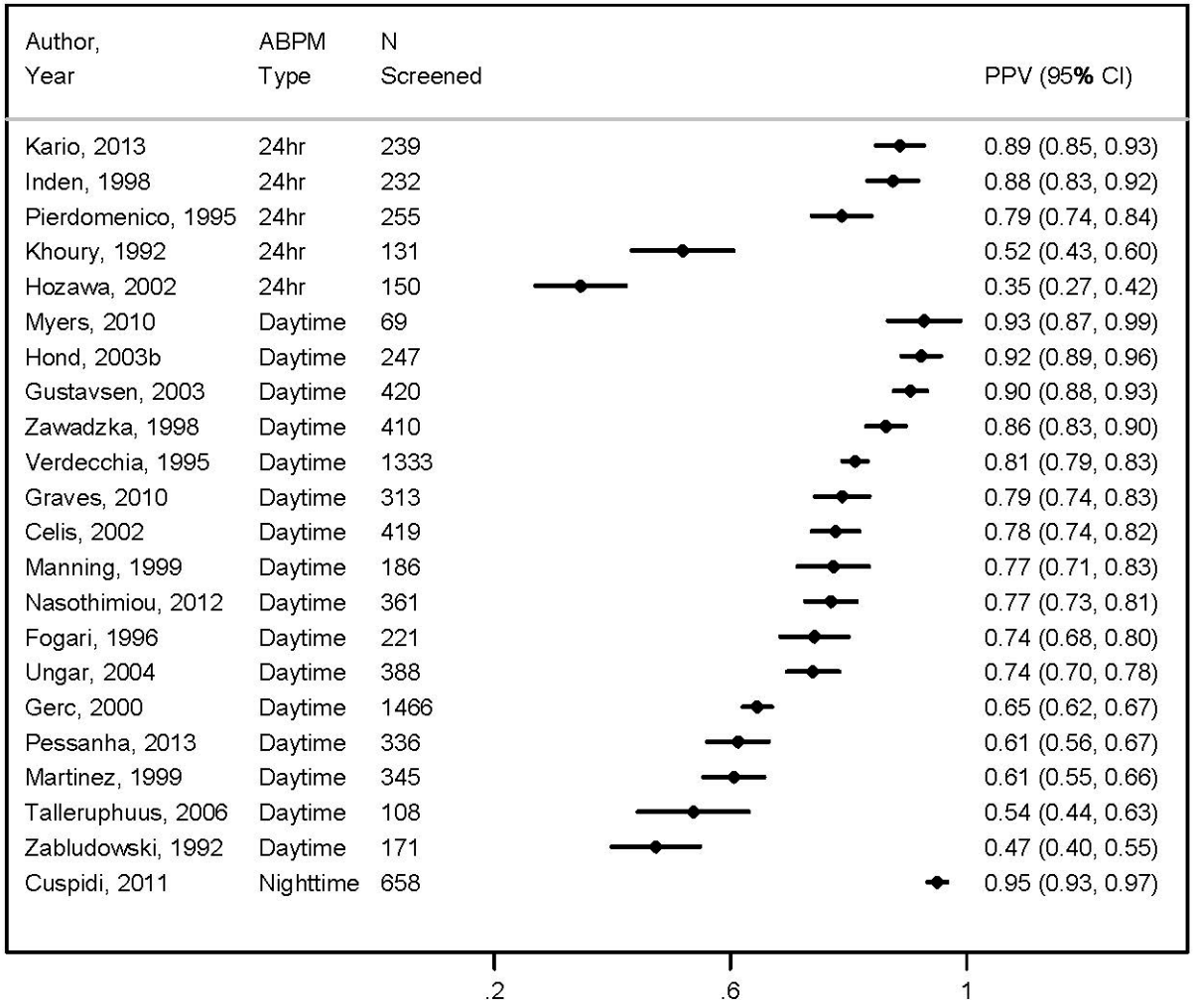
Abbreviations: CI = confidence interval; CV = cardiovascular; HR = hazard ratio; MI = myocardial infarction; TIA = transient ischemic attack.

Figure 9. Risk for Cardiovascular and Mortality Outcomes: Systolic HBPM, Not Adjusted for OBPM



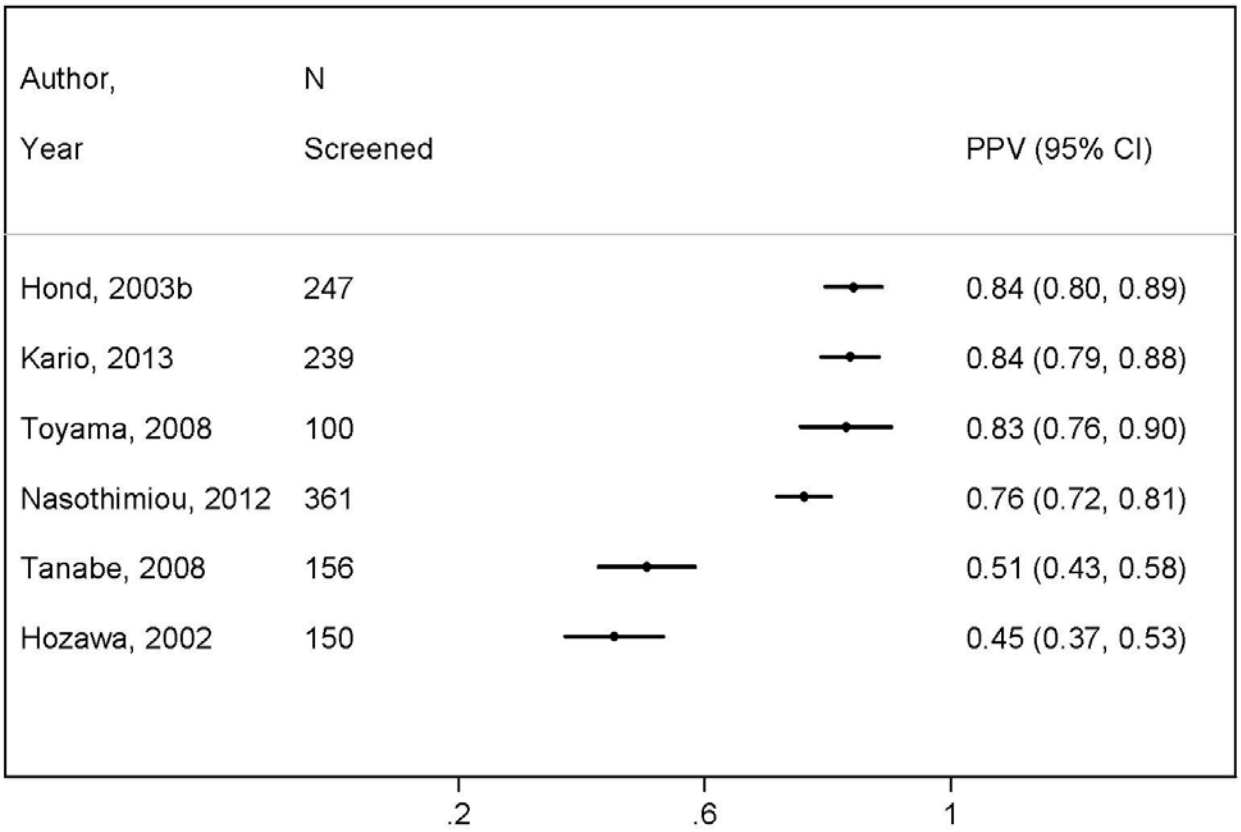
Abbreviations: CI = confidence interval; CV = cardiovascular; HR = hazard ratio; MI = myocardial infarction.

Figure 10. Proportion of Elevated Office-Based Screening Results That Are Confirmed Hypertension by ABPM



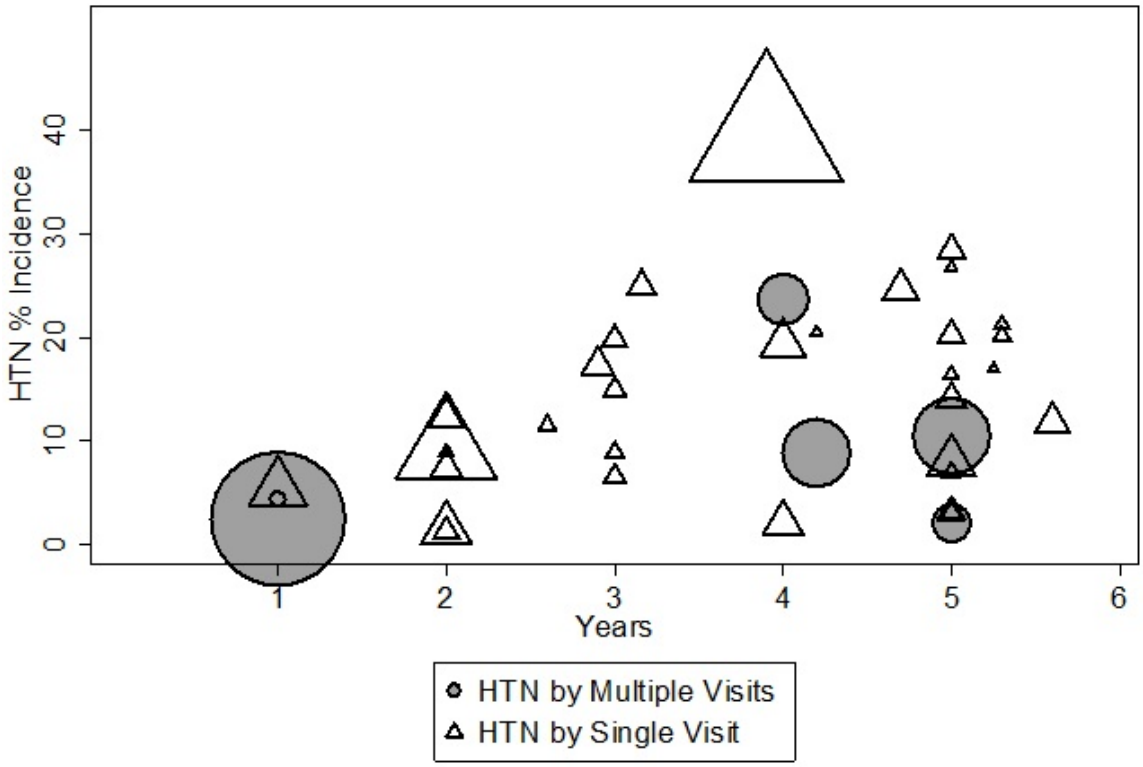
Abbreviations: ABPM = ambulatory blood pressure monitoring; CI = confidence interval; hr = hour; PPV = positive predictive value.

Figure 11. Proportion of Elevated Office-Based Screening Results That Are Confirmed Hypertension by HBPM



Abbreviations: CI = confidence interval; HBPM = home blood pressure monitoring; PPV = positive predictive value.

Figure 12. Scatterplot of Hypertension Incidence by Rescreening Interval



Abbreviation: HTN = hypertension.

* The size of the symbol represents the number of participants in the study.

Figure 13. Hypertension Incidence by Rescreening Interval, Stratified by Baseline Blood Pressure Level

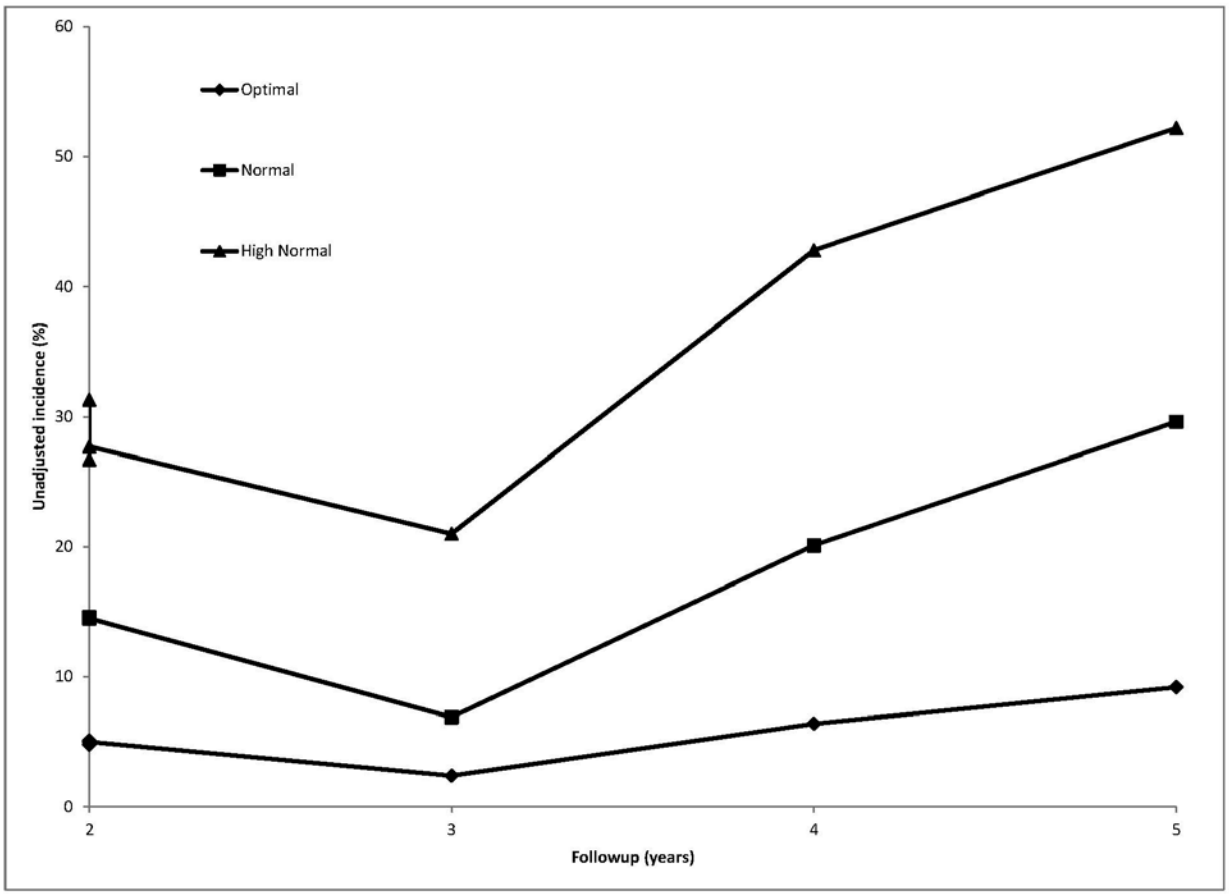
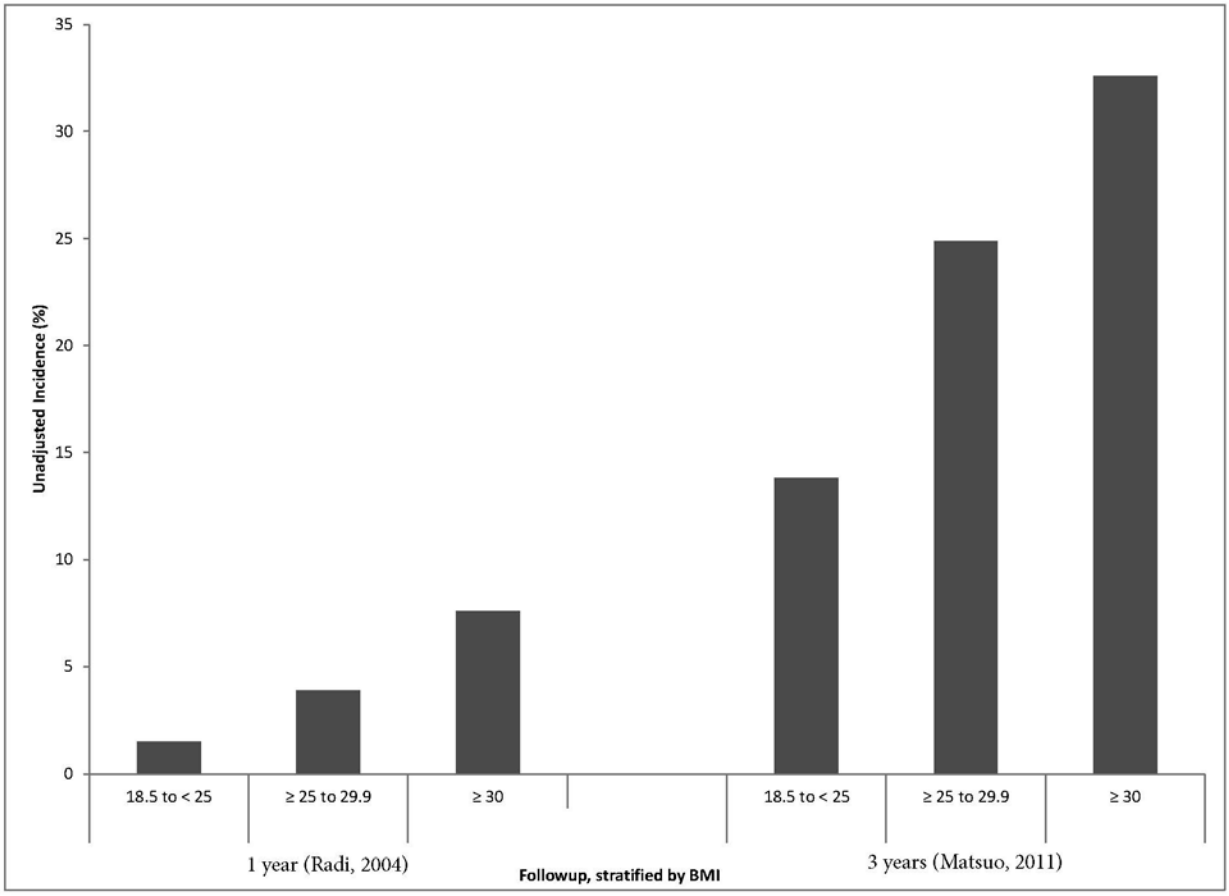


Figure 14. Hypertension Incidence by Rescreening Interval, Stratified by Baseline Body Mass Index



Abbreviation: BMI = body mass index.

Table 1. JNC 7 Blood Pressure Classifications

Blood Pressure Classification	SBP (mm Hg)	DBP (mm Hg)
Normal	<120	and <80
Prehypertension	120-139	or 80-89
Stage 1 hypertension	140-159	or 90-99
Stage 2 hypertension*	≥160	or ≥100

*Previous definitions of Stage 2 and Stage 3 hypertension have been combined under Stage 2 hypertension.

Abbreviations: DBP = diastolic blood pressure; SBP = systolic blood pressure.

Table 2. Prevalence of High Blood Pressure in Adults Age 20 Years and Older in the United States, 2010[*]

Demographic	Characteristic	Male	Female
Overall	All persons	33.6	32.2
Age (years)	20-34	9.1	6.7
	35-44	24.4	17.6
	45-54	37.7	34.0
	55-64	52.0	52.0
	65-74	63.9	70.8
	75+	72.1	80.1
Race	Non-Hispanic white	33.4	30.7
	Non-Hispanic black	42.6	47.0
	Mexican American	30.1	28.8
	Asian	21.2	
	American Indian/Alaska Native	24.8	

*From reference 19.

Table 3. Recommendations for Diagnosing Hypertension From Other Organizations

Organization, Year	Indications	Diagnostic Protocol and Threshold
American Society of Hypertension, 2014[71]	Hypertension, white-coat hypertension	Diagnosis of hypertension should be confirmed at an additional patient visit, usually 1-4 weeks after the first measurements. If white-coat hypertension is suspected, consider HBPM, taking the average blood pressure measured over 5-7 days, if possible in duplicate. ABPM is another approach if available. OBPM diagnostic threshold: ≥140/90 mm Hg HBPM diagnostic threshold: ≥135/85 mm Hg
Joint National Committee on Prevention, Detection, Evaluation and Treatment of Blood Pressure (JNC 7),* 2004[1]	Suspected white-coat hypertension among hypertensive patients and no target organ damage; hypotensive symptoms with antihypertensive medication; episodic hypertension and autonomic dysfunction	Stage 1 hypertension diagnosis should be confirmed within 2 months after initial elevated OBPM (no further protocol details reported). Stage 2 hypertension should be confirmed within 1 month; those with ≥180/110 mm Hg evaluate and treat immediately. ABPM diagnostic threshold: ≥135/85 mm Hg (awake), ≥120/75 mm Hg (asleep)
National Institute for Health and Care Excellence, 2011[2]	Hypertension, white-coat hypertension	Adults aged 18-21 years only. Based on repeated measures in both arms followed by ABPM (at least 14 measurements) or HBPM (twice in morning and evening for at least 4 days, ideally 7 days) if ABPM not tolerable. OBPM diagnostic threshold: ≥140/90 mm Hg ABPM diagnostic threshold: ≥135/85 mm Hg (daytime)
National Heart, Lung, and Blood Institute, 2013[260]	Hypertension, white-coat hypertension	Based on two OBPM measurements, confirm elevated reading with contralateral arm.
University of Michigan Health System, 2009[287]	Hypertension, white-coat and masked hypertension	Based on taking mean blood pressure levels from recordings over several visits. Suspected white-coat hypertension: three or more OBPM >140/90 mm Hg and at least two ABPM <140/90 mm Hg.
Canadian Hypertension Education Program (CHEP), 2013[261]	Hypertension, suspected white-coat hypertension, and masked hypertension	OBPM diagnostic threshold: ≥160/110 mm Hg averaged across three visits; or if ≥140/90 mm Hg averaged across five visits ABPM diagnostic threshold: ≥135/85 mm Hg (awake) or ≥130/80 mm Hg (24 hours) HBPM diagnostic threshold: ≥135/85 mm Hg
European Society of Hypertension, 2008[73]	Sustained, masked or white-coat hypertension	ABPM diagnostic threshold: ≥135/85 mm Hg (awake), ≥120/70 mm Hg (asleep) and ≥130/80 mm Hg (24 hours) HBPM diagnostic threshold: 135/85 mm Hg
Institute for Clinical Systems Improvement, 2012[288]	Confirming initial elevated BP; white-coat or masked hypertension	Based on a combination of one or more followup visits with at least two blood pressure readings at each visit and an out-of-office blood pressure measurement (e.g., HBPM) or 24 hour ABPM. ABPM diagnostic threshold: 140/85 mm Hg (awake), 120/70 mm Hg (asleep), and 130/80 mm Hg (24-hour)
Japanese Society of Hypertension, 2009[74]	Diagnosis of essential, white-coat, and masked hypertension	Based on blood pressures measured on at least two different clinic-based occasions. OBPM diagnostic threshold: ≥140/90 mm Hg HBPM diagnostic threshold: ≥135/85 mm Hg ABPM diagnostic threshold: ≥130/80 mm Hg (24 hour), ≥135/85 mm Hg (day), ≥120/70 mm Hg (night)

*The JNC 8 Panel did not address diagnosis of hypertension in its 2014 guidelines. A supplement to the guidelines includes additional content not supported by a systematic review but that is intended to aid in implementing the main guidelines. In the supplement, the JNC 8 Panel recommends averaging 2-3 measurements at each visit to establish a diagnosis of hypertension. Definitions of hypertension were not addressed, but thresholds for pharmacological treatment were defined. HBPM and ABPM were not addressed.[8]

Abbreviations: ABPM = ambulatory blood pressure monitoring; HBPM = home blood pressure monitoring; NR = not reported; OBPM = office blood pressure measurement.

Table 4. Recommendations for Blood Pressure Screening From Other Organizations

Organization, Year	Start Age (y)	Frequency	Additional Recommendations and Information
American Academy of Family Physicians (AAFP), 2007[289]	18	Not stated	Based on the USPSTF recommendation.
American Congress of Obstetricians and Gynecologists (ACOG), 2013[290]	13	Annual	Recommended as part of a woman's annual health care visit.
American Heart Association (AHA), 2012[291]	20	At least every 2 years	Recommended at each regular health care visit or at least once every 2 years if blood pressure <120/80 mm Hg.
Joint National Committee on Prevention, Detection, Evaluation and Treatment of Blood Pressure (JNC 7)*, 2004[1]	Adult	At least every 2 years	Routine blood pressure measurements should be taken at least once every 2 years for adults with <120/80 mm Hg, and every year for those with 120-139/80-89 mm Hg.
Michigan Quality Improvement Consortium (MQIC), 2012[75,76]	18	At least every 2 years	Screening every 2 years if blood pressure ≤120/80 mm Hg or annually if blood pressure 120-139/80-89 mm Hg and more frequently if warranted. Based on the USPSTF recommendation.
National Heart, Lung and Blood Institute (NHLBI), 2013[260]	18-21	All health care visits	Measure blood pressure, evaluate and treat per JNC guidelines.
University of Michigan Health System, 2009[287]	Adult	At least every 2 years	Recommended screening at least every 2 years for normotensives; annual for those with risk factors.
Canadian Hypertension Education Program (CHEP), 2013[72]	Adult	All clinical visits	Measurement should be taken by health care professionals who have been specifically trained to measure blood pressure accurately using standardized measurement techniques; automated clinic blood pressure measurements can be used in the assessment of clinic-based pressure.
Institute for Clinical Systems Improvement (ICSI), 2012[77]	19	At least every 2 years	Blood pressure must be measured at least every 2 years for adults with blood pressures <120/80 mm Hg and every year if blood pressure is 120-139/80-89 mm Hg. Higher blood pressures would be confirmed and managed per protocol. Most reliably implemented if blood pressure is measured at every patient visit.

*The JNC 8 Panel did not address diagnosis of hypertension in its 2014 guidelines. A supplement to the guidelines includes additional content not supported by a systematic review but that is intended to aid in implementing the main guidelines. In the supplement, the JNC 8 Panel recommends measuring blood pressure using procedures similar to the ones described in JNC 7. Rescreening intervals are not addressed.[8]

Abbreviations: JNC = Joint National Committee; USPSTF = U.S. Preventive Services Task Force; y = years.

Table 5. Diagnostic Accuracy of Automated vs. Manual OBPM Devices

Author, Year Quality	n	Population	Mean Age (y)	% Female	Mean Office SBP/DBP (mm Hg)	Definition of BP	Diagnostic Threshold	Sens (calc)	Spec (calc)	PPV (calc)	NPV (calc)	Manual BP Device	Automated BP Device
Kroke, 1998[107] Good	399	Women (ages 35-65 years) and men (aged 40-65 years)	NR	64.4	139.2/86.4	Mean of second and third BP measurement	≥160/95 mm Hg	0.907	0.960	0.880	0.970	BOSO Roid II Aneroid	BOSO Oscillomat
Lim, 2013[108] Good	454	Age ≥20 years	50.7	52.8	117.3/75.3	Mean of second and third BP measurement (assumed)	≥140/90 mm Hg	0.590	0.982	0.837	0.939	Mercury	A&D UA-767PC
Ostchega, 2010[105] Good	509	Adults age ≥18 years meeting the inclusion criteria set by the AAMI	49.4	39.5	122.3/69.8	Mean of first, second, and third BP measurement	≥140/90 mm Hg	0.679	0.959	0.792	0.929	Mercury	OMRON HEM-907XL
Pavlik, 2000[109] Fair	1166	Patients presenting to the ER or medical clinic during study days	48.5	59.9	129.5/79.6	Single BP measurement	≥140/90 mm Hg	0.509	0.972	0.761	0.918	Mercury	Critikon Dinamap Plus Model 8710 or 1846SX

Abbreviations: AAMI = Association for the Advancement of Medical Instrumentation; BP = blood pressure; calc = calculated; DBP = diastolic blood pressure; ER = emergency room; NPV = negative predictive value; PPV = positive predictive value; SBP = systolic blood pressure; sens = sensitivity; spec = specificity; y = years.

Table 6. Diagnostic Reclassifications of OBPM Protocol Characteristics

Author, Year Quality	N	Population	Mean Age (y)	% Female	Mean Office SBP/DBP (mm Hg)	Diagnostic Threshold	Comparison	Diagnostic Reclassification	BP Measurement Device
Peters, 1999[110] Fair	50	Normotensives	25.1	54	105/59	≥140/90 mm Hg	Legs crossed vs. legs uncrossed	None	Omron HEM 706*
Pincomb, 1996[111] Fair	48	Healthy white men ages 20-39 years, caffeine use (50-800 mg/day) within 30% of normal weight according to Metropolitan Life Insurance Company norms, no aerobic functional impairment during exercise	NR	0	NR/NR	≥140/90 mm Hg	Caffeine vs. no caffeine	17% reclassified as hypertensive with caffeine	Dinamap Vital Signs Monitor model 1896
Handler, 2012[106] Good	20,155	Adults age ≥18 years in NHANES 1999-2008 with three BP measurements (all participants excluding treated hypertensives)	45.3	51.42	124.3/72.1	≥140/90 mm Hg	1 reading vs. 1+2 readings	20.0% Stage I hypertensives reclassified as normal	Mercury
							1 reading vs. 1+2+3 readings	27.5% Stage I hypertensives reclassified as normal	
							1 reading vs. 2+3 readings	35.5% Stage I hypertensives reclassified as normal	

*Device validation reported in study.

Abbreviations: BP = blood pressure; calc = calculated; DBP = diastolic blood pressure; NHANES = National Health and Nutrition Examination Survey; NR = not reported; SBP = systolic blood pressure; y = years.

Table 7. Number of Included Studies Reporting Eligible Outcomes for Key Question 3a

Comparison	k	All-Cause Mortality				CV Mortality				CV Events				Fatal or Nonfatal Stroke				Cardiac Events			
		Systolic		Diastolic		Systolic		Diastolic		Systolic		Diastolic		Systolic		Diastolic		Systolic		Diastolic	
		A	U	A	U	A	U	A	U	A	U	A	U	A	U	A	U	A	U	A	U
ABPM (24-hr) vs. OBPM	9	4	4	3	3	5	4	3	2	2	2	2	2	5	2	3	0	2	2	1	1
ABPM (daytime) vs. OBPM	10	3	4	2	3	3	2	2	2	4	4	4	4	4	2	3	0	2	2	1	1
ABPM (nighttime) vs. OBPM	9	3	4	2	3	3	2	2	2	3	3	3	3	4	2	3	0	2	2	1	1
HBPM vs. OBPM	5	1	3	1	3	1	2	1	2	1	1	1	1	1	0	1	0	0	0	0	0
ABPM (daytime) vs. HBPM	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
ABPM (nighttime) vs. HBPM	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
ABPM (daytime) vs. ABPM (nighttime)	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
ABPM (nighttime) vs. ABPM (daytime)	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0

Note: Clement 2003 is not in the stroke plot, as it provides a p-value rather than hazard ratio for the between-group comparison; Hansen 2005 does the same for all-cause mortality.

Abbreviations: APBM = ambulatory blood pressure monitoring; A = adjusted for comparison blood pressure measurement; CV = cardiovascular; HBPM = home blood pressure monitoring; U = unadjusted for comparison blood pressure measurement.

Table 8. 24-hr ABPM vs. OBPM: Fatal and Nonfatal Strokes

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment	ABPM (24-hr) HR (95% CI)	ABPM (24-hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24-hr)	Additional Model Covariates†
SBP												
Clement, 2003[115] Good	Belgium	1963	36	100 100	155.01/93.06	5	10 mm Hg	NR	NR, NS	1.21 (1.04 to 1.42)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry, OBPM
Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79*	100 52.42	154.85/95.27	8.2	10 mm Hg	NR	1.37 (1.20 to 1.56)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.40 (1.21 to 1.62)	NR	1.04 (0.94 to 1.15)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	30	100 42.6	173.3/86.0	4.4	10 mm Hg	1.40 (1.12 to 1.76)	1.36 (1.04 to 1.79)	1.29 (0.98 to 1.71)	NR	Previous CV complications, residence in western Europe
Dolan, 2005[116] Fair	Ireland	5292	103†	100 0	162.3/93.1	7.9	10 mm Hg	1.27 (1.15 to 1.40)†	1.28 (1.15 to 1.43)†	1.07 (1.00 to 1.15)†	NR	BMI, DM, history of CV events, OBPM
DBP												
Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79*	100 52.42	154.85/95.27	8.2	5 mm Hg	NR	1.24 (1.09 to 1.42)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.32 (1.16 to 1.49)	NR	1.03 (0.95-1.13)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
Dolan, 2005[116] Fair	Ireland	5292	103†	100 0	162.3/93.1	7.9	5 mm Hg	1.13 (1.05 to 1.22)†	1.12 (1.03 to 1.22)†	1.06 (0.99 to 1.12)†	NR	BMI, DM, history of CV events, OBPM

* Strokes also available by hemorrhagic, ischemic, and undetermined type.
† Fatal strokes only.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 9. 24-hr ABPM vs. OBPM: Fatal and Nonfatal Cardiovascular Events

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	ABPM (24-hr) HR (95% CI)	ABPM (24-hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24-hr)	Additional Model Covariates‡
SBP													
MI or stroke, fatal or nonfatal	Clement, 2003[111] Good	Belgium	1963	77	100 100	155.01/93.06	5	10 mm Hg	1.30 (1.12 to 1.51)	1.30 (1.10 to 1.55)	1.10 (0.98 to 1.25)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
CV events (CV death, MI or stroke)	Hermida, 2011[120]‖ Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	10 mm Hg	1.45 (1.31 to 1.60)	1.33 (1.17 to 1.52)	1.30 (1.19 to 1.42)	NR	DM
CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	10 mm Hg	1.19 (1.14 to 1.26)	1.19 (1.13 to 1.27)	1.06 (1.02 to 1.10)	NR	BMI, DM, history of CV events
	Gasowski, 2008[118] Fair	Belgium	1167	50	22.88 14.82	126/77	13	10 mm Hg	1.38 (1.14 to 1.68)	1.42 (1.14 to 1.77)	1.10 (0.94 to 1.29)	0.96 (0.79 to 1.16)	BMI, anti-HTN treatment, TC, drinking
	Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	10 mm Hg	1.51 (1.28 to 1.77)*	NR, p=0.0003	1.25 (1.10 to 1.42)*	NR, p=0.96	NR
	Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.27 (1.04 to 1.55)	NR	1.04 (0.91 to 1.19)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	36	100 42.6	173.3/86.0	4.4	10 mm Hg	1.20 (0.98 to 1.49)	1.11 (0.88 to 1.40)	1.32 (1.03 to 1.68)	NR	Previous CV complications, residence in western Europe
DBP													
MI or stroke, fatal or nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	5 mm Hg	1.17 (1.04 to 1.30)	1.17 (1.04 to 1.32)	1.06 (0.93 to 1.21)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
CV events (CV death, MI or stroke)	Hermida, 2011[120]‖ Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	5 mm Hg	1.22 (1.10 to 1.34)	1.18 (1.04 to 1.33)	1.14 (1.05 to 1.24)	NR	DM
CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	5 mm Hg	1.07 (1.03 to 1.12)	1.09 (1.02 to 1.11)	1.03 (1.00 to 1.07)	NR	BMI, DM, history of CV events

Table 9. 24-hr ABPM vs. OBPM: Fatal and Nonfatal Cardiovascular Events

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	ABPM (24-hr) HR (95% CI)	ABPM (24-hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24-hr)	Additional Model Covariates‡
	Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	5 mm Hg	1.43 (1.26 to 1.61)	NR, p<0.0001	1.21 (1.08 to 1.35)*	NR, p=0.49	NR
	Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	5 mm Hg	NR	1.13 (0.94 to 1.34)	NR	1.00 (0.89 to 1.12)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia

* Relative risk.
‡ All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24-hr) or OBPM.
§ See Appendix C for original data.
‖ ABPM 48-hr.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure; TC = total cholesterol.

Table 10. 24-hr ABPM vs. OBPM: Fatal and Nonfatal Cardiac Endpoints

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	ABPM (24-hr) HR (95% CI)	ABPM (24-hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24-hr)	Additional Model Covariates‡
SBP													
Cardiac endpoint, fatal and nonfatal	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	69	100 42.6	173.3/86.0	4.4	10 mm Hg	1.12 (0.96 to 1.31)	1.11 (0.93 to 1.31)	1.11 (0.91 to 1.35)	NR	Previous CV complications, residence in western Europe
Cardiac endpoints, fatal	Dolan, 2005[116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	10 mm Hg	1.17 (1.09 to 1.24)	1.16 (1.07 to 1.25)	1.06 (1.01 to 1.10)	NR	BMI, DM, history of CV events
DBP													
Cardiac endpoints, fatal	Dolan, 2005[116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	5 mm Hg	1.05 (1.00 to 1.10)	1.05 (0.99 to 1.11)	1.02 (0.98 to 1.09)	NR	BMI, DM, history of CV events

‡All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24-hr) or OBPM.
§ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 11. 24-hr ABPM vs. OBPM: Congestive Heart Failure

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	ABPM (24-hr) HR (95% CI)	ABPM (24-hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24-hr)	Additional Model Covariates
Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	10 mm Hg	1.08 (0.94 to 1.24)	1.01 (0.85 to 1.19)	1.13 (0.99 to 1.29)	1.12 (0.95 to 1.32)	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol
Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	5 mm Hg	1.08 (0.94 to 1.25)	1.03 (0.86 to 1.23)	1.09 (0.95 to 1.25)	1.06 (0.90 to 1.26)	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol

§ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 12. 24-hr ABPM vs. OBPM: All-Cause Mortality

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment‡	ABPM (24-hr) HR (95% CI)	ABPM (24-hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24-hr)	Additional Model Covariates†
SBP												
Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	10 mm Hg	1.11 (0.96 to 1.28)	1.02 (0.86 to 1.20)	1.17 (1.05 to 1.32)	NR	BMI, DM, cholesterol, CV complications at entry, use of lipid-lowering drugs
Dolan, 2005[116] Fair	Ireland	5292	646	100 0	162.3/93.1	7.9	10 mm Hg	1.11 (1.07 to 1.16)	1.13 (1.08 to 1.19)	1.02 (0.99 to 1.05)	NR	BMI, DM, history of CV events
Hansen, 2005[119] Fair	Denmark (population-based)	1700	174	NR 9.41	128/82	9.5	10 mm Hg	1.18 (1.06 to 1.31)*	NR, p=0.001	1.05 (0.96 to 1.14)*	NR, p=0.23	NR
Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	68	100 42.6	173.3/86.0	4.4	10 mm Hg	1.16 (0.99 to 1.35)	1.09 (0.92 to 1.29)	1.24 (1.03 to 1.49)	NR	Previous CV complications, residence in western Europe
DBP												
Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	5 mm Hg	1.09 (0.98 to 1.22)	1.07 (0.95 to 1.20)	1.11 (0.99 to 1.25)	NR	BMI, DM, cholesterol, CV complications at entry, use of lipid-lowering drugs
Dolan, 2005[116] Fair	Ireland	5292	646	100 0	162.3/93.1	7.9	5 mm Hg	1.06 (1.02 to 1.09)	1.05 (1.02 to 1.09)	1.01 (0.99 to 1.04)	NR	BMI, DM, history of CV events
Hansen, 2005[119] Fair	Denmark (population-based)	1700	174	NR 9.41	128/82	9.5	5 mm Hg	1.18 (1.09 to 1.28)*	NR, p<0.0001	1.06 (0.99 to 1.14)*	NR, p=0.17	NR

* Relative risk.

† All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24-hr) or OBPM.

‡ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 13. Nighttime ABPM vs. OBPM: Fatal and Nonfatal Strokes

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional Model Covariates†
SBP												
Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79	100 52.42	154.85/95.27	8.2	10 mm Hg	NR	1.43 (1.25 to 1.64)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.26 (1.10 to 1.43)	NR	1.08 (0.98 to 1.19)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	30	100 42.6	173.3/86.0	4.4	10 mm Hg	1.35 (1.11 to 1.65)	1.31 (1.06 to 1.62)	1.29 (0.98 to 1.71)	NR	Previous CV complications, residence in western Europe
Dolan, 2005[116] Fair	Ireland	5292	103*	100 0	162.3/93.1	7.9	10 mm Hg	1.30 (1.19 to 1.40)	1.30 (1.19 to 1.42)	1.07 (1.00 to 1.15)	NR	BMI, DM, history of CV events
DBP												
Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79	100 52.42	154.85/95.27	8.2	5 mm Hg	NR	1.24 (1.10 to 1.38)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.21 (1.08 to 1.36)	NR	1.07 (0.98 to 1.16)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
Dolan, 2005[116] Fair	Ireland	5292	103*	100 0	162.3/93.1	7.9	5 mm Hg	1.14 (1.07 to 1.22)	1.14 (1.06 to 1.22)	1.06 (0.99 to 1.12)	NR	BMI, DM, history of CV events

* Fatal strokes only.
† All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (nighttime) or OBPM.
‡ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 14. Nighttime ABPM vs. OBPM: Fatal and Nonfatal Cardiovascular Events

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional Model Covariates‡
SBP													
MI or stroke, fatal and nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	10 mm Hg	1.16 (1.02 to 1.33)	1.13 (0.98 to 1.31)	1.10 (0.98 to 1.25)	NR	BMI, smoking, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
Major CV events	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	10 mm Hg	1.22 (1.09 to 1.38)	1.23 (1.07 to 1.40)	1.06 (0.94 to 1.18)	0.98 (0.86 to 1.12)	BMI, smoking, DM, anti-HTN treatment, smoking, serum TC
	Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	10 mm Hg	1.45 (1.33 to 1.57)	1.37 (1.24 to 1.53)	1.30 (1.19 to 1.42)	NR	DM
CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	10 mm Hg	1.21 (1.16 to 1.27)	1.21 (1.15 to 1.27)	1.06 (1.02 to 1.10)	NR	BMI, smoking, DM, history of CV events
	Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	10 mm Hg	1.41 (1.23 to 1.62)*	NR	1.25 (1.10 to 1.42)	NR	NR
	Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.33 (1.11 to 1.58)	NR	1.05 (0.92 to 1.20)	Smoking, DM, history of CVD, anti-HTN treatment, hypercholesterolemia
	Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	36	100 42.6	173.3/86.0	4.4	10 mm Hg	1.23 (1.03 to 1.46)	1.18 (0.98 to 1.42)	1.32 (1.03 to 1.68)	NR	Smoking, previous CV complications, residence in western Europe
DBP													
MI or stroke, fatal and nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	5 mm Hg	1.11 (1.00 to 1.22)	1.09 (0.98 to 1.22)	1.06 (0.93 to 1.21)	NR	BMI, smoking, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
Major CV events	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	5 mm Hg	1.18 (1.06 to 1.32)	1.22 (1.08 to 1.38)	1.02 (0.92 to 1.14)	0.91 (0.80 to 1.03)	BMI, smoking, DM, anti-HTN treatment, smoking, serum TC
	Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	5 mm Hg	1.27 (1.17 to 1.39)	1.26 (1.14 to 1.39)	1.14 (1.05 to 1.24)	NR	DM

Table 14. Nighttime ABPM vs. OBPM: Fatal and Nonfatal Cardiovascular Events

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional Model Covariates‡
CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	5 mm Hg	1.09 (1.05 to 1.13)	1.09 (1.04 to 1.13)	1.03 (1.00 to 1.07)	NR	BMI, smoking, DM, history of CV events
	Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	5 mm Hg	1.36 (1.22 to 1.51)	NR	1.21 (1.08 to 1.35)	NR	NR
	Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	5 mm Hg	NR	1.20 (1.02 to 1.41)	NR	0.99 (0.89 to 1.11)	Smoking, DM, history of CVD, anti-HTN treatment, hypercholesterolemia

* Relative risk.
‡ All adjusted for age and sex. All covariates are from the model adjusted for ABPM (nighttime) or OBPM.
§ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure; TC = total cholesterol.

Table 15. Nighttime ABPM vs. OBPM: Fatal and Nonfatal Cardiac Endpoints

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment*	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional Model Covariates‡
SBP													
Cardiac endpoint, fatal and nonfatal	Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	69	100 42.6	173.3/86.0	4.4	10 mm Hg	1.17 (1.03 to 1.33)	1.16 (1.02 to 1.33)	1.11 (0.91 to 1.35)	NR	Previous CV complications, residence in western Europe
Cardiac endpoints, fatal	Dolan, 2005[116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	10 mm Hg	1.16 (1.10 to 1.23)	1.15 (1.04 to 1.23)	1.06 (1.01 to 1.10)	NR	BMI, DM, history of CV events
DBP													
Cardiac endpoints, fatal	Dolan, 2005[116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	5 mm Hg	1.06 (1.01 to 1.11)	1.06 (1.01 to 1.11)	1.02 (0.98 to 1.09)	NR	BMI, DM, history of CV events

* See Appendix C for original data.
‡ All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (nighttime) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 16. Nighttime ABPM vs. OBPM: Congestive Heart Failure

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment*	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional Model Covariates
SBP												
Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	10 mm Hg	1.11 (0.99 to 1.25)	1.08 (0.94 to 1.22)	1.13 (0.99 to 1.29)	NR	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol
DBP												
Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	5 mm Hg	1.14 (1.01 to 1.28)	1.12 (0.98 to 1.29)	1.09 (0.95 to 1.25)	NR	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol

* See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 17. Nighttime ABPM vs. OBPM: All-Cause Mortality

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment‡	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional Model Covariates†
SBP												
Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	10 mm Hg	1.10 (0.97 to 1.25)	1.03 (0.89 to 1.19)	1.17 (1.05 to 1.32)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry, OBPM
Dolan, 2005[116] Fair	Ireland	5292	646	100 0	162.3/93.1	7.9	10 mm Hg	1.14 (1.10 to 1.18)	1.15 (1.11 to 1.20)	1.02 (0.99 to 1.05)	NR	BMI, DM, history of CV events, OBPM
Hansen, 2005[119] Fair	Denmark	1700	174	NR 9.41	128/82	9.5	10 mm Hg	1.19 (1.08 to 1.30)*	NR	1.05 (0.96 to 1.14)*	NR	NR
Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	68	100 42.6	173.3/86.0	4.4	10 mm Hg	1.17 (1.03 to 1.33)	1.14 (1.00 to 1.30)	1.24 (1.03 to 1.49)	NR	Previous CV complications, residence in western Europe
DBP												
Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	5 mm Hg	1.08 (0.98 to 1.20)	1.07 (0.96 to 1.18)	1.11 (0.99 to 1.25)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry, OBPM
Dolan, 2005[116] Fair	Ireland	5292	646	100 0	162.3/93.1	7.9	5 mm Hg	1.07 (1.04 to 1.10)	1.08 (1.04 to 1.11)	1.01 (0.99 to 1.04)	NR	BMI, DM, history of CV events, OBPM
Hansen, 2005[119] Fair	Denmark	1700	174	NR 9.41	128/82	9.5	5 mm Hg	1.16 (1.08 to 1.25)*	NR	1.06 (0.99 to 1.14)*	NR	NR

* Relative risk.
† All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (nighttime) or OBPM.
‡ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 18. Daytime ABPM vs. OBPM: Fatal and Nonfatal Strokes

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment	ABPM (Day) HR (95% CI)	ABPM (Day) HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for ABPM (Day)	Additional Model Covariates‡
SBP												
Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79*	100 52.42	154.85/95.27	8.2	10 mm Hg	NR	1.33 (1.13 to 1.55)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.37 (1.19 to 1.57)	NR	1.03 (0.93 to 1.15)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	30	100 42.6	173.3/86.0	4.4	10 mm Hg	1.30 (1.05 to 1.62)	1.25 (0.97 to 1.61)	1.29 (0.98 to 1.71)	NR	Previous CV complications, residence in western Europe
Dolan, 2005[116] Fair	Ireland	5292	103†	100 0	162.3/93.1	7.9	10 mm Hg	1.18 (1.08 to 1.30)†	1.17 (1.05 to 1.30)†	1.07 (1.00 to 1.15)	NR	BMI, DM, history of CV events, OBPM
DBP												
Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79*	100 52.42	154.85/95.27	8.2	5 mm Hg	NR	1.24 (1.07 to 2.43)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.29 (1.15 to 1.45)	NR	1.03 (0.95 to 1.12)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
Dolan, 2005[116] Fair	Ireland	5292	103†	100 0	162.3/93.1	7.9	5 mm Hg	1.09 (1.01 to 1.17)†	1.07 (0.99 to 1.16)†	1.06 (0.99 to 1.12)	NR	BMI, DM, history of CV events, OBPM

* Strokes also available by hemorrhagic, ischemic, and undetermined type.
† Fatal strokes only.
‡ All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (daytime) or OBPM.
§ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 19. Daytime ABPM vs. OBPM: Fatal and Nonfatal Cardiovascular Events

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	ABPM (Day) HR (95% CI)	ABPM (Day) HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for ABPM (Day)	Additional Model Covariates‡
SBP													
MI or stroke, fatal or nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	10 mm Hg	1.30 (1.12 to 1.51)	1.31 (1.11 to 1.55)	1.10 (0.98 to 1.25)	NR	BMI, smoking, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
Major CV events	Celis, 2002[114] Fair	Belgium	419	20	100 0	164.7/103.4	5.3	10 mm Hg	1.51 (1.19 to 1.88)	1.51 (1.13 to 2.01)	1.17 (0.94 to 1.42)	NR	Smoking, anti-HTN treatment
	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	10 mm Hg	1.23 (1.05 to 1.43)	1.27 (1.05 to 1.54)	1.06 (0.94 to 1.18)	0.96 (0.86 to 1.14)	BMI, smoking, DM, anti-HTN treatment, smoking, serum TC
	Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	10 mm Hg	1.38 (1.25 to 1.54)	1.23 (1.08 to 1.41)	1.30 (1.19 to 1.42)	NR	DM
CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	10 mm Hg	1.15 (1.10 to 1.21)	1.12 (1.06 to 1.18)	1.06 (1.02 to 1.10)	NR	BMI, smoking, DM, history of CV events
	Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	10 mm Hg	1.50 (1.27 to 1.76)*	NR	1.25 (1.10 to 1.42)*	NR	NR
	Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.17 (0.97 to 1.41)	NR	1.06 (0.93 to 1.21)	Smoking, DM, history of CVD, anti-HTN treatment, hypercholesterolemia
	Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	36	100 42.6	173.3/86.0	4.4	10 mm Hg	1.17 (0.96 to 1.44)	1.07 (0.85 to 1.34)	1.32 (1.03 to 1.68)	NR	Smoking, previous CV complications, residence in western Europe
DBP													
MI or stroke, fatal or nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	5 mm Hg	1.17 (1.05 to 1.30)	1.18 (1.05 to 1.32)	1.06 (0.93 to 1.21)	NR	BMI, smoking, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry, OBPM
Major CV events	Celis, 2002[114] Fair	Belgium	419	20	100 0	164.7/103.4	5.3	5 mm Hg	1.28 (1.07 to 1.53)	1.34 (1.07 to 1.68)	1.09 (0.87 to 1.36)	NR	Smoking, anti-HTN treatment

Table 19. Daytime ABPM vs. OBPM: Fatal and Nonfatal Cardiovascular Events

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	ABPM (Day) HR (95% CI)	ABPM (Day) HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for ABPM (Day)	Additional Model Covariates‡
	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	5 mm Hg	1.14 (1.00 to 1.29)	1.22 (1.05 to 1.42)	1.02 (0.92 to 1.14)	0.91 (0.80 to 1.03)	BMI, smoking, DM, anti-HTN treatment, smoking, serum TC
	Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	5 mm Hg	1.16 (1.05 to 1.27)	1.08 (0.96 to 1.23)	1.14 (1.05 to 1.24)	NR	DM
CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	5 mm Hg	1.04 (1.00 to 1.08)	1.03 (0.99 to 1.07)	1.03 (1.00 to 1.07)	NR	BMI, smoking, DM, history of CV events
	Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	5 mm Hg	1.40 (1.24 to 1.58)*	NR	1.21 (1.08 to 1.35)*	NR	NR
	Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	5 mm Hg	NR	1.07 (0.91 to 1.26)	NR	1.01 (0.90 to 1.13)	Smoking, DM, history of CVD, anti-HTN treatment, hypercholesterolemia

* Relative risk.
‡ All adjusted for age and sex. All covariates are from the model adjusted for ABPM (daytime) or OBPM.
§ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure; TC = total cholesterol.

Table 20. Daytime ABPM vs. OBPM: Fatal and Nonfatal Cardiac Endpoints

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment*	ABPM (Day) HR (95% CI)	ABPM (Day) HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for ABPM (Day)	Additional Model Covariates‡
SBP													
Cardiac endpoint, fatal and nonfatal	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	69	100 42.6	173.3/86.0	4.4	10 mm Hg	1.06 (0.91 to 1.23)	1.03 (0.87 to 1.21)	1.11 (0.91 to 1.35)	NR	Previous CV complications, residence in western Europe
Cardiac endpoints, fatal	Dolan, 2005[116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	10 mm Hg	1.12 (1.06 to 1.19)	1.11 (1.04 to 1.19)	1.06 (1.01 to 1.10)	NR	BMI, DM, history of CV events
DBP													
Cardiac endpoints, fatal	Dolan, 2005[116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	5 mm Hg	1.03 (0.98 to 1.07)	1.02 (0.97 to 1.07)	1.02 (0.98 to 1.09)	NR	BMI, DM, history of CV events

* See Appendix C for original data.
‡ All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (daytime) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 21. Daytime ABPM vs. OBPM: Congestive Heart Failure

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment*	ABPM (Day) HR (95% CI)	ABPM (Day) HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for ABPM (Day)	Additional Model Covariates
SBP												
Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	10 mm Hg	1.05 (0.90 to 1.21)	0.96 (0.80 to 1.15)	1.13 (0.99 to 1.29)	NR	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol
DBP												
Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	5 mm Hg	0.99 (0.86 to 1.16)	0.92 (0.77 to 1.10)	1.09 (0.95 to 1.25)	NR	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol

* See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; DBP = diastolic blood pressure; DM = diabetes mellitus; HR = hazard ratio; HTN = hypertension; MI = myocardial infarction; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 22. Daytime ABPM vs. OBPM: All-Cause Mortality

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment‡	ABPM (Day) HR (95% CI)	ABPM (Day) HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for ABPM (Day)	Additional Model Covariates†
SBP												
Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	10 mm Hg	1.11 (0.96 to 1.28)	1.02 (0.87 to 1.20)	1.17 (1.05 to 1.32)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
Dolan, 2005[116] Fair	Ireland	5292	656	100 0	162.3/93.1	7.9	10 mm Hg	1.09 (1.04 to 1.13)	1.07 (1.03 to 1.12)	1.02 (0.99 to 1.05)	NR	BMI, DM, history of CV events, OBPM
Hansen, 2005[119] Fair	Denmark	1700	174	NR 9.41	128/82	9.5	10 mm Hg	1.15 (1.04 to 1.28)*	NR	1.05 (0.96 to 1.14)	NR	NR
Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	68	100 42.6	173.3/86.0	4.4	10 mm Hg	1.07 (0.91 to 1.24)	0.98 (0.83 to 1.17)	1.24 (1.03 to 1.49)	NR	Previous CV complications, residence in western Europe
DBP												
Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	5 mm Hg	1.09 (0.98 to 1.21)	1.06 (0.95 to 1.19)	1.11 (0.99 to 1.25)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
Dolan, 2005[116] Fair	Ireland	5292	656	100 0	162.3/93.1	7.9	5 mm Hg	1.02 (0.99 to 1.06)	1.02 (0.99 to 1.05)	1.01 (0.99 to 1.04)	NR	BMI, DM, history of CV events, OBPM
Hansen, 2005[119] Fair	Denmark	1700	174	NR 9.41	128/82	9.5	5 mm Hg	1.16 (1.08 to 1.26)*	NR	1.06 (0.99 to 1.14)	NR	NR

* Relative risk.

† All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (daytime) or OBPM.

‡ See Appendix C for original data.

Abbreviations: ABPM = ambulatory blood pressure monitoring; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 23. HBPM vs. OBPM: Fatal and Nonfatal Cardiovascular Events

Outcome	Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	HBPM HR (95% CI)	HBPM HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for HBPM	Additional Model Covariates‡
SBP													
CV events (stroke, MI, CV death)	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	10 mm Hg	1.13 (1.03 to 1.24)	1.17 (1.02 to 1.33)	1.06 (0.94 to 1.18)	0.96 (0.83 to 1.11)	BMI, DM, serum TC
CV mortality	Bobrie, 2004[113] Good	France	4939	85	100 100	152/85	3.2	10 mm Hg	1.10 (0.90 to 1.22)	NR	1.00 (0.82 to 1.10)	NR	NR
	Ohkubo, 1998[124] Good	Japan	1789	NR	NR 32.53	133.3/75.9	6.6 (2.3)	10 mm Hg	1.23 (1.01 to 1.49)*	1.1 (0.98 to 1.34)*	1.05 (0.90 to 1.22)	1.02 (0.88 to 1.20)	History of CVD
									1.014 (0.96 to 1.034)†	1.23 (1.00 to 1.51) †	1.05 (0.90 to 1.22)	1.00 (0.85 to 1.17)	
DBP													
CV events (stroke, MI, CV death)	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	5 mm Hg	1.18 (1.07 to 1.31)	1.24 (1.11 to 1.40)	1.02 (0.92 to 1.14)	0.91 (0.81 to 1.03)	BMI, DM, serum TC
CV mortality	Bobrie, 2004[113] Good	France	4939	85	100 100	152/85	3.2	5 mm Hg	1.10 (0.95 to 1.22)	NR	0.95 (0.86 to 1.10)	NR	NR
	Ohkubo, 1998[124] Good	Japan	1789	NR	NR 32.53	133.3/75.9	6.6 (2.3)	5 mm Hg	1.07 (0.95 to 1.20)*	1.06 (0.94 to 1.20)*	1.04 (0.92 to 1.18)	1.03 (0.91 to 1.16)	History of CVD
									1.08 (0.93 to 1.25)†	1.07 (0.91 to 1.24)†	1.04 (0.92 to 1.18)	1.03 (0.90 to 1.16)	

* Initial HBPM.
† Multiple HBPM.
‡ All adjusted by age, sex, smoking, and anti-HTN treatment. All covariates are from the model adjusted for HBPM or OBPM.
§ See Appendix C for original data.

Abbreviations: adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HBPM = home blood pressure monitoring; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 24. HBPM vs. OBPM: All-Cause Mortality

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	HBPM HR (95% CI)	HBPM HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for HBPM	Additional Model Covariates‡
SBP												
Bobrie, 2004[113] Good	France	4939	205	100 100	152/85	3.2	10 mm Hg	1.00 (1.00 to 1.10)	NR	0.90 (0.90 to 1.00)	NR	NR
Niiranen, 2010[123] Good	Finland	2081	118	NR 22.68	137.4/83.7	6.8	10 mm Hg	1.11 (1.01 to 1.23)	1.22 (1.09 to 1.37)	1.05 (0.96 to 1.15)	1.01 (0.92 to 1.12)	Age, sex, smoking, DM, history of CV events, anti-HTN treatment, hypercholesterolemia
Ohkubo, 1998[124] Good	Japan	1789	160	NR 32.53	133.3/75.9	6.6 (2.3)	10 mm Hg	1.15 (1.03 to 1.28)* 1.12 (1.02 to 1.23)†	NR	1.01 (0.92 to 1.09) 1.01 (0.92 to 1.09)	NR	NR
DBP												
Bobrie, 2004[113] Good	France	4939	205	100 100	152/85	3.2	5 mm Hg	1.05 (0.95 to 1.10)	NR	0.95 (0.86 to 1.05)	NR	NR
Niiranen, 2010[123] Good	Finland	2081	118	NR 22.68	137.4/83.7	6.8	5 mm Hg	1.08 (0.98 to 1.12)	1.15 (1.05 to 1.26)	0.95 (0.87 to 1.04)	1.06 (0.97 to 1.16)	Age, sex, smoking, DM, history of CV events, anti-HTN treatment, hypercholesterolemia
Ohkubo, 1998[124] Good	Japan	1789	160	NR 32.53	133.3/75.9	6.6 (2.3)	5 mm Hg	1.06 (0.98 to 1.15)* 1.07 (1.00 to 1.14)†	NR	1.01 (0.95 to 1.08) 1.01 (0.95 to 1.08)	NR	NR

* Multiple HBPM measurements.
† Initial HBPM measurement only.
‡ All covariates are from the model adjusted for HBPM or OBPM.
§ See Appendix C for original data.

Abbreviations: adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HBPM = home blood pressure monitoring; HTN = hypertension; HR = hazard ratio; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 25. HBPM vs. OBPM: Fatal and Nonfatal Strokes

Study, Quality	Country	N at BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean Followup (y)	Cox Regression Model, BP Variable Increment§	HBPM HR (95% CI)	HBPM HR (95% CI), Adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), Adj. for HBPM	Additional Model Covariates‡
SBP												
Asayama, 2006[112] Good	Japan	1766	156	54.3, 28.54	NR/NR	10.6	10 mm Hg	NR	1.34 (1.18 to 1.51)*	NR	1.00 (0.91 to 1.10)*	Age, sex, BMI, smoking, DM, past history of CVD, hypercholesterolemia
									1.36 (1.19 to 1.54)†		1.00 (0.91 to 1.09)†	
									1.39 (1.22 to 1.59)		0.99 (0.90 to 1.09)	
DBP												
Asayama, 2006[112] Good	Japan	1766	156	54.3, 28.54	NR/NR	10.6	5 mm Hg	NR	1.23 (1.12 to 1.36)*	NR	0.99 (0.92 to 1.07)	Age, sex, BMI, smoking, DM, past history of CVD, hypercholesterolemia
									1.27 (1.14 to 1.40)†		0.98 (0.91 to 1.06)†	
									1.28 (1.15 to 1.41)		0.98 (0.91 to 1.06)	

* Morning HBPM.
† Evening HBPM.
‡ All covariates are from the model adjusted for HBPM or OBPM.
§ See Appendix C for original data.

Abbreviations: adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HBPM = home blood pressure monitoring; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; NR = not reported; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure.

Table 26. Selected Characteristics of Studies Reporting the Positive Predictive Value of OBPM for Selected Confirmatory Measurement Methods

Author, Year Quality	Inclusion Criteria	# OBPM Measurements [Interventionist]	Diagnostic Accuracy N (% Female)	Mean Age, y (Range)	Mean BL Office SBP/DBP (mm Hg)	BP Threshold (mm Hg) if Different From Standard*	Reference	Definition of ABPM or HBPM	PPV of (1st) OBPM for Reference (95% CI)
ABPM									
Kario, 2013[136] Fair	Patients diagnosed as having HTN by a clinical practitioner	1 BP measurement (method NR) [clinical practitioner]	239 (47)	66.3	157/89	ABPM ≥130	ABPM (24-hr)	Average over 24 hours	0.89 (0.85 to 0.93)
Inden, 1998[135] Fair	Essential HTN patients who visited the HTN clinic of Nagoya Daini Red Cross Hospital; elevated BP by screening	Average of 2 (manual) [NR]	232 (53)	54.2 (18-80)	167/98	ABPM nighttime ≥120/75	ABPM (24-hr)	Average after removing the first 2 measurements	0.88 (0.83 to 0.92)
Pierdomenico, 1995[143] Fair	Untreated consecutive patients with newly diagnosed arterial HTN	Average of 3 (manual) [NR]	255 (47)	49 (33-65)	162/99	NA	ABPM (24-hr)	Average over 24 hours	0.79 (0.74 to 0.84)
Khoury, 1992[137] Fair	≥2 previous BP measurements showed DBP >90 mm Hg but <115 mm Hg.	1 on day of ABPM and any from previous 12 months averaged (manual) [Nurses]	131 (47)	53.9	155/93	NA	ABPM (24-hr)	Average over 24 hours	0.52 (0.43 to 0.60)
Hozawa, 2002[127] Fair	Subpopulation of Ohasama community study; age ≥40 years, untreated	Average of 2 (automated) [nurse or technician]	150 (68)	NR (≥40)	154/84	NA	ABPM (24-hr)	Average over 24 hours	0.35 (0.27 to 0.42)
Myers, 2010[141] Good	Consecutive untreated patients referred to ABPM by physician	Average of 5 (automated) [NR]	69 (52)	56.8	150/89	ABPM ≥130/80	ABPM (daytime)	Mean calcuated for the awake period from patient diary	0.93 (0.87 to 0.99)
Hond, 2003b[134] Fair	HTN patients whose sitting DBP was ≥95 mm Hg on conventional measurement	Average of last 2 measurements of each of 2 visits (manual) [physician]	247 (54)	50.4	155/100	NA	ABPM (daytime)	Daytime time-weighted means 10 am to 8 pm	0.92 (0.89 to 0.96)
Gustavsen, 2003[133] Fair	Ages 18-80 years, newly diagnosed grade I or II (mild to moderate) HTN	Average of ≥3 BP measurements taken ≥1 week apart (manual) [physician]	420 (53)	47.7 (18-80)	156/100	NA	ABPM (daytime)	Average daytime BP 8 am to 10 pm	0.90 (0.88 to 0.93)
Zawadzka, 1998[151] Fair	Consecutive untreated patients with mean of 3 DBP measurements on different occasions	Average of 3 (automated) [physician, clinic nurse]	410 (NR)	NR	168/107	NA	ABPM (daytime)	NR	0.86 (0.83 to 0.90)

Table 26. Selected Characteristics of Studies Reporting the Positive Predictive Value of OBPM for Selected Confirmatory Measurement Methods

Author, Year Quality	Inclusion Criteria	# OBPM Measurements [Interventionist]	Diagnostic Accuracy N (% Female)	Mean Age, y (Range)	Mean BL Office SBP/DBP (mm Hg)	BP Threshold (mm Hg) if Different From Standard*	Reference	Definition of ABPM or HBPM	PPV of (1st) OBPM for Reference (95% CI)
Verdecchia, 1995[149] Fair	Essential HTN, previous anti-HTN medications withdrawn for ≥4 weeks; agreement within 5 mm Hg between mercury column and automatic recorder in ≥3 consecutive measurements taken simultaneously in each arm before ABPM	Average of 3 (automated) [physician]	1333 (51)	50.6	156/98	Daytime ABPM ≥131/86 (women) or ≥136/87 (men)	ABPM (daytime)	Average daytime BP 6 am to 10 pm	0.81 (0.79 to 0.83)
Graves, 2010[132] Fair	Mild to moderate HTN requiring therapy	Average of 3 (manual) [NR]	313 (42)	51 (26-79)	150/97	Daytime ABPM ≥135/90	ABPM (daytime)	Average daytime BP 9 am to 9 pm	0.79 (0.74 to 0.83)
Celis, 2002[114] Fair	Patients previously participating in APTH trial whose office DBP was ≥95 mm Hg while off treatment; age ≥18 years	Average of 2 visit mean BPs (3 readings per visit) [NR]	419 (54)	52.6 (≥18)	165/103	OBPM DBP >95; daytime ABPM ≥140/90	ABPM (daytime)	Daytime time-weighted mean 10 am to 8 pm	0.78 (0.74 to 0.82)
Nasothimiou, 2012[142] Good	Referral for elevated BP, untreated	Average of the 2nd and 3rd clinic BPs from each of 3 visits (manual) [physician]	361 (41)	49	143/94	NA	ABPM (daytime)	Determined according to diary	0.77 (0.73 to 0.81)
Manning, 1999[139] Fair	Patients referred to outpatient HTN unit who were not currently on anti-HTN meds and had not been in past year	Average of 3 visit mean BPs (3 readings per visit) (manual) [NR]	186 (49)	46 (18-71)	161/101	NA	ABPM (daytime)	Determined according to diary	0.77 (0.71 to 0.83)
Ungar, 2004[148] Good	Consecutive patients referred to HTN center	Average of 2 to 3 (manual) [physician]	388 (51)	60 (21-95)	151/93	NA	ABPM (daytime)	Average daytime BP 7 am to 10 pm	0.74 (0.70 to 0.78)
Fogari, 1996[130] Fair	Consecutive men with newly diagnosed, never-treated essential HTN	Average of 2 (manual) [physician]	221 (NR)	NR (31-60)	164/104	Daytime ABPM ≥134/90	ABPM (daytime)	Average daytime BP 6 am to 10 pm	0.74 (0.68 to 0.80)
Gerc, 2000[131]‡ Fair	Patients classified with elevated BP in physician's office and referred to HTN clinic for confirmation of diagnosis	Average of 3 (manual) [nurse]	1466 (42)	46.9 (13-85)	141/91	Daytime ABPM ≥140/90	ABPM (daytime)	"12-hour daytime period"	0.65 (0.62 to 0.67)
Pessanha, 2013[152]	Newly diagnosed HTN patients from July 2006 to November 2007 without anti-HTN treatment	Average of 3 clinical readings [NR]	336 (57)	51 (NR)	158/93	NA	ABPM (daytime)	Average daytime BP 7 am to 11 pm	0.61 (0.56 to 0.67)

Table 26. Selected Characteristics of Studies Reporting the Positive Predictive Value of OBPM for Selected Confirmatory Measurement Methods

Author, Year Quality	Inclusion Criteria	# OBPM Measurements [Interventionist]	Diagnostic Accuracy N (% Female)	Mean Age, y (Range)	Mean BL Office SBP/DBP (mm Hg)	BP Threshold (mm Hg) if Different From Standard*	Reference	Definition of ABPM or HBPM	PPV of (1st) OBPM for Reference (95% CI)
Martinez, 1999[140] Fair	Ages 18-75 years, diagnosis of mild to moderate essential HTN according to JNC 1993; no previous HTN treatment or none within 3 weeks	Average of 3 visit mean BPs (2 readings per visit) (manual) [nurses and doctors]	345 (52)	51.8 (18-75)	NR	NA	ABPM (daytime)	Average daytime BP 10 am to 8 pm	0.61 (0.55 to 0.66)
Talleruphuus, 2006[145] Fair	Living persons born between April 1, 1916 and September 30, 1926 from community registers; screened with isolated systolic hypertension	Average of 3 consecutive measurements on arm with highest BP (manual) [technician]	108 (49)	75 (70-82)	173/81	OBPM ≥160/90 Daytime ABPM ≥154/87	ABPM (daytime)	Median daytime BP 7 am to 11 pm	0.54 (0.44 to 0.63)
Zabludowski, 1992[150] Fair	Untreated borderline HTN (DBP occasionally, but not consistently >90 mm Hg)	Average of 3 (manual) [physician or nurse]	171 (67)	48	159/91	Daytime ABPM DBP >90 mm Hg	ABPM (daytime)	Average daytime BP 6 am to 12 am	0.47 (0.40 to 0.55)
Cuspidi, 2011[129] Good	Grade 1 or 2 HTN diagnosed in the previous 12 months and confirmed during 2 visits at the outpatient clinic	Average of 3 (manual) [NR]	658 (48)	46	145/96	Nighttime ABPM ≥120/70	ABPM (nighttime)	Average nighttime 11 pm to 7 am	0.95 (0.93 to 0.97)
HBPM									
Hond, 2003b[134] Fair	HTN on conventional measurement	Average of last 2 measurements of each of 2 visits (manual) [physician]	247 (54)	50.4	155/100	NA	HBPM	3 morning, 3 evening for 1 week	0.84 (0.80 to 0.89)
Kario, 2013[136] Fair	Patients diagnosed with HTN by a clinical practitioner	1 BP measurement (method NR) [clinical practitioner]	239 (47)	66.3	157/89	NA	HBPM	1 morning, 1 evening for 3 days	0.84 (0.79 to 0.88)
Toyama, 2008[147] Fair	Students of Tohoku University with 3 previous positive BP screens	Above threshold in 3 screens; last screen (1 measurement) used as office BP (automated) [physician]	100 (NR)	21.6 (<30)	156/91	NA	HBPM	Mean of at least 7 morning measurements	0.83 (0.76 to 0.90)
Nasothimiou, 2012[142] Good	Referral for elevated BP, untreated subpopulation only	Average of the 2nd and 3rd clinic BP from each of 3 visits (manual) [physician]	361 (41)	49	143/94	NA	HBPM	Duplicate morning and evening measurements for 6 days	0.76 (0.72 to 0.81)
Tanabe, 2008[146] Fair	Age ≥18 years, spoke English, elevated initial and repeated ED BP, ≥4 home BPs stored in the monitor	2 BP measurements (method NR) [research assistant]	156 (52)	47.5 (≥18)	153/93†	HBPM ≥140/90	HBPM	1 morning, 1 evening for 1 week	0.51 (0.43 to 0.58)

Table 26. Selected Characteristics of Studies Reporting the Positive Predictive Value of OBPM for Selected Confirmatory Measurement Methods

Author, Year Quality	Inclusion Criteria	# OBPM Measurements [Interventionist]	Diagnostic Accuracy N (% Female)	Mean Age, y (Range)	Mean BL Office SBP/DBP (mm Hg)	BP Threshold (mm Hg) if Different From Standard*	Reference	Definition of ABPM or HBPM	PPV of (1st) OBPM for Reference (95% CI)
Hozawa, 2002[127] Fair	Subpopulation of Ohasama community study; age ≥40 years, untreated	Average of 2 (automated) [nurse or technician]	150 (NR)	NR (≥40)	154/84	NA	HBPM (morning)	2 morning, 2 evening for 4 weeks	0.45 (0.37 to 0.53)
OBPM									
Fogari, 1996[130] Fair	Consecutive male patients with newly diagnosed, never-treated essential HTN (DBP >90 mm Hg) ages 31-60 years	Average of 2 (manual) [physician]	221 (0)	31-60	164.1/103.5	DBP >90 mm Hg	OBPM (2nd screen)	NA	0.96 (NR)
Pessanha, 2013[152]	Newly diagnosed hypertensive patients from July 2006 to November 2007 without anti-HTN treatment	Average of 3 clinical readings [NR]	336 (57)	51 (NR)	158/93	NA	OBPM (2nd screen	NA	0.93 (NR)
Nasothimiou, 2012[142] Good	Referral for elevated BP, untreated subpopulation only	Average of the 2nd and 3rd clinic BP from each of 3 visits (manual) [physician]	361 (41)	49	143/94	NA	OBPM (2nd screen)	NA	0.83 (NR)
Ungar, 2004[148] Good	Consecutive patients referred to HTN center	Average of 2 to 3 (manual) [physician]	388 (51)	60 (21-95)	151/93	NA	OBPM (2nd screen	NA	0.82 (NR)
Khoury, 1992[137] Fair	≥2 previous BPs showed DBP >90 but <115 mm Hg	1 on day of ABPM and any from previous 12 months averaged (manual) [nurses]	131 (47)	53.9	155/93	DBP ≥90 mm Hg	OBPM (2nd screen	NA	0.76 (NR)
Zabludowski, 1992[150] Fair	Untreated borderline HTN (DBP occasionally, but not consistently >90 mm Hg)	Average of 3 (manual) [physician or nurse]	171 (67)	48	159/91	NA	OBPM (2nd screen	NA	0.67 (NR)
Radi, 2004[144] Good	Working population from any sector besides agricultural, enrolled by occupational physicians; untreated subpopulation	Average of 3 (automated) [NR]	3464 (NR)	15-69	NR	NA	OBPM (2nd screen)	NA	0.58 (NR)

* OBPM: 140/90 mm Hg; ABPM and HBPM: 135/85 mm Hg.

† Mean of medians.

‡ The numbers in this study do not add up (among the untreated, 520 (35%) had white coat HTN and 971 (65%) had sustained HTN, which does not = 1,466, as reported). We used 520 as the accurate number and calculates backwards.

Abbreviations: ABPM = ambulatory blood pressure monitoring; BP = blood pressure; CI = confidence interval; DBP = diastolic blood pressure; ED = emergency department; HBPM = home blood pressure monitoring; HTN = hypertension; NA = not applicable; NR = not reported; OBPM = office-based blood pressure measurement; PPV = positive predictive value.

Table 27. Studies Reporting the Positive Predictive Value of OBPM for Selected Confirmatory Measurement Methods

Author, Year	OBPM	Confirmatory BP	PPV of OBPM for Confirmatory BP
Khoury, 1992[137]	Prestudy visit	First OBPM visit	0.76
	Prestudy visit	ABPM	0.52
	First study OBPM visit	ABPM	0.56
Fogari, 1996[130]	Prestudy visit	First OBPM visit	0.96
	Prestudy visit	Final OBPM visit	0.82
	Prestudy visit	ABPM	0.74

Abbreviations: ABPM = ambulatory blood pressure monitoring; BP = blood pressure; OBPM = office-based blood pressure measurement; PPV = positive predictive value.

Table 28. Weighted Mean Hypertension Incidence by Rescreening Interval

	1 Year	2 Years	3 Years	4 Years	5 Years
Weighted mean incidence, % (range)	2.5% (2.5 to 4.4)*	7.7% (1.2 to 12.3)	16.6% (6.6 to 24.9)	34.4% (2.1 to 39.2)†	13.7% (2.1 to 28.4)
Number of studies (N)	2 (17,740)	6 (76,753)	7 (20,822)	6 (141,514)†	16 (54,964)

* If the incidence rate based on one visit in Radi, 2004 is used instead of the incidence rate based on two visits, the mean weighted incidence is 5.4% (range, 4.4 to 5.4).
† If Okubo, 2014 (n=115,736) is not included in the 4-year interval, the weighted mean incidence is 12.4% (range, 2.1 to 23.7) in 5 studies (N=25,778).

Table 29. Hypertension Incidence at Various Rescreening Intervals (Sorted by Interval)

Author, Year Quality	Country	N	Mean Age, y; Range	Mean BL Office SBP/DBP (mm Hg)	% Female	Mean BMI; % With BMI >30 kg/m^2 if Reported	% Smokers	Interval, y	Unadjusted Incidence, %	Diagnostic Threshold
Bakx, 1987[155] Fair	The Netherlands	1953 followed for max 17 years; N at 0.5 years NR	NR; 20-50	NR	61.0	NR	NR	0.5	2.0*	DBP ≥100 mm Hg
Cacciolati, 2013[158] Fair	France	275	77.8; ≥73	133.0/72.8	67.6	24.4	NR	1	4.4†	≥140/90 mm Hg in office and ≥135/85 mm Hg at home
Kubo, 2013[188] Fair	Japan	10173 followed for max 27.5 years; N at 1 year NR	23.6; <30	118.9/67.2	0	21.7	49.37	1	4.3*	≥140/90 mm Hg
Radi, 2004[144] Fair	France	17465	38.2; 15-69	119.5/75.3	44.5	23.9; 5.95%	33.47	1	2.5†	≥140/90 mm Hg or meds
Radi, 2004[144] Fair	France	16655	38.2; 15-69	119.5/75.3	44.5	23.9; 5.95%	33.47	1	5.4‡	≥140/90 mm Hg or meds
Bakx, 1987[155] Fair	The Netherlands	1953 followed for max 17 years; N at 1.5 years NR	NR; 20-50	NR	61.0	NR	NR	1.5	3.6*	DBP ≥100 mm Hg
Fitchett, 2009[163] Fair	United States	1001	50.0; 42-52	118.4/NR	100	30.1	NR	2	8.9	≥140/90 mm Hg or meds
Kim, 2006[166] Good	Korea	5869	50.8; 40-69	113.1/75.3	52.4	24.2	26.07	2	12.3	≥140/90 mm Hg or meds
Kim, 2011[167] Fair	Korea	49228	37.9; 30-54	112.4/72.8	32.7	22.3	40.32	2	9.2	≥140/90 mm Hg
Kubo, 2013[188] Fair	Japan	10173 followed for max 27.5 years; N at 2 years NR	23.6; <30	118.9/67.2	0	21.7	49.37	2	7.5*	≥140/90 mm Hg
Levine, 2011[174] Good	United States	3436	25.1; 18-30	109.5/68.1	57.1	24.3; 10.62%	26.27	2	1.2	≥140/90 mm Hg or meds
Schulz, 2005[180] Fair	Germany	12362	47.5; 19-69	119/78	69.1	24.9; 8.51%	22.18	2	1.4	Self-reported diagnosis or meds verified by doctor
Tozawa, 2002[182] Fair	Japan	4857	46; NR	115/71	36.0	31% with BMI ≥25 kg/m^2	30	2	7.4	≥140/90 mm Hg

Table 29. Hypertension Incidence at Various Rescreening Intervals (Sorted by Interval)

Author, Year Quality	Country	N	Mean Age, y; Range	Mean BL Office SBP/DBP (mm Hg)	% Female	Mean BMI; % With BMI >30 kg/m^2 if Reported	% Smokers	Interval, y	Unadjusted Incidence, %	Diagnostic Threshold
Bakx, 1987[155] Fair	The Netherlands	1953 followed for max 17 years; N at 2.5 years NR	NR; 20-50	NR	61.0	NR	NR	2.5	4.8*	DBP ≥100 mm Hg
Jung, 2014[187] Good	South Korea	1553	53.9; 40-70	116.9/73.8	62.4	NR; 32.52	16.74	2.6	11.5	≥140/90 mm Hg or meds
Matsuo, 2011[175] Fair	Japan	5201	41.2; 30-59	121.8/73.8	0	23.7	41.9	2.9	17.2	≥140/90 mm Hg or meds
Apostolides, 1982[153] Fair	United States	2738	NR; 30-69	NR	52.7	NR	NR	3	14.9	DBP >95 mm Hg or meds
Juhaeri, 2002[165] Good	United States	9319	53.4; 46-65	113.6/70.0	55.1	26.7	25.9	3	10.4	≥140/90 mm Hg or meds
Kubo, 2013[188] Fair	Japan	10173 followed for max 27.5 years; N at 3 years NR	23.6; <30	118.9/67.2	0	21.7	49.37	3	10.0*	≥140/90 mm Hg
Satoh, 2010[179] Fair	Japan	2278	46; 35-55	117/74	0	23.7	51.1	3	6.6	≥140/90 mm Hg or meds
Yambe, 2007[185] Good	Japan	1758	40.6; NR to <64	117.9/73.6	0	23.3	41.13	3	8.9	≥140/90 mm Hg or meds
Zambrana, 2014[190] Fair	United States	3145	NR; 50-79	NR	100	NR; 30.52	7.22	3	19.8	≥140/90 mm Hg, self-reported physician diagnosis, or meds
Fagot-Campagna, 1997[162] Fair	France	4149	49.3§; 43-54	130/80§	0	25.3	NR	3.16	24.9	≥160/95 mm Hg or meds
Bakx, 1987[155] Fair	The Netherlands	1953 followed for max 17 years; N at 3.5 years NR	NR; 20-50	NR	61.0	NR	NR	3.5	6.0*	DBP ≥100 mm Hg
Okubo, 2014[189] Fair	Japan	115,736	54.5; 40-79	120.9/73.3	67.76	22.8	21.57	3.9	39.2	>140/90 mm Hg or meds

Table 29. Hypertension Incidence at Various Rescreening Intervals (Sorted by Interval)

Author, Year Quality	Country	N	Mean Age, y; Range	Mean BL Office SBP/DBP (mm Hg)	% Female	Mean BMI; % With BMI >30 kg/m^2 if Reported	% Smokers	Interval, y	Unadjusted Incidence, %	Diagnostic Threshold
Dernellis, 2005[160] Fair	Greece	2512	64.6; 35-94	119.8/77.2	57.3	26.8	20.98	4	23.7†	≥140/90 mm Hg
Kubo, 2013[188] Fair	Japan	10,173 followed for max 27.5 years; N at 4 years NR	23.6; <30	118.9/67.2	0	21.7	49.37	4	12.5*	≥140/90 mm Hg
Lee, 2004a[171] Good	Korea	8170	38.7; 25-50	114.9/72.7	0	22.5	NR	4	2.1	≥160/95 mm Hg
Vasan, 2001[183] Good	United States	9845	52.1; 35-94	118.5/74	57.3	25.8	26.4	4	19.4	≥140 mm Hg or meds
Brantsma, 2006[157] Good	The Netherlands	4635	45.2; 28-75	119.1/69.6	54.4	25.1	39.31	4.2	8.9†	≥140/90 mm Hg or meds
Everson, 2000[161] Good	Finland	616	50.4; 42-60	126.4/83.2	0	25.9	33.12	4.2	20.4	≥165/95 mm Hg or meds as confirmed during medical exam
Bakx, 1987[155] Fair	The Netherlands	1953 followed for max 17 years; N at 4.5 years NR	NR; 20-50	NR	61.0	NR	NR	4.5	7.1*	DBP ≥100 mm Hg
Shook, 2012[181] Fair	United States	6278	44.7; 20-80	115.1/76.9	23.9	25.2	11.6	4.7	24.6	≥140/90 mm Hg
Arima, 2002[154] Fair	Japan	1133	56; 40-79	124.7/74.4	64.3	22.7	20.56	5	16.4	≥160/95 mm Hg or meds
Boyko, 2008[156] Fair	Australia	4306	47.6; ≥25 to NR	120.2/67.0	57.0	26.1	12.63	5	14.0	≥140/90 mm Hg or meds
Kubo, 2013[188] Fair	Japan	10,173 followed for max 27.5 years; N at 5 years NR	23.6; <30	118.9/67.2	0	21.7	49.37	5	15.0*	≥140/90 mm Hg
Lakoski, 2011[170] Good	United States	3543	59; 45-84	NR	51.2	27.4	14.56	5	20.2	≥140/90 mm Hg or history of HTN and meds
Lee, 2004b[173] Fair	Japan	5840	48.6; 30-69	110.5/69.8	41.3	22.9; 1.18%	35.58	5	10.5†	≥160/95 mm Hg more than once or meds
Lee, 2011[172] Fair	Korea	730	56.6; ≥20 to NR	119.8/75.8	63.7	23.2	24.66	5	26.7	≥140/90 mm Hg or meds

Table 29. Hypertension Incidence at Various Rescreening Intervals (Sorted by Interval)

Author, Year Quality	Country	N	Mean Age, y; Range	Mean BL Office SBP/DBP (mm Hg)	% Female	Mean BMI; % With BMI >30 kg/m^2 if Reported	% Smokers	Interval, y	Unadjusted Incidence, %	Diagnostic Threshold
Levine, 2011[174] Good	United States	3436	25.1; 18-30	109.5/68.1	57.1	24.3;10.62%	26.27	5	3.23	≥140/90 mm Hg or meds
Morikawa, 1999[176] Good	Japan	1551	34.7; 18-49	117.7/69.4	0	22.2	66.2	5	7.0	≥140/90 mm Hg
Nakanishi, 2003[177] Good	Japan	3784	42.0; 23-59	121.3/72.9	0	23.0	48.97	5	28.4	≥140/90 mm Hg or meds
Okubo, 2004[178] Fair	Japan	2107	45.8; 40-54	122.10/73.29	0	23.1	60.13	5	3.1	≥140/90 mm Hg
Sung, 2014[186] Fair	South Korea	11448	40.6; NR	111.4/72.0	30.64	23.6	48.88	5	8.0	≥140/90 mm Hg or meds
Yamada, 1991[184] Good	Japan	1393	42.4; 35-54	119.2/73.5	0	23.1	NR	5	2.1†	>160/95 mm Hg during annual checkup and confirmed by average of 3 or 4 subsequent visits
Giubertoni, 2013[164] Fair	Italy	640	55.2; NR to <65	NR/NR	100	26.3	17.7	5.25	17.0	>140/90 mm Hg (med status in definition NR)
Cheung, 2012[159] Fair	Hong Kong	1115	48.3; 25-74	113.9/72.2	56.6	23.6	16.32	5.3	21.2	≥140/90 mm Hg or meds
Volzke, 2013[191] Good	Germany	1605	42.9; 20-79	120.5/76.8	63.05	25.4	30.34	5.3	20.1	≥140/90 mm Hg or meds
Bakx, 1987[155] Fair	The Netherlands	1953 followed for max 17 years; N at 5.5 years NR	NR; 20-50	NR	61.0	NR	NR	5.5	8.6*	DBP ≥100 mm Hg
Kivimaki, 2009[168] Fair	United Kingdom	6055	44.6; 35-55	118.9/74.6	31.1	24.3	15.69	5.6	11.8	≥140/90 mm Hg or meds

∗ Not included in plots or pooled estimates because estimated from figure; N at specified interval NR.
† Measure based on more than 1 visit or involved additional confirmation step.
‡ Not included in pooled estimates (Radi, 2004 incidence based on 2 visits was pooled); included for illustration only.
§ Median.

Abbreviations: BL = baseline; BMI = body mass index; DBP = diastolic blood pressure; HTN = hypertension; NR = not reported; SBP = systolic blood pressure.

Table 30. Weighted Mean Hypertension Incidence at Various Rescreening Intervals in a Priori Identified Subgroups

	1 Year			2 Years			3 Years			4 Years			5 Years		
Subgroup	**k (N)**	**%***	**Range**	**k (N)**	**%***	**Range**	**k (N)**	**%***	**Range**	**k (N)**	**%***	**Range**	**k (N)**	**%***	**Range**
Age															
18 to 40/45 years	1† (9617)	1.0	--	1 (3436)	1.2	--	--	--	--	1 (7797)	1.8	--	3 (4568)	4.1	3.2 to 17.8
40/45 to 60/65 years	1† (5805)	4.0	--	1 (1001)	8.9	--	2 (13,468)	14.9	10.4 to 24.9	2 (989)	15.3	6.7 to 20.4	3 (3052)	7.1	3.1 to 23.7
60/65 years or older	1 (275)	4.4	--	--	--	--	--	--	--	2 (2858)	37.5	35.4 to 40.3	1 (204)	37.7	--
BP level															
High-normal	--	--	--	2 (5000)	27.7	26.7 to 31.3	3 (3323)	26.7	21.0 to 30.4	2 (4736)	50.3	42.8 to 58.0	2 (1544)	46.4	32.7 to 52.2
Normal	--	--	--	2 (50,117)	7.7	7.6 to 7.8	3 (4318)	7.0	4.4 to 9.0	1 (7443)	11.8	--	2 (2970)	18.6	16.6 to 18.8
Sex															
Male	1† (9691)	3.4	--	4 (40,519)	10.6	1.8 to 13.0	7 (19,447)	15.4	6.6 to 24.9	5 (49,283)‡	34.6	2.1 to 43.3	14 (31,153)	13.0	2.1 to 28.4
Female	1† (7774)	1.5	--	5 (23,872)	6.0	0.9 to 11.6	5 (19,308)	7.8	1.4 to 19.8	3 (82,386)‡	36.0	8.7 to 37.3	11 (17,533)	11.2	2.5 to 28.8
BMI															
18.5 to <25 kg/m^2	1 (11,751)	1.5	--	1 (3351)	5.5	--	1 (3521)	13.8	--	--	--	--	--	--	--
≥25 to 29.9 kg/m^2	1 (4674)	3.9	--	--	--	--	1 (1456)	24.9	--	--	--	--	--	--	--
≥30 kg/m^2	1 (1040)	7.6	--	1 (1039)	3.8	--	1 (138)	32.6	--	--	--	--	--	--	--
Smoking															
Current	1 (5845)	2.8	--	1 (1457)	5.4	--	1 (1164)	5.8	--	2 (7194)	3.4	1.8 to 8.3	6 (5288)	10.6	3.0 to 22.0
Non or former smoker	1 (11,620)	2.4	--	1 (3400)	8.3	--	1 (1114)	7.5	--	2 (5611)	6.0	2.6 to 9.3	6 (13,222)	15.1	3.4 to 21.0

* Weighted mean incidence.

† Incidence based on two visits; incidence based on one visit also reported but not pooled (Radi, 2004).[144]

‡ Okubo[189] categorized in 4-year interval based on overall mean followup of 3.9 years; mean followup for women was 4.1 years and 3.4 years for men. If Okubo, 2014 (n=115,736) is not included in the 4-year interval, the weighted mean incidence for men is 7.3% with a range of 2.1% to 35.6% in 4 studies (N=11,973) and the weighted mean incidence for women is 10.9% with a range of 8.7% to 14.8% in 2 studies (N=3,960).

Abbreviations: BMI = body mass index; BP = blood pressure.

Table 31. Hypertension Incidence by Age Category at Various Rescreening Intervals (Sorted by Interval)

Author, Year Quality	Mean Age, y; Range	Country	N (% Ages 18 to 40/45 y)	Diagnostic Threshold	Mean BL Office SBP/DBP (mm Hg)	% Female	Interval, y	Unadjusted Incidence (Ages 18 to 40/45 y)	Unadjusted Incidence (Ages 40/45 to 60/65 y)	Unadjusted Incidence (Age ≥60/65 y)
Radi, 2004[144] Fair	38.2; 15-69	France	17,465 (55.1)	≥140/90 mm Hg or meds	119.5/75.3	44.5	1	1.0*	4.4*†	NR
Lee, 2004a[171] Good	38.7; 25-50	Korea	8170 (95.4)	≥160/95 mm Hg	114.9/72.7	0	4	1.8	6.7	NA
Lee, 2011[172] Fair	56.6; ≥20	Korea	730 (15.3)	≥140/90 mm Hg or meds	119.8/75.8	63.7	5	17.9	23.7	37.7
Morikawa, 1999[176] Good	34.7; 18-49	Japan	1551 (65.8)	≥140/90 mm Hg	117.7/69.4	0	5	5.5	10.0	NA

Note: Baseline characteristics are reported for the overall study population and are not further stratified by the identified subgroup.
* Includes persons ages 40 to 69 years.
† Measure based on more than one visit or involved additional confirmation step.
‡ Median.

Abbreviations: BL = baseline; DBP = diastolic blood pressure; HTN = hypertension; NA = not applicable; NR = not reported; SBP = systolic blood pressure.

Table 32. Hypertension Incidence by Blood Pressure Strata in Studies Reporting Three Strata

Study	Categories	Cases/N	Unadjusted Incidence, %
Kim, 2006[166] 2-year interval	Optimal BP: <120/80 mm Hg	158/3302	4.8
	Normal: 120-129/80-84 mm Hg	217/1485	14.6
	High-normal: 130-139/85-89 mm Hg	345/1102	31.3
Kim, 2011[167] 2-year interval	Optimal BP: <120/80 mm Hg	1671/32929	5.1
	Normal: 120-129/80-84 mm Hg	1800/12401	14.5
	High-normal: 130-139/85-89 mm Hg	1040/3898	26.7
Yambe, 2007[185] 3-year interval	Optimal BP: <120/80 mm Hg	17/702	2.4
	Normal: 120-129/80-84 mm Hg	40/581	6.9
	High-normal: 130-139/85-89 mm Hg	100/475	21.0
Vasan, 2001[183] 4-year interval	Optimum: <120/80 mm Hg	286/4499	6.4
	Normal: 120-129/80-84 mm Hg	592/2944	20.1
	High-normal: 130-139/85-89 mm Hg	1029/2402	42.8
Nakanishi, 2003[177] 5-year interval	Low-normal: <120/80 mm Hg	130/1418	9.2
	Normal: 120-129/80-84 mm Hg	379/1281	29.6
	High-normal: 130-139/85-89 mm Hg	567/1085	52.2

Abbreviation: BP = blood pressure.

Table 33. Hypertension Incidence by Sex at Various Rescreening Intervals (Sorted by Interval)

Author, Year Quality	Country	N (% Female)	Mean Age, y; Range	Diagnostic Threshold	Mean BL Office SBP/DBP (mm Hg)	Interval, y	Male Unadjusted Incidence, %	Female Unadjusted Incidence, %	Incidence Ratio Male:Female
Radi, 2004[144] Fair	France	17,465 (44.5)	38.2; 15-69	≥140/90 mm Hg or meds	119.5/75.3	1	3.4*	1.5*	2.3
Kim, 2006[166] Good	Korea	5869 (52.4)	50.8; 40-69	≥140/90 mm Hg or meds	113.1/75.3	2	13.0	11.6	1.1
Kim, 2011[167] Fair	Korea	49,228 (32.7)	37.9; 30-54	≥140/90 mm Hg	112.4/72.8	2	11.0	5.4	2.0
Levine, 2011[174] Good	United States	3436 (57.1)	25.1; 18-30	≥140/90 mm Hg or meds	109.5/68.1	2	1.8	0.9	2.0
Tozawa, 2002[182] Fair	Japan	4857 (36.0)	46; NR	≥140/90 mm Hg	115/71	2	8.0	6.3	1.3
Jung, 2014[187] Good	Korea	1553 (62.4)	53.9; 40-70	≥140/90 or meds	116.9/73.8	2.6	13.5	10.2	1.3
Apostolides, 1982[153] Fair	United States	2738 (52.7)	NR; 30-69	DBP >95 mm Hg or meds	NR	3	14.8	15.0	1.0
Juhaeri, 2002[165] Good	United States	9319 (55.1)	53.4; 46-65	≥140/90 mm Hg or meds	113.6/70.0	3	11.6	9.4	1.2
Okubo, 2014[189] Fair	Japan	115,736 (67.76)	54.5; 40-79	>140/90 mm Hg or meds	120.9/73.3	3.9 (3.4 for men, 4.1 for women)	43.3	37.3	1.2
Dernellis, 2005[160] Fair	Greece	2512 (57.3)	64.6; 35-94	≥140/90 mm Hg	119.8/77.2	4	35.6*	14.8*	2.4
Brantsma, 2006[157] Good	Netherlands	4635 (54.4)	45.2; 28-75	≥140/90 mm Hg or meds	119.1/69.6	4.2	9.2*	8.7*	1.1
Arima, 2002[154] Fair	Japan	1133 (64.3)	56; 40-79	≥160/95 mm Hg or meds	124.7/74.4	5	16.0	16.6	1.0
Boyko, 2008[156] Fair	Australia	4306 (57.0)	47.6; ≥25 to NR	≥140/90 mm Hg or meds	120.2/67.0	5	15.6	12.7	1.2
Klein, 2006[169‡] Good	United States	NR (56.8)	57.6; 43-84	≥140/90 mm Hg or meds	119/74	5	19	16.6	1.1
Lakoski, 2011[170] Good	United States	3543 (51.2)	59; 45-84	≥140/90 mm Hg or history of HTN and meds	NR	5	19.6	20.7	0.9
Lee, 2004b[173] Fair	Japan	5840 (41.3)	48.6; 30-69	≥160/95 mm Hg more than once or meds	110.5/69.8	5	11.7*	8.9*	1.3
Lee, 2011[172] Fair	Korea	730 (63.7)	56.6; ≥20 to NR	≥140/90 mm Hg or meds	119.8/75.8	5	23.0	28.8	0.8

Table 33. Hypertension Incidence by Sex at Various Rescreening Intervals (Sorted by Interval)

Author, Year Quality	Country	N (% Female)	Mean Age, y; Range	Diagnostic Threshold	Mean BL Office SBP/DBP (mm Hg)	Interval, y	Male Unadjusted Incidence, %	Female Unadjusted Incidence, %	Incidence Ratio Male:Female
Levine, 2011[174] Good	United States	3436 (57.1)	25.1; 18-30	≥140/90 mm Hg or meds	109.5/68.1	5	4.2	2.5	1.7
Sung, 2014[186] Fair	Korea	11448 (30.64)	40.6; NR	≥140/90 mm Hg or meds	111.4/72.0	5	9.7	4.0	2.4
Cheung, 2012[159] Fair	China (Hong Kong)	1115 (56.6)	48.3; 25-74	≥140/90 mm Hg or meds	113.9/72.2	5.3	22.5	20.1	1.1
Volzke, 2013[191] Good	Germany	1605 (63.05)	42.9; 20-79	≥140/90 mm Hg or meds	120.5/76.8	5.3	23.9	17.9	1.3
Kivimaki, 2009[168] Fair	United Kingdom	6055 (31.1)	44.6; 35-55	≥140/90 mm Hg or meds	118.9/74.6	5.6	12.6	10.2	1.2

Note: Baseline characteristics are reported for the overall study population and are not further stratified by the identified subgroup.
* Measure based on more than one visit or involved additional confirmation step.
† Median.
‡ Not included in plots because estimated from figure; N at specified interval NR.

Abbreviations: BMI = body mass index; DBP = diastolic blood pressure; HTN = hypertension; NR = not reported.

Table 34. Hypertension Incidence by Smoking Status at Various Rescreening Intervals (Sorted by Interval)

Author, Year Quality	Country	N (% Smokers)	Mean Age, y; Range	Diagnostic Threshold	Mean BL Office SBP/DBP (mm Hg)	% Female	Mean BMI; % With BMI >30 kg/m^2	Interval, y	Incidence, % in Current Smokers	Incidence, % in Non- and Ex-Smokers
Radi, 2004[144] Fair	France	17,465 (33.47)	38.2; 15-69	≥140/90 mm Hg or meds	119.5/75.3	44.5	23.9; 5.95%	1	2.8*	2.4*
Tozawa, 2002[182] Fair	Japan	4857 (30)	46; NR	≥140/90 mm Hg	115/71	36.0	NR; 31% with BMI ≥25 kg/m^2	2	5.4	8.3
Satoh, 2010[179] Fair	Japan	2278 (51.1)	46; 35-55	≥140/90 mm Hg or meds	117/74	0	23.7	3	5.8	7.5
Lee, 2001[293] Good	Japan	8161 (65.75)	34.7; NR	≥160/95 mm Hg	114.9/72.7	0	22.5	4	1.8	2.6
Brantsma, 2006[157] Good	Netherlands	4635 (39.31)	45.2; 28-75	≥140/90 mm Hg or meds	119.1/69.6	54.4	25.1	4.2	8.3*	9.3*
Boyko, 2008[156] Fair	Australia	4306 (12.63)	47.6; ≥25 to NR	≥140/90 mm Hg or meds	120.2/67.0	57.0	26.1	5	12.1	14.2
Cheung, 2012[159] Fair	China (Hong Kong)	1115 (16.32)	48.3; 25-74	≥140/90 mm Hg or meds	113.9/72.2	56.6	23.6	5.3	22.0	21.0
Lakoski, 2011[170] Good	United States	3537† (14.56)	59; 45-84	≥140/90 mm Hg or history of HTN and meds	NR	51.2	27.4	5	19.6	20.3
Lee, 2004b[173] Fair	Japan	5840 (35.58)	48.6; 30-69	≥160/95 mm Hg more than once or meds	110.5/69.8	41.3	22.9; 1.18%	5	9.9*	10.9*
Okubo, 2004[178] Fair	Japan	2107 (60.13)	45.8; 40-54	≥140/90 mm Hg	122.10/73.29	0	23.10	5	3.0	3.4
Sung, 2011[203] Fair	Korea	10,894 (30.33)	40.4; NR	≥140/90 mm Hg or history of HTN in 2003-2008	111.3/72.0	31.1	23.5	5	9.7	7.4
Volzke, 2013[191] Good	Germany	1605 (30.34)	42.9; 20-79	≥140/90 mm Hg or meds	120.5/76.8	63.05	25.4	5.3	18.3	20.9

Note: Baseline characteristics are reported for the overall study population and are not further stratified by the identified subgroup.
* Measure based on more than one visit or involved additional confirmation step.
† Smoking status not reported for six participants.

Abbreviations: BMI = body mass index; DBP = diastolic blood pressure; HTN = hypertension; NR = not reported.

Table 35. Hypertension Incidence by Race/Ethnicity at Various Rescreening Intervals (Sorted by Interval)

Author, Year* Quality	Mean Age, y; Range	Diagnostic Threshold	Mean BL Office SBP/DBP (mm Hg)	Interval, y	N	Race/ Ethnicity	Unadjusted Incidence, %
Fitchett, 2009[163] Fair	50.0; 42-52	≥140/90 mm Hg or meds	118.4/NR	2	262	African American	17.9
					739	White	5.7
Levine, 2011[174] Good	25.1; 18-30	≥140/90 mm Hg or meds	109.5/68.1	2	1582	African American	1.8
					1854	White	0.8
Juhaeri, 2002[165] Good	53.4; 46-65	≥140/90 mm Hg or meds	113.6/70.0	3	1567	African American	16.4
					7752	White	9.2
Apostolides, 1982[153] Fair	NR; 30-69	DBP >95 mm Hg or meds	NR	3	1222	African American	24.5
					1516	White	7.1
Levine, 2011[174] Good	25.1; 18-30	≥140/90 mm Hg or meds	109.5/68.1	5	1582	African American	4.7
					1854	White	2.0
Lakoski, 2011[170] Good	59; 45-84	≥140/90 mm Hg or history of HTN and meds	NR	5	470	Asian	16.2
					713	African American	27.5
					1552	White	17.5
					808	Hispanic	21.2

Note: Baseline characteristics are reported for the overall study population and are not further stratified by the identified subgroup.
* All studies were conducted in the United States.
† Measure based on more than one visit or involved additional confirmation step.

Abbreviations: BMI = body mass index; DBP = diastolic blood pressure; HTN = hypertension; NR = not reported.

Table 36. Overall Summary of Evidence

Key Question	Studies (k)	Overall Quality	Limitations	Consistency	Primary Care Applicability	Summary of Findings
KQ 1 Screening and CVD and mortality	k=1	Good, limited to 1 trial	Evidence limited to results from 1 good-quality study	NA (1 study)	Moderate Appropriate to an elderly primary care population; screening program evaluated within the context of a universal payer	A cluster randomized, controlled trial (39 clusters; n=140,642) of a BP screening program in Ontario, Canada, targeted to those age ≥65 years, reported a statistically significant 9% relative reduction in the number of composite cardiovascular events (rate ratio, 0.91 [95% CI, 0.86 to 0.97]; p=0.002). There were 3.02 fewer annual hospital admissions per 1,000 persons for CV disease in the intervention group than the no screening group. When analyzed by number of unique residents with hospital admissions, there was a significant relative reduction only in the individual outcome of acute MI.
KQ 2a Diagnostic accuracy of clinic-based blood pressure measurement methods	k=4	Fair to Good	Differences in study design; clinically unrealistic design in 1 study; use of different automated devices in 1 study without attempt to ensure comparability or validity	Inconsistent Sensitivity differs greatly in 1 study	High 3 of 4 studies used clinically applicable protocols to measure the diagnostic accuracy of automated oscillometric BP devices	1 unique study that likely minimized human error more than can be achieved in the typical clinical setting compared manual BP measurement by sphygmomanometer (reference standard) to automated oscillometric measurement, reporting 91% sensitivity, 96% specificity, 88% PPV, and 97% NPV. 3 studies of similar comparisons but with more clinically applicable study designs reported much lower sensitivities (51%-68%) and lower PPVs (76%-84%).
KQ 2b Diagnostic accuracy of protocol characteristics	k=3	Fair to Good	Different protocol characteristics addressed; populations not uniformly representative of screening populations; in 1 study, a carefully controlled protocol may limit applicability	NA Each study evaluated a different component of BP measurement	Moderate Studies addressed basic questions regarding BP measurement methods	1 study showed that the first of 3 BP measurements had a high sensitivity (0.95) but only a moderate PPV (0.76) for detecting hypertension compared with the average of the 2nd and 3rd measurements, suggesting that the main value of repeated measurements is in confirming initially elevated results. In a study of normotensive persons, different leg positions, including leg crossing, did not result in reclassification to hypertensive BP. BP measured after double-blind administration of oral caffeine resulted in reclassification of 17% of persons who ingested caffeine from normotensive to hypertensive.
KQ 3a Prediction of events	k=15	Fair to Good	No U.S.-based study populations; limited data for HBPM; only 1 study compared all 3 methods	High	ABPM independently predicts CV outcomes compared with OBPM and can be considered the reference method for BP measurement	24-hour ABPM predicted stroke and other CV fatal and nonfatal events significantly and independently of OBPM. When both were in the model, OBPM added no significant predictive capacity. Results were inconsistently significant for cardiac events, CHF, and all-cause mortality. The pattern of results was similar for nighttime and daytime ABPM compared with OBPM; no single ABPM protocol appeared best. Results of 5 studies suggest that HBPM predicts CV outcomes significantly and independently of OBPM but too few studies are available for firm conclusions. Only 1 study compared ABPM with HBPM; evidence was insufficient for conclusions. Limited evidence suggests that CV outcomes for the subgroup with isolated clinic HTN at baseline are more similar to those of normotensive than sustained hypertensive persons.

Table 36. Overall Summary of Evidence

Key Question	Studies (k)	Overall Quality	Limitations	Consistency	Primary Care Applicability	Summary of Findings
KQ 3b Diagnostic accuracy to confirm diagnosis	k=27	Fair to Good	Factors influencing variability in the proportion of persons with isolated clinic HTN are not apparent	Limited	High Persons with false-positive BP results by OBPM and without confirmation (isolated clinic hypertension) could be misdiagnosed and unnecessarily treated	Initial screening by office-based methods variably predicts true HTN, defined primarily by ABPM; the proportion of persons with an elevated screen who are normotensive upon confirmatory testing by ABPM (or HBPM) ranges from 5 to 65% across all studies; this population has isolated clinic hypertension
KQ 3c Diagnostic accuracy to confirm diagnosis in subpopulations	k=27	Fair to Good	As above	As above	As above No additional subpopulations identified by the available data. Confirmation near threshold for hypertension most important	The subpopulation of isolated clinic hypertensives was identified in KQ 3b. No associations between reported race/ethnicity, sex, or smoking were qualitatively detected. Increasing baseline BP associated with increasing positive predictive value (i.e., lower likelihood of misdiagnosis).
KQ 4a Shortest rescreening interval	k=39	Fair to Good	Only 1 study reporting rescreening incidence at <1 year and most studies at 5 years; majority of studies conducted in Asia	Moderate	High Rescreening without confirmation may result in overestimation of HTN incidence and misdiagnosis in persons	In a small number of studies that used a separate confirmation step, a significant proportion of incident HTN cases were not confirmed. Thus, estimates of the weighted mean incidence of HTN at yearly intervals <6 years derived from a small number of studies (except at 5 years) with highly variable results are likely to be overestimates, since most studies did not include a confirmation step. For example, the weighted mean incidence at 5 years of 14% actually ranged from 2% to 28%. Variation results from criteria for diagnosis and also from study population characteristics.
KQ 4b Shortest rescreening interval by patient characteristics	k=39	Fair to Good	As above Limited subgroup reporting	Moderate	High Higher incidence of HTN was seen in persons with BP in the high-normal range, the elderly, those with BMI above normal, and African Americans; much lower incidence was seen in those without risk factors	HTN incidence increases as much as 2- to 4-fold moving from the 18 to 40/45 age category to 40/45 to 60/65 years. HTN incidence consistently triples between optimal and normal BP categories within each study and approximately doubles between normal and high-normal categories. Incidence is generally higher in males than females, but is especially higher among males in younger populations. Incidence was 2-fold higher in overweight and 3-fold higher in obese persons compared with those of normal weight, but not increased in smokers compared with nonsmokers or former smokers. There was consistently higher incidence of HTN at rescreening in African American than white participants.

Table 36. Overall Summary of Evidence

Key Question	Studies (k)	Overall Quality	Limitations	Consistency	Primary Care Applicability	Summary of Findings
KQ 5 Adverse effects	k=9	Fair to Good	Different study designs, different outcomes assessed, difficult to compare results across studies	NA Studies addressed different outcomes	Moderate Sleep disturbance and physical discomfort are associated with ABPM use	3 trials found no significant differences in psychological distress or quality of life after persons were labeled as hypertensive or prehypertensive. 1 trial reported significantly decreased mood, general physical state, sexual functioning, and sleep quality after labeling. 1 cohort study reported significantly increased absenteeism up to 4 years after labeling compared with the year before. 3 cohort studies reported significant sleep disturbances associated with ABPM use and 2 studies reported that significant proportions of ABPM users experienced pain, skin irritation, and overall discomfort.

Abbreviations: ABPM = ambulatory blood pressure monitoring; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; CVD = cardiovascular disease; KQ = Key Question; HBPM = home blood pressure monitoring; HTN = hypertension; NA = not applicable; NPV = negative predictive value; OBPM = office-based blood pressure measurement; PPV = positive predictive value.

Systematic Reviews Literature Search Strategy

Cochrane Database of Systematic Reviews

#1 (hypertensi*:ti,ab,kw or "blood pressure":ti,ab,kw) near/5 (screen*:ti,ab,kw or monitor*:ti,ab,kw or determin*:ti,ab,kw or diagnos*:ti,ab,kw or measur*:ti,ab,kw) from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#2 [mh ^hypertension/DI] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#3 [mh ^Sphygmomanometers] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#4 [mh ^"Blood Pressure Monitors"] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#5 [mh ^"Blood Pressure Monitoring, Ambulatory"] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#6 [mh ^"Blood Pressure Determination"] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#7 [mh ^"White Coat Hypertension"] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#8 [mh ^"Masked Hypertension"] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#9 [mh ^Prehypertension/DI] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#10 or #1-#9 from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#11 [mh ^hypertension] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#12 [mh ^"blood pressure"] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#13 [mh ^"arterial pressure"] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#14 or #11-#13 from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#15 [mh ^"mass screening"] from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#16 #14 and #15 from 2005 to 2013, in Cochrane Reviews (Reviews and Protocols)
#17 #10 or #16

DARE

1 (hypertensi* NEAR5 determin*) OR (determin* NEAR5 hypertensi*) OR (hypertensi* NEAR5 diagnos*) OR (diagnos* NEAR5 hypertensi*) IN DARE FROM 2005 TO 2013
2 (hypertensi* NEAR5 screen*) OR (screen* NEAR5 hypertensi*) OR (hypertensi* NEAR5 monitor*) OR (monitor* NEAR5 hypertensi*) IN DARE FROM 2005 TO 2013
3 (hypertensi* NEAR5 measur*) OR (measur* NEAR5 hypertensi*) OR (blood pressure NEAR5 screen*) OR (screen* NEAR5 blood pressure) IN DARE FROM 2005 TO 2013
4 (blood pressure NEAR5 monitor*) OR (monitor* NEAR5 blood pressure) OR (blood pressure NEAR5 determin*) OR (determin* NEAR5 blood pressure) IN DARE FROM 2005 TO 2013

5 (blood pressure NEAR5 diagnos*) OR (diagnos* NEAR5 blood pressure) OR (blood pressure NEAR5 measur*) OR (measur* NEAR5 blood pressure) IN DARE FROM 2005 TO 2013
6 #1 OR #2 OR #3 OR #4 OR #5
7 (Sphygmomanometer*) IN DARE FROM 2005 TO 2013
8 #6 OR #7

HTA

1 (hypertensi* NEAR5 determin*) OR (determin* NEAR5 hypertensi*) OR (hypertensi* NEAR5 diagnos*) OR (diagnos* NEAR5 hypertensi*) IN HTA FROM 2005 TO 2013
2 (hypertensi* NEAR5 screen*) OR (screen* NEAR5 hypertensi*) OR (hypertensi* NEAR5 monitor*) OR (monitor* NEAR5 hypertensi*) IN HTA FROM 2005 TO 2013
3 (hypertensi* NEAR5 measur*) OR (measur* NEAR5 hypertensi*) OR (blood pressure NEAR5 screen*) OR (screen* NEAR5 blood pressure) IN HTA FROM 2005 TO 2013
4 (blood pressure NEAR5 monitor*) OR (monitor* NEAR5 blood pressure) OR (blood pressure NEAR5 determin*) OR (determin* NEAR5 blood pressure) IN HTA FROM 2005 TO 2013
5 (blood pressure NEAR5 diagnos*) OR (diagnos* NEAR5 blood pressure) OR (blood pressure NEAR5 measur*) OR (measur* NEAR5 blood pressure) IN HTA FROM 2005 TO 2013
6 (Sphygmomanometer*) IN HTA FROM 2005 TO 2013
7 #1 OR #2 OR #3 OR #4 OR #5 OR #6

MEDLINE

1 *Sphygmomanometers/
2 *Blood Pressure Monitors/
3 *Blood Pressure Monitoring, Ambulatory/
4 *Blood Pressure Determination/
5 *Hypertension/di [Diagnosis]
6 *White Coat Hypertension/
7 *Masked Hypertension/
8 *Prehypertension/di [Diagnosis]
9 *Blood Pressure/
10 *Arterial Pressure/ or *hypertension/ or *Prehypertension/
11 9 or 10
12 Mass Screening/
13 (screen$ or monitor$ or determin$ or diagnos$ or measur$).ti.
14 12 or 13
15 11 and 14
16 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 15
17 limit 16 to systematic reviews
18 limit 17 to "all adult (19 plus years)"
19 limit 17 to "all child (0 to 18 years)"
20 19 not 18
21 17 not 20
22 limit 21 to english language
23 limit 22 to yr="2005 -Current"

24 ((hypertensi$ or blood pressure) adj5 (screen$ or monitor$ or determin$ or diagnos$ or measur$)).ti,ab.
25 limit 24 to systematic reviews
26 limit 25 to ("in data review" or in process or "pubmed not medline")
27 limit 26 to english language
28 limit 27 to yr="2005 -Current"
29 23 or 28

PubMed

#1 (hypertensi*[ti] OR blood pressure[ti]) AND (screen*[tiab] OR monitor*[tiab] OR determin*[tiab] OR diagnos*[tiab] OR measur*[tiab])
#2 #1 AND systematic[sb]
#3 #2 AND publisher[sb] Filters: Publication date from 2005/01/01; English

Key Questions 1 and 5 Search Strategies

PubMed

#6 Search #5 AND publisher[sb] Filters: Publication date from 2003/01/01; English
#5 Search #3 and #4
#4 Search random*[tiab] OR trial*[tiab]
#3 Search #1 AND #2
#2 Search screen[tiab] OR screens[tiab] OR screening[tiab] OR screened[tiab] OR diagnos*[tiab] OR measur*[tiab] OR monitor*[tiab] OR determin*[tiab]
#1 Search hypertension[ti] OR hypertensive[ti] OR prehypertension[ti] OR prehypertensive[ti] OR "Arterial Pressure"[ti] OR "blood pressure"[ti]

MEDLINE

1 Hypertension/ ()
2 Masked Hypertension/ ()
3 White Coat Hypertension/ ()
4 Prehypertension/ ()
5 Blood Pressure/ ()
6 Arterial Pressure/ ()
7 hypertensi$.ti. ()
8 prehypertensi$.ti. ()
9 Arterial Pressure.ti. ()
10 (systolic pressure or diastolic pressure).ti,ab. ()
11 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 ()
12 Mass Screening/ ()
13 screen$.ti,ab. ()
14 12 or 13 ()
15 clinical trials as topic/ or controlled clinical trials as topic/ or randomized controlled trials as topic/ ()
16 (clinical trial or controlled clinical trial or meta analysis or randomized controlled trial).pt. ()

17 random$.ti,ab. ()
18 Meta-Analysis as Topic/ ()
19 control groups/ or double-blind method/ or single-blind method/ ()
20 clinical trial$.ti,ab. ()
21 controlled trial$.ti,ab. ()
22 15 or 16 or 17 or 18 or 19 or 20 or 21 ()
23 11 and 14 and 22 ()
24 limit 23 to english language ()
25 limit 24 to yr="2003-Current" ()
26 limit 25 to "all adult (19 plus years)" ()
27 limit 25 to "all child (0 to 18 years)" ()
28 27 not 26 ()
29 25 not 28 ()
30 hypertensi$.ti,ab. ()
31 prehypertensi$.ti,ab. ()
32 Arterial Pressure.ti,ab. ()
33 blood pressure.ti,ab. ()
34 (systolic pressure or diastolic pressure).ti,ab. ()
35 30 or 31 or 32 or 33 or 34 ()
36 screen$.ti,ab. ()
37 random$.ti,ab. ()
38 clinical trial$.ti,ab. ()
39 controlled trial$.ti,ab. ()
40 37 or 38 or 39 ()
41 35 and 36 and 40 ()
42 limit 41 to ("in data review" or in process or "pubmed not medline") ()
43 limit 42 to english language ()
44 limit 43 to yr="2003 -Current" ()
45 29 or 44 ()
46 remove duplicates from 45 ()

1 Hypertension/di ()
2 Prehypertension/di ()
3 1 or 2 ()
4 Hypertension/ ()
5 Masked hypertension/ ()
6 White coat hypertension/ ()
7 Prehypertension/ ()
8 Blood Pressure/ ()
9 Arterial Pressure/ ()
10 hypertensi$.ti. ()
11 prehypertensi$.ti. ()
12 arterial pressure.ti. ()
13 blood pressure.ti. ()
14 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 ()
15 Mass screening/ ()
16 screen$.ti,ab. ()
17 diagnos$.ti. ()

18 Awareness/ ()
19 15 or 16 or 17 or 18 ()
20 14 and 19 ()
21 (aware$ adj5 (hypertensi$ or prehypertensi$ or "blood pressure" or "arterial pressure")).ti,ab. ()
22 known hypertension.ti,ab. ()
23 3 or 20 or 21 or 22 ()
24 ae.fs. ()
25 Quality of life/ ()
26 Absenteeism/ ()
27 Sick leave/ ()
28 Sick role/ ()
29 Illness behavior/ ()
30 Anxiety/ ()
31 Depression/ ()
32 quality of life.ti,ab. ()
33 self rated health.ti,ab. ()
34 (psychological adj (distress or effect$ or impact)).ti,ab. ()
35 anxiety.ti,ab. ()
36 (depression or depressed or depressive).ti,ab. ()
37 absenteeism.ti,ab. ()
38 ((disability or sick) adj3 day$).ti,ab. ()
39 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 ()
40 23 and 39 ()
41 (label$ adj5 (hypertensi$ or prehypertensi$ or "blood pressure" or "arterial pressure")).ti,ab. ()
42 40 or 41 ()
43 limit 42 to (english language and yr="2003 -Current") ()
44 remove duplicates from 43 ()

CENTRAL

#1 hypertens*:ti,ab,kw from 2003 to 2014, in Trials
#2 prehypertens*:ti,ab,kw from 2003 to 2014, in Trials
#3 "masked hypertension":ti,ab,kw from 2003 to 2014, in Trials
#4 "white coat hypertension":ti,ab,kw from 2003 to 2014, in Trials
#5 "blood pressure":ti,ab,kw from 2003 to 2014, in Trials
#6 "arterial pressure":ti,ab,kw from 2003 to 2014, in Trials
#7 "systolic pressure":ti,ab,kw from 2003 to 2014, in Trials
#8 "diastolic pressure":ti,ab,kw from 2003 to 2014, in Trials
#9 #1 or #2 or #3 or #4 or #5 or #6 or #7 or #8
#10 screen*:ti,ab,kw from 2003 to 2014, in Trials
#11 #9 and #10 from 2003 to 2014, in Trials

CINAHL

S8 S5 AND S6 Limiters - Published Date from: 20030101-20131231; Language: English
S7 S5 AND S6

S6 (MH "Meta Analysis") OR (MH "Control Group") OR (MH "Single-Blind Studies") OR (MH "Double-Blind Studies") OR (MH "Triple-Blind Studies") OR (MH "Randomized Controlled Trials") OR (MH "Clinical Trials") OR (MH "Random Assignment") OR (AB clinical n1 trial*) OR (AB controlled n1 trial*) OR (TI clinical n1 trial*) OR (TI controlled n1 trial*) OR (PT Clinical trial) OR (PT randomized controlled trial)
S5 S3 OR S4
S4 (TI hypertensi* N3 determin*) OR (AB hypertensi* N3 determin*) OR (TI hypertensi* N3 diagnos*) OR (AB hypertensi* N3 diagnos*) OR (TI hypertensi* N3 measur*) OR (AB hypertensi* N3 measur*) OR (TI hypertension N3 monitor*) OR (AB hypertension N3 monitor*) OR (TI blood pressure N3 measur*) OR (AB blood pressure N3 measur*) OR (TI blood pressure N3 monitor*) OR (AB blood pressure N3 monitor*) OR (TI blood pressure N3 determin*) OR (AB blood pressure N3 determin*) OR (TI blood pressure N3 diagnos*) OR (AB blood pressure N3 diagnos*)
S3 S1 AND S2
S2 TI "screen*" OR AB "screen*"
S1 MH "Hypertension" OR MH "Hypertension, White Coat" OR MH "Masked Hypertension" OR MH "Prehypertension" OR MH "Blood Pressure" OR MH "Arterial Pressure" OR MH "Systolic Pressure" OR MH "Diastolic Pressure" OR TI ("blood pressure" OR hypertens* OR prehypertens* OR "arterial pressure" OR "systolic pressure" OR "diastolic pressure") OR AB ("blood pressure" OR hypertens* OR prehypertens* OR "arterial pressure" OR "systolic pressure" OR "diastolic pressure")

S29 S28 Limiters - Published Date from: 20030101-20131231; Language: English
S28 S26 OR S27
S27 TI ((labelled or labeled or labeling or labelling) N5 (hypertens* or prehypertensi* or "blood pressure" or "arterial pressure")) OR AB ((labelled or labeled or labeling or labelling) N5 (hypertens* or prehypertensi* or "blood pressure" or "arterial pressure"))
S26 S8 AND S25 512
S25 S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24
S24 TI ((disability or sick) N3 day*) OR AB ((disability or sick) N3 day*)
S23 TI absenteeism OR AB absenteeism
S22 TI anxiety OR AB anxiety
S21 TI (depression or depressed or depressive) OR AB (depression or depressed or depressive)
S20 TI (psychological N1 (distress or effect* OR impact)) OR AB (psychological N1 (distress or effect* OR impact))
S19 TI "self rated health" OR AB "self rated health"
S18 TI "quality of life" OR AB "quality of life"
S17 MW adverse effects
S16 (MH "Depression")
S15 (MH "Anxiety")
S14 (MH "Attitude to Illness")
S13 (MH "Sick Role")
S12 (MH "Sick Leave")
S11 (MH "Absenteeism")
S10 (MH "Quality of Life")

S9 (MH "Adverse Health Care Event")
S8 S5 OR S6 OR S7
S7 TI "known hypertension" OR AB "known hypertension"
S6 TI (aware* N5 (hypertensi* or prehypertens* OR "blood pressure" or "arterial pressure")) OR AB (aware* N5 (hypertensi* OR prehypertensi* OR "blood pressure" or "arterial pressure"))
S5 S3 OR S4
S4 MH Hypertension/DI
S3 S1 AND S2
S2 TI "screen*" OR AB "screen*" OR TI diagnos*
S1 MH "Hypertension" OR MH "Hypertension, White Coat" OR MH "Masked Hypertension" OR MH "Prehypertension" OR MH "Blood Pressure" OR MH "Arterial Pressure" OR MH "Systolic Pressure" OR MH "Diastolic Pressure" OR TI ("blood pressure" OR hypertens* OR prehypertens* OR "arterial pressure" OR "systolic pressure" OR "diastolic pressure") OR AB ("blood pressure" OR hypertens* OR prehypertens* OR "arterial pressure" OR "systolic pressure" OR "diastolic pressure")

Key Questions 2 and 3 Search Strategies

PubMed

#5 #4 AND publisher[sb] Filters: Publication date from 1992/01/01; English
#4 #3 NOT ((child*[ti] OR adolescen*[ti]))
#3 #1 AND #2
#2 (screen[tiab] OR screens[tiab] OR screening[tiab] OR screened[tiab] OR diagnos*[tiab] OR measur*[tiab] OR monitor*[tiab] OR determin*[tiab])
#1 (hypertensi*[ti] OR blood pressure[ti])

MEDLINE

1 Hypertension/di ()
2 Blood pressure determination/ ()
3 Blood pressure monitoring, Ambulatory/ ()
4 Blood pressure monitors/ ()
5 Sphygmomanometers/ ()
6 1 or 2 or 3 or 4 or 5 ()
7 (("blood pressure$" or BP) adj1 (monitor$ or measure$)).ti,ab. ()
8 ((office or clinic) adj3 ("blood pressure$" or BP)).ti,ab. ()
9 ((self$ or home or ambulatory) adj3 ("blood pressure$" or BP)).ti,ab. ()
10 ((manual$ or automated) adj3 ("blood pressure$" or BP)).ti,ab. ()
11 AOBP.ti,ab. ()
12 MOBP.ti,ab. ()
13 ABPM.ti,ab. ()
14 sphygmomanometer$.ti,ab. ()
15 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 ()
16 limit 15 to ("in data review" or in process or "pubmed not medline") ()
17 (hypertens$ and screen$ and instrument$).ti,ab. ()

18 6 or 16 or 17 ()
19 "Sensitivity and Specificity"/ ()
20 "Predictive Value of Tests"/ ()
21 ROC Curve/ ()
22 False Negative Reactions/ ()
23 False Positive Reactions/ ()
24 Diagnostic Errors/ ()
25 "Reproducibility of Results"/ ()
26 Reference Values/ ()
27 Reference Standards/ ()
28 Observer Variation/ ()
29 Prevalence/ ()
30 Receiver operat$.ti,ab. ()
31 ROC curve$.ti,ab. ()
32 sensitivit$.ti,ab. ()
33 specificit$.ti,ab. ()
34 predictive value.ti,ab. ()
35 accuracy.ti,ab. ()
36 false positive$.ti,ab. ()
37 false negative$.ti,ab. ()
38 miss rate$.ti,ab. ()
39 error rate$.ti,ab. ()
40 prevalence.ti,ab. ()
41 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 ()
42 18 and 41 ()
43 Blood Pressure Determination/mt, st ()
44 ((BP or "blood pressure$" or hypertens$) adj3 confirm$).ti,ab. ()
45 (clinic or office).ti. ()
46 (home or self$ or ambulatory).ti. ()
47 ("blood pressure$" or hypertens$).ti. ()
48 45 and 46 and 47 ()
49 42 or 43 or 44 or 48 ()
50 ((cardiovascular or CV) adj3 (risk or predict$ or stratif$ or event$ or morbidit$ or prognos$ or outcome$)).ti,ab. ()
51 18 and 50 ()
52 49 or 51 ()
53 limit 52 to "all adult (19 plus years)" ()
54 limit 52 to "all child (0 to 18 years)" ()
55 54 not 53 ()
56 52 not 55 ()
57 (child$ or adolescen$).ti. ()
58 56 not 57 ()
59 limit 58 to humans ()
60 limit 58 to animals ()
61 60 not 59 ()

62 58 not 61 ()
63 limit 62 to (case reports or comment or editorial or letter or news) ()
64 62 not 63 ()
65 limit 64 to english language ()
66 limit 65 to yr="1992 -Current" ()

CENTRAL

#1 (prehypertens*:ti or hypertensi*:ti or "blood pressure":ti or sphygmomanometer*:ti) from 1992 to 2014, in Trials
#2 (hypertensi*:ti,ab,kw or "blood pressure":ti,ab,kw) near/5 (screen*:ti,ab,kw or monitor*:ti,ab,kw or determin*:ti,ab,kw or diagnos*:ti,ab,kw or measur*:ti,ab,kw or confirm*:ti,ab,kw) from 1992 to 2014, in Trials
#3 #1 and #2 from 1992 to 2014, in Trials
#4 (sensitivity:ti,ab,kw or specificity:ti,ab,kw or accuracy:ti,ab,kw or "predictive value":ti,ab,kw) from 1992 to 2014, in Trials
#5 #1 and #4 from 1992 to 2014, in Trials
#6 (cardiovascular:ti,ab,kw or CV:ti,ab,kw) near/5 (risk:ti,ab,kw or predict*:ti,ab,kw or stratif*:ti,ab,kw or event*:ti,ab,kw or morbidit*:ti,ab,kw or prognos*:ti,ab,kw or outcome*:ti,ab,kw) from 1992 to 2014, in Trials
#7 #1 and #6 from 1992 to 2014, in Trials
#8 #3 or #5 or #7 from 1992 to 2014, in Trials
#9 (child*:ti or adolescen*:ti) from 1992 to 2014, in Trials
#10 #8 not #9 from 1992 to 2014, in Trials

Key Question 4 Search Strategies

PubMed

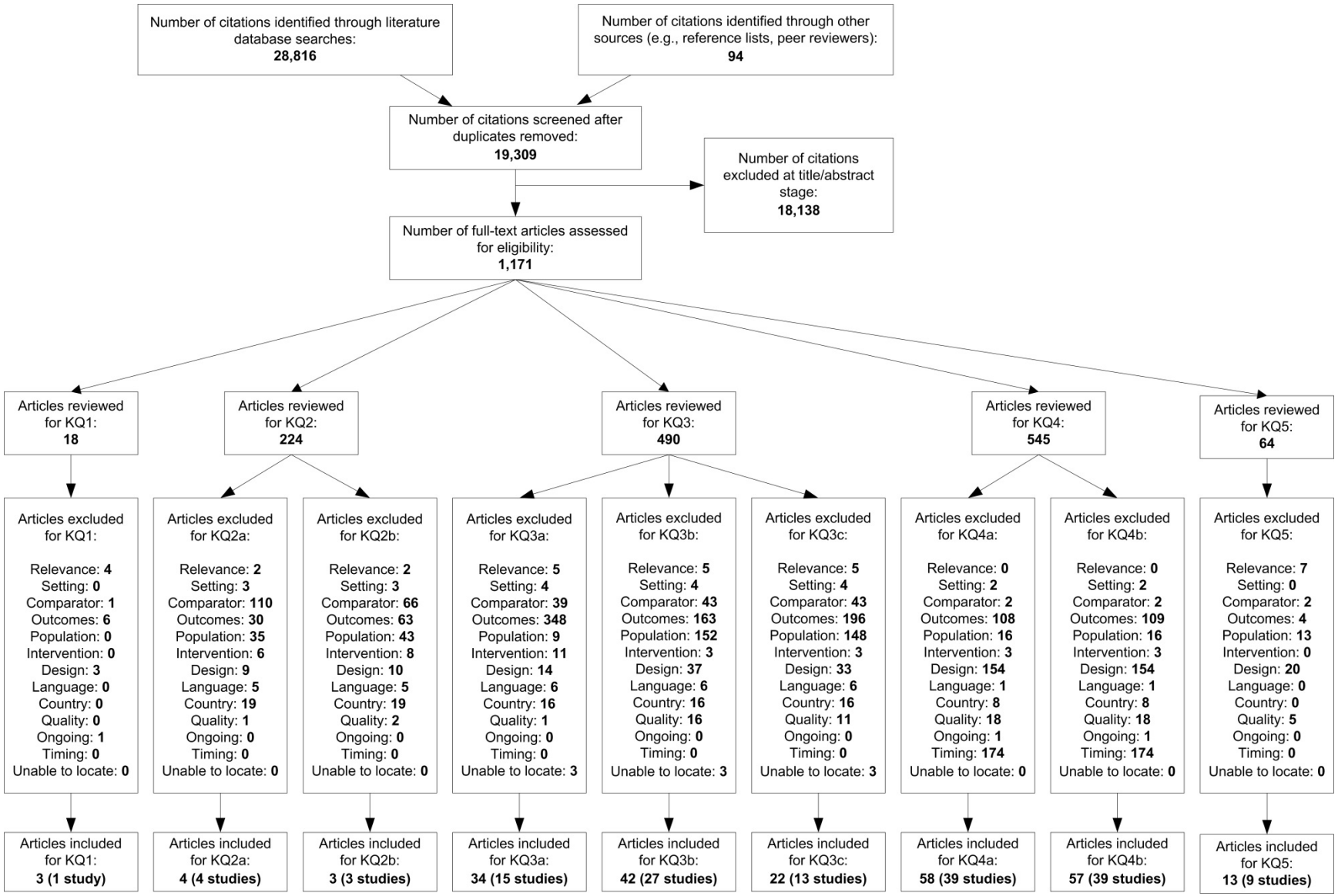
#8 #7 AND publisher[sb] Filters: Publication date from 1966/01/01; English
#7 #6 NOT ((child*[ti] OR adolescen*[ti]))
#6 #4 AND #5
#5 cohort*[tiab] OR longitudinal[tiab] OR follow up[tiab] OR followup[tiab] OR retrospective[tiab] OR prospective[tiab]
#4 #1 AND (#2 OR #3)
#3 incident hypertension[tiab]
#2 change*[tiab] OR progress*[tiab] OR develop[tiab] OR develops[tiab] OR developed[tiab] OR development[tiab] OR predict*[tiab] OR re-screen*[tiab] OR re-measure*[tiab] OR rescreen*[tiab] OR re measure*[tiab]
#1 blood pressure[ti] OR BP[ti] OR arterial pressure[ti] OR hypertensi*[ti]

MEDLINE

1 *Hypertension/ ()
2 *Blood pressure/ ()
3 *Arterial pressure/ ()
4 *Blood pressure determination/ ()

5 *Blood pressure monitoring, Ambulatory/ ()
6 *Prehypertension/ ()
7 1 or 2 or 3 or 4 or 5 or 6 ()
8 (inciden$ adj3 hypertens$).ti,ab. ()
9 ((progress$ or develop$ or predict$) adj5 (hypertens$ or prehypertens$ or pre hypertens$)).ti,ab. ()
10 (change$ adj5 (blood pressure or BP or arterial pressure)).ti,ab. ()
11 (rescreen$ or re-screen$ or remeasure$ or re-measure$).ti,ab. ()
12 (previous$ adj1 (screen$ or measur$ or monitor$)).ti,ab. ()
13 8 or 9 or 10 or 11 or 12 ()
14 epidemiologic studies/ or cohort studies/ or longitudinal studies/ or follow-up studies/ or prospective studies/ or retrospective studies/ ()
15 7 and 13 and 14 ()
16 limit 15 to (english language and yr="1966 -Current") ()
17 (blood pressure or BP or hypertens$ or arterial pressure).ti. ()
18 (11 or 12) and 17 ()
19 8 or 9 or 10 or 18 ()
20 cohort.ti,ab. ()
21 longitudinal.ti,ab. ()
22 incidence stud$.ti,ab. ()
23 retrospective.ti,ab. ()
24 (follow-up or followup).ti,ab. ()
25 prospective.ti,ab. ()
26 20 or 21 or 22 or 23 or 24 or 25 ()
27 19 and 26 ()
28 limit 27 to ("in data review" or in process or "pubmed not medline") ()
29 limit 28 to (english language and yr="1966 -Current") ()
30 16 or 29 ()
31 limit 30 to "all adult (19 plus years)" ()
32 limit 30 to "all child (0 to 18 years)" ()
33 32 not 31 ()
34 30 not 33 ()
35 (child$ or adolesc$).ti. ()
36 34 not 35 ()
37 remove duplicates from 36 ()

Appendix A Figure 1. Literature Flow Diagram



Appendix A Table 1. Inclusion and Exclusion Criteria

Category	Inclusion	Exclusion
Aim	**KQs 1, 2, 4, 5:** Screening for high blood pressure in a primary care setting (alone or as part of a clinical examination) **KQ 3:** Measuring blood pressure to confirm diagnosis of hypertension	Measurement of short-term diet-, exercise-, or drug-induced blood pressure changes; measurement of blood pressure as part of a disease management program for heart failure or weight loss; mathematical transformation of BP results (e.g., pulse pressure, variability, morning surge, dipping) for use as additional diagnostic criteria and/or predicting risk
Population	**KQs 1, 2, 5:** Adults age 18 years or older **KQ 3:** Adults age 18 years or older with at least one elevated blood pressure measurement (as defined by study) identified by clinic-based screening **KQ 4:** Adults age 18 years or older whose previous clinic-based blood pressure screening was normal or not in the treatable range, or for whom an initial diagnosis of hypertension was not confirmed	Pregnant women, children (age <18 years), inpatients, institutionalized persons, patients with underlying causes of high blood pressure, and highly selected groups of patients (e.g., patients with diabetes, chronic kidney disease, or renal transplant) who do not represent a primary screening population **KQs 1, 2, 3b, 3c, 4, 5:** • Patients treated for hypertension with medication (if study is among hypertensives, assume all treated if no details about current treatment are available) • Studies that include more than 20% of the above excluded populations and in which the data are not stratified **KQ 4**: Patients with treatable high blood pressure within the current treatment guidelines
Intervention	**KQs 1, 2, 4, 5:** Clinic-based, noninvasive blood pressure measurement using any commonly used device or screening protocol during a single encounter; blood pressure measurements conducted as part of a multicomponent cardiovascular risk assessment in which blood pressure elevation is the initial and sole factor that determines whether a patient proceeds to additional assessment **KQ 3:** Any clinic-based blood pressure measurement confirmed by another clinic-based, home, or ambulatory blood pressure measurement (with any device or measurement protocol). For all ambulatory devices, average 24- or 48-hour, daytime, and nighttime blood pressure measurements are acceptable	Wrist and finger monitors, forearm cuffing, ankle and toe measures; any method not commonly used in routine BP screening (e.g., invasive methods, non-invasive method of central blood pressure measurement); Osler's maneuver
Comparator	**KQs 1, 5:** No blood pressure screening **KQ 2:** A noninvasive blood pressure measurement method that differs either by device or protocol (e.g., manual vs. automated; clinic-based using one protocol vs. clinic-based using a different protocol) **KQ 3:** Any clinic-based blood pressure measurement confirmed by another clinic-based, home, or ambulatory blood pressure measurement (with any device or protocol) **KQ 4:** Time interval for rescreening using the same method	**KQs 2, 3:** Within-class comparative effectiveness of devices (e.g., automated vs. automated; random zero vs. standard sphygmomanometer) with identical screening protocols; validation and accuracy studies of devices compared to standards or using specific protocols (e.g., British Hypertension Society protocol, Association for the Advancement of Medical Instrumentation)

Appendix A Table 1. Inclusion and Exclusion Criteria

Category	Inclusion	Exclusion
Outcomes	**KQ 1:** • Mortality (all-cause and cardiovascular-related) • Cardiovascular disease, as defined by fatal and nonfatal cardiovascular events, including: myocardial infarction, sudden cardiac death, stroke, heart failure, atrial fibrillation, transient ischemic attack; composite measures are eligible if they do not contain excluded outcomes • End-stage kidney disease (i.e., doubling of serum creatinine, halving of glomerular filtration rate, or transition to dialysis/transplant) **KQs 2, 3b, 3c:** Sensitivity, specificity, positive and negative predictive value (or comparable statistics or data that allow calculation of such), concordance for hypertension diagnosis (e.g., Kappa statistics for categories of diagnosis) **KQ 3a:** Measures of association of blood pressure and fatal or nonfatal cardiovascular events (as listed above), such as risk ratio or hazard ratio **KQ 4:** Change in blood pressure classification (i.e., normal to diagnosis of hypertension) when rescreened at different time intervals (e.g., 1 year, 5 years) as identified through BP measurements or physician diagnosis (e.g., medical chart review) **KQ 5:** • Psychological effects of labeling • Absenteeism • Quality of life	**KQs 1, 3:** Cardiovascular symptoms (e.g., palpitations), angina pectoris (chest pain), revascularization, carotid intima-media thickness, left ventricular hypertrophy, patient satisfaction, quality of life **KQs 2, 3b:** Studies that do not provide enough data to create 2×2 tables or calculate sensitivity and specificity; studies that are designed to assess devices versus blood pressure measurement standards. Mean differences in blood pressure or other correlations based on numeric BP values will not be included at full-text stage (e.g., r, r^2, p-value for comparison of or difference of means). Lack of directionality with a reported change in diagnosis **KQ 3a:** Studies that do not define composite cardiovascular disease outcomes; composite cardiovascular outcomes that contain excluded outcomes (as listed above, excepting patient satisfaction, quality of life) **KQ 4:** Studies that report only average change in blood pressure for the entire population; studies that report incident antihypertensive drug use only or studies that utilize self-reported measures (BP, medication use or physician diagnosis) but do not report change in classification from measured BP or change in physician diagnosis
Timing of outcome assessment	No restrictions for KQs 1, 2, 3, and 5. **KQ4**: Less than 6 years	No restrictions for KQs 1, 2, 3, and 5. **KQ4**: Greater than or equal to 6 years
Setting	**KQs 1, 2, 4, 5:** Eligible primary care settings must have personnel trained in blood pressure measurement, established blood pressure measurement protocols, and ongoing documentation procedures for each (e.g., internal medicine, family practice, obstetrics/gynecology, school- and military-based health clinics, pharmacies, retail and mobile clinics, dental offices) **KQ 3:** Primary care settings (see above for definition), home	Health care or nonhealth care settings (e.g., worksites, school) that do not have personnel trained in blood pressure measurement, do not have established blood pressure measurement protocols, or do not have ongoing documentation procedures for each; inpatient/residential facilities, correctional facilities
Study design	**KQ 1:** Randomized, controlled trials (RCTs) or controlled clinical trials (CCTs) **KQ 2:** Diagnostic accuracy studies, RCTs, CCTs, cohort studies **KQ 3:** Diagnostic accuracy studies, RCTs, CCTs, cohort studies, case-control studies **KQ 4:** Longitudinal cohort studies **KQ 5:** RCTs, CCTs, cohort studies	**All KQs:** Before-after studies, time series, case series, case reports; studies enrolling treated hypertension patients with less than a 2-week washout period; comparison of diagnostic accuracy of devices in different populations within the same study, case-control studies; simulation studies **KQ3b, 3c**: Study size of untreated hypertensives < 100 **KQ 4**: Use of the untreated placebo group from treatment trials as a cohort; use of individuals from other intervention trials as a cohort study (e.g., SU.VI.MAX); study size < 1,000 individuals **KQ 5**: Cross-sectional studies

Appendix A Table 1. Inclusion and Exclusion Criteria

Category	Inclusion	Exclusion
Country	Studies in countries rated as "very high" on the 2013 Human Development Index: Andorra, Argentina, Australia, Austria, Barbados, Belgium, Brunei Darussalam, Canada, Chile, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, New Zealand, Norway, Poland, Portugal, Qatar, Seychelles, Singapore, Slovakia, Slovenia, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States	Studies in countries rated below "very high" on the 2013 Human Development Index
Literature search dates	**KQs 1, 5:** January 2002 to present (which includes carrying forward any previously included studies in the previous USPSTF systematic review) **KQs 2, 3:** January 1992 to present. The rationale is based on that of Verberk and colleagues;[81] 1992 was chosen because the first protocol with guidelines for validation of blood pressure monitoring devices was published in 1990, and a lag time of 2 years was added to allow the guidelines to be fully implemented. **KQ 4:** January 1965 to present. The rationale is that this is a new KQ that has never been addressed in a USPSTF systematic review	
Language	English	Other languages than English
Study quality	Fair or good	Poor, according to design-specific USPSTF criteria

Abbreviations: BP = blood pressure; CCT = controlled clinical trial; KQ = Key Question; RCT = randomized controlled trial; USPSTF = U.S. Preventive Services Task Force.

Appendix A Table 2. Quality Assessment Criteria

Study Design	Adapted Quality Criteria
Randomized controlled trials, adapted from the USPSTF methods[97]	• Valid random assignment? • Was allocation concealed? • Was eligibility criteria specified? • Were groups similar at baseline? • Were measurements equal, valid and reliable? • Was there intervention fidelity? • Was there adequate adherence to the intervention? • Were outcome assessors blinded? • Was there acceptable followup? • Were the statistical methods acceptable? • Was the handling of missing data appropriate? • Was there evidence of selective reporting of outcomes? • Was the device calibration and/or maintenance reported?
Observational studies (e.g., prospective cohort studies), adapted from the Newcastle-Ottawa Scale (NOS)[100]	• Was the cohort systematically selected to avoid bias? • Was eligibility criteria specified? • Were groups similar at baseline? • Was the outcome of interest not present at baseline? • Were measurements equal, valid and reliable? • Were outcome assessors blinded? • Was there acceptable followup? • Were the statistical methods acceptable? • Was the handling of missing data appropriate?

Diagnostic accuracy studies, adapted from the Quality Assessment of Diagnostic Accuracy Studies (QUADAS) II instrument[98]	• Risk of Bias: Could the selection of patients have introduced bias?
	  o Signaling Question 1: Was a consecutive or random sample of patients enrolled
	  o Signaling Question 2: Was a case-control design avoided?
	  o Signaling Question 3: Did the study avoid inappropriate exclusions?
	• Risk of Bias: Could the conduct or interpretation of the index test have introduced bias?
	  o Signaling Question 1: Were the tests evaluated independently and were assessors blinded to results?
	  o Signaling Question 2: If a threshold was use, was it prespecified?
	• Risk of Bias: Could the patient flow have introduced bias?
	  o Signaling Question 1: Was there an appropriate interval between the tests and was it applied consistently?
	  o Signaling Question 2: Did all patients receive the same tests?
	  o Signaling Question 3: Were all patients included in the analysis?
	  o Was the handling of missing data appropriate?
	  o Was the order of tests randomized among patients?
	• Other quality considerations:
	  o Was the device calibration and/or maintenance reported?
	  o Were the devices validated?
	  o Was the training of interventionists reported?
	  o Was there intervention fidelity?
	  o Was there adequate adherence to the intervention?

Appendix A Table 2. Quality Assessment Criteria

Study Design	Adapted Quality Criteria
Prognostic studies, adapted from the Quality in Prognosis Studies (QUIPS) tool[99]	• Does the study sample adequately represent the population of interest? o Was there a description of source population or population of interest (i.e., was there a generalizable population)? o Was there adequate participation in the study by eligible persons? o Was there an adequate description of the inclusion and exclusion criteria? o Was there an adequate description of the sampling frame, recruitment period and place? o Was there a description of the baseline study sample? o Were subject with the outcome of interest at baseline excluded or handled in the analysis? • Does the study data available adequately represent the study sample? o Was there acceptable followup? o Were the attempts to collect information on participants who dropped out described and were those lost to followup similar to those who remained? o Were the reasons for loss to followup provided? • Was the prognostic factor measure in a similar way for all participants? o Was the prognostic factor clear defined? o Was the method of prognostic factor measurement valid and reliable (i.e., equal and similar for all participants)? o Was there an adequate proportion of the study sample who had complete data for the prognostic factor? o Were the methods and settings of the measurement of the prognostic factor the same across all participants and across all timepoints? • Was the outcome of interest measured in a similar way for all participants? o Was there a clear definition of the outcome? o Was the method and setting of outcome measurement the same for all participants (i.e., valid and reliable)? • Were important confounding factors appropriately accounted for in the study design and analysis? • Was the statistical analysis appropriate? o Was there evidence of selective reporting of outcomes?

Appendix B. Excluded Studies

Code	Reason for Exclusion
E1	Wrong study aim/relevance
E2	Wrong setting
E3	Wrong comparator
E4	No relevant outcomes
E4a	Composite outcome which includes excluded outcomes
E4b	Self-reported measures or anti-hypertensive use only to measure incidence of hypertension (KQ4)
E4c	Prevalence of hypertension or hypertension diagnoses provided, not enough data to complete 2x2 table (KQ2 and KQ3b/c)
E4d	Relevant outcomes in a non-relevant subgroup
E5	Population
E5a	>20% of excluded populations and data not stratified
E5b	Patients with treatable high blood pressure within the current treatment guidelines (KQ4)
E5c	Patients without an initial elevated blood pressure screen (KQ3)
E6	Wrong intervention
E6a	Unattended blood pressure measurement kiosks
E7	Wrong study design
E7a	Cross-sectional study of screening harms (KQ5 only)
E7b	< 2 week washout period for studies in treated hypertensives
E7c	Use of untreated placebo group or use of individuals from other intervention trials as a cohort study (KQ4) (e.g., TROPHY, TROP, SUVIMAX)
E7e	< 1,000 non-hypertensive patients at baseline (KQ4)
E7f	< 100 untreated individuals w/ a previous elevated BP screen (KQ3b/c)
E8	Non-English
E9	Non-Very High HDI Country
E9a	Conducted in Brazil
E10	Poor study quality
E10a	High or differential attrition (<60% of study population followed; >10% difference btwn groups on % followed up)
E10b	Other quality issue
E11	Ongoing study, no outcomes published
E12	Timing of outcome assessment ≥ 6 years (KQ4)
E13	Unable to locate publication

1. Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure. The Trials of Hypertension Prevention, phase II. The Trials of Hypertension Prevention Collaborative Research Group. Arch Intern Med 1997 Mar 24;157(6):657-67. **KQ4aE7c, KQ4bE7c.**
2. -NCT00841308. Antihypertensive Drug Treatment Decisions Based on Home Blood Pressure Monitoring. ClinicalTrials gov [http://clinicaltrials gov] 2009 PMID: None. **KQ3aE4, KQ3bE5a, KQ3cE5a.**
3. Abdoh AA, Krousel-Wood MA, Re RN. Accuracy of telemedicine in detecting uncontrolled hypertension and its impact on patient management. Telemed J E Health 2003;9(4):315-23. PMID: 14980088. **KQ3aE4, KQ3bE5a, KQ3cE5a.**
4. Addison C, Varney S, Coats A. The use of ambulatory blood pressure monitoring in managing hypertension according to different treatment guidelines. J Hum Hypertens 2001 Aug;15(8):535-8. PMID: 11494091. **KQ3aE4, KQ3bE7f, KQ3cE7f.**
5. Adiyaman A, Verhoeff R, Lenders JW, et al. The position of the arm during blood pressure measurement in sitting position. Blood Press Monit 2006 Dec;11(6):309-13. PMID: 17106314. **KQ2aE3, KQ2bE4.**
6. Aeschbacher BC, Hutter D, Fuhrer J, et al. Diastolic dysfunction precedes myocardial hypertrophy in the development of hypertension. Am J Hypertens 2001 Feb;14(2):106-13. PMID: 11243300. **KQ4aE7e, KQ4bE7e.**
7. Agarwal R, Bunaye Z, Bekele DM. Prognostic significance of between-arm blood pressure differences. Hypertension 2008 Mar;51(3):657-62. PMID: 18212263. **KQ2aE3, KQ2bE4, KQ3aE3, KQ3bE3, KQ3cE3.**

8. Aihara A, Imai Y, Sekino M, et al. Discrepancy between screening blood pressure and ambulatory blood pressure: a community-based study in Ohasama. Hypertens Res 1998 Jun;21(2):127-36. PMID: 9661809. **KQ3aE4.**
9. Aiyer AN, Kip KE, Mulukutla SR, et al. Predictors of significant short-term increases in blood pressure in a community-based population. Am J Med 2007 Nov;120(11):960-7. PMID: 17976423. **KQ4aE7e, KQ4bE7e.**
10. Aksoy I, Deinum J, Lenders JW, et al. Does masked hypertension exist in healthy volunteers and apparently well-controlled hypertensive patients? Neth J Med 2006 Mar;64(3):72-7. PMID: 16547360. **KQ2aE3, KQ2bE3, KQ3aE4, KQ3bE5c, KQ3cE5c.**
11. Alderman MH, Charlson ME, Melcher LA. Labelling and absenteeism: the Massachusetts Mutual experience. Clin Invest Med 1981;4(3-4):165-71. PMID: 7337987. **KQ5E5a.**
12. Alderman MH, Melcher LA. Occupationally-sponsored, community-provided hypertension control. J Occup Med 1983 Jun;25(6):465-70. PMID: 6886849. **KQ5E5a.**
13. Alderman MH. Quality of life in hypertensive patients: does it matter and should we measure it? J Hypertens 2005 Sep;23(9):1635-6. PMID: 16093905. **KQ5E7.**
14. Alli C, Avanzini F, Bettelli G, et al. The long-term prognostic significance of repeated blood pressure measurements in the elderly: SPAA (Studio sulla Pressione Arteriosa nell'Anziano) 10-year follow-up. Arch Intern Med 1999 Jun 14;159(11):1205-12. PMID: 10371228. **KQ3aE3, KQ3bE3, KQ3cE3, KQ4aE4, KQ4bE4.**
15. Alli C, Mariotti G, Avanzini F, et al. Long-term prognostic impact of repeated measurements over 1 year of pulse pressure and systolic blood pressure in the elderly. J Hum Hypertens 2005 May;19(5):355-63. PMID: 15772693. **KQ3aE3, KQ3bE3, KQ3cE3.**
16. Almeida AE, Stein R, Gus M, et al. Improved diagnostic accuracy of a 3-day protocol of home blood pressure monitoring for the diagnosis of arterial hypertension. Blood Press Monit 2013 Apr;18(2):119-26. PMID: 23406684. **KQ3aE9a, KQ3bE9a, KQ3cE9a.**
17. Almgren T, Persson B, Wilhelmsen L, et al. Stroke and coronary heart disease in treated hypertension -- a prospective cohort study over three decades. J Intern Med 2005 Jun;257(6):496-502. PMID: 15910553. **KQ4aE4, KQ4bE4.**
18. Almoosawi S, Prynne CJ, Hardy R, et al. Time-of-day of energy intake: association with hypertension and blood pressure 10 years later in the 1946 British Birth Cohort. J Hypertens 2013 May;31(5):882-92. PMID: 23385650. **KQ4aE12, KQ4bE12.**
19. Alonso A, Beunza JJ, Delgado-Rodriguez M, et al. Low-fat dairy consumption and reduced risk of hypertension: the Seguimiento Universidad de Navarra (SUN) cohort. Am J Clin Nutr 2005 Nov;82(5):972-9. PMID: 16280427. **KQ4aE4b, KQ4bE4b.**
20. Altorf-van der Kuil W, Engberink MF, van Rooij FJ, et al. Dietary protein and risk of hypertension in a Dutch older population: the Rotterdam study. J Hypertens 2010 Dec;28(12):2394-400. PMID: 20827221. **KQ4aE12, KQ4bE12.**
21. Altorf-van der Kuil W, Engberink MF, De NM, et al. Dietary amino acids and the risk of hypertension in a Dutch older population: the Rotterdam Study. Am J Clin Nutr 2013 Feb;97(2):403-10. PMID: 23283504. **KQ4aE12, KQ4bE12.**
22. Altunkan S, Genc Y, Altunkan E. A comparative study of an ambulatory blood pressure measuring device and a wrist blood pressure monitor with a position sensor versus a mercury sphygmomanometer. Eur J Intern Med 2007 Mar;18(2):118-23. PMID: 17338963. **KQ3aE4, KQ3bE4, KQ3cE4.**
23. Alves LM, Nogueira MS, Godoy S, et al. Prevalence of white coat hypertension in primary health care. Arq Bras Cardiol 2007 Jul;89(1):28-35. PMID: 17768580. **KQ2aE9a, KQ2bE9a, KQ3aE9a, KQ3bE9a, KQ3cE9a.**
24. Ambrosio GB, Dissegna L, Zamboni S, et al. Psychological effects of hypertension labelling during a community survey. A two-year follow-up. J Hypertens Suppl 1984 Dec;2(3):S171-S173. PMID: 6599664. **KQ5E10b.**

25. Andreadis EA, Agaliotis GD, Angelopoulos ET, et al. Automated office blood pressure and 24-h ambulatory measurements are equally associated with left ventricular mass index. Am J Hypertens 2011 Jun;24(6):661-6. PMID: 21415839. **KQ3aE4, KQ3bE7f, KQ3cE4.**
26. Andreadis EA, Angelopoulos ET, Tsakanikas AP, et al. Automated office versus home measurement of blood pressure in the assessment of morning hypertension. Blood Press Monit 2012 Feb;17(1):24-34. PMID: 22218221. **KQ3aE4, KQ3cE4.**
27. Antonicelli R, Partemi M, Spazzafumo L, et al. Blood pressure self-measurement in the elderly: differences between automatic and semi-automatic systems. J Hum Hypertens 1995 Apr;9(4):229-31. PMID: 7595903. **KQ3aE4, KQ3bE4, KQ3cE4.**
28. Aris IB, Wagie AA, Mariun NB, et al. An internet-based blood pressure monitoring system for patients. J Telemed Telecare 2001;7(1):51-3. PMID: 11265939. **KQ2aE1, KQ2bE1, KQ3aE1, KQ3bE1, KQ3cE1.**
29. Arnett DK, Tang W, Province MA, et al. Interarm differences in seated systolic and diastolic blood pressure: the Hypertension Genetic Epidemiology Network study. J Hypertens 2005 Jun;23(6):1141-7. PMID: 15894889. **KQ2aE4, KQ2bE4, KQ3aE4, KQ3bE4, KQ3cE4.**
30. Asagami T, Kushiro T, Inoue J, et al. Long-term reproducibility and usefulness of daytime recording of noninvasive 24-hour ambulatory blood pressure monitoring in borderline hypertension: a two-year follow-up study. Clin Exp Hypertens 1996 Jul;18(5):637-57. PMID: 8781751. **KQ3aE4, KQ3bE4, KQ3cE4.**
31. Asayama K, Ohkubo T, Kikuya M, et al. Use of 2003 European Society of Hypertension-European Society of Cardiology guidelines for predicting stroke using self-measured blood pressure at home: the Ohasama study. Eur Heart J 2005 Oct;26(19):2026-31. PMID: 15917279. **KQ3bE5a, KQ3cE5a.**
32. Asayama K, Ohkubo T, Kikuya M, et al. Prediction of stroke by home "morning" versus "evening" blood pressure values: the Ohasama study. Hypertension 2006 Oct;48(4):737-43. PMID: 16952977. **KQ3bE4, KQ3cE4.**
33. Asayama K, Ohkubo T, Hara A, et al. Repeated evening home blood pressure measurement improves prognostic significance for stroke: a 12-year follow-up of the Ohasama study. Blood Press Monit 2009 Jun;14(3):93-8. PMID: 19359986. **KQ3bE4, KQ3cE4.**
34. Asayama K, Thijs L, Brguljan-Hitij J, et al. Risk stratification by self-measured home blood pressure across categories of conventional blood pressure: a participant-level meta-analysis. PLoS Medicine / Public Library of Science 2014 Jan;11(1):e1001591. PMID: 24465187. **KQ3aE7, KQ3bE7, KQ3cE7.**
35. Ascherio A, Rimm EB, Giovannucci EL, et al. A prospective study of nutritional factors and hypertension among US men. Circulation 1992 Nov;86(5):1475-84. PMID: 1330360. **KQ4aE4b, KQ4bE4b.**
36. Ascherio A, Hennekens C, Willett WC, et al. Prospective study of nutritional factors, blood pressure, and hypertension among US women. Hypertension 1996 May;27(5):1065-72. PMID: 8621198. **KQ4aE4b, KQ4bE4b.**
37. Asferg C, Mogelvang R, Flyvbjerg A, et al. Interaction between leptin and leisure-time physical activity and development of hypertension. Blood Press 2011 Dec;20(6):362-9. PMID: 22017362. **KQ4aE12, KQ4bE12.**
38. Asmar R, Nisse DS, Assaad M, et al. Quality of blood pressure measurement in the management of hypertension: A pilot study. Arch Mal Coeur Vaiss 2001;94:885-8. PMID: 11575224. **KQ2aE8, KQ2bE8, KQ3aE8, KQ3bE8, KQ3cE8.**
39. Aylett M. Use of home blood pressure measurements to diagnose "white coat hypertension' in general practice. J Hum Hypertens 1996 Jan;10(1):17-20. PMID: 8642185. **KQ3aE4, KQ3bE7f, KQ3cE7f.**
40. Aylett M, Marples G, Jones K, et al. Evaluation of normal and large sphygmomanometer cuffs using the Omron 705CP. J Hum Hypertens 2001 Feb;15(2):131-4. PMID: 11317193. **KQ2aE3, KQ2bE4.**

41. Babic BK, Bagatin J, Kokic S, et al. Comparison between continuous ambulatory arterial blood pressure monitoring and standard blood pressure measurements among patients of younger and older age group. Coll Antropol 2009 Mar;33(1):65-70. PMID: 19408605. **KQ3aE4, KQ3bE7f, KQ3cE7f.**
42. Backer HD, Decker L, Ackerson L. Reproducibility of increased blood pressure during an emergency department or urgent care visit. Ann Emerg Med 2003 Apr;41(4):507-12. PMID: 12658251. **KQ2aE5, KQ2bE5, KQ3aE4, KQ3bE10b, KQ3cE4.**
43. Baguet JP, Joseph X, Ormezzano O, et al. Ambulatory blood pressure variation in healthy subjects, hypertensive elderly and type 1 diabetic patients in relation to the sitting or standing position. Blood Press Monit 2001 Aug;6(4):191-4. PMID: 11805467. **KQ2aE3, KQ2bE4, KQ3aE3, KQ3bE3, KQ3cE3.**
44. Bakx C, Oerlemans G, Hoogen H, et al. The influence of cuff size on blood pressure measurement. J Hum Hypertens 1997;11:439-45. PMID: 9283061. **KQ2aE3, KQ2bE4.**
45. Bakx JC, van den Hoogen HJ, van den Bosch WJ, et al. Development of blood pressure and the incidence of hypertension in men and women over an 18-year period: results of the Nijmegen Cohort Study. J Clin Epidemiol 1999 Jun;52(6):531-8. PMID: 10408992. **KQ4aE12, KQ4bE12.**
46. Banda JA, Clouston K, Sui X, et al. Protective health factors and incident hypertension in men. Am J Hypertens 2010 Jun;23(6):599-605. PMID: 20224555. **KQ4aE12, KQ4bE12.**
47. Banegas JR, Rodriguez-Artalejo F, Ruilope LM, et al. Hypertension magnitude and management in the elderly population of Spain. J Hypertens 2002 Nov;20(11):2157-64. **KQ4aE4b, KQ4bE4b.**
48. Banegas JR, Guallar-Castillon P, Rodriguez-Artalejo F, et al. Association between awareness, treatment, and control of hypertension, and quality of life among older adults in Spain. Am J Hypertens 2006 Jul;19(7):686-93. PMID: 16814122. **KQ5E5a.**
49. Banegas JR, Messerli FH, Waeber B, et al. Discrepancies between office and ambulatory blood pressure: clinical implications. Am J Med 2009 Dec;122(12):1136-41. PMID: 1958892. **KQ3aE4, KQ3bE5a, KQ3cE5a.**
50. Barba G, Galletti F, Cappuccio FP, et al. Incidence of hypertension in individuals with different blood pressure salt-sensitivity: results of a 15-year follow-up study. J Hypertens 2007 Jul;25(7):1465-71. PMID: 17563570. **KQ4aE7e, KQ4bE7e.**
51. Barger SD, Muldoon MF. Hypertension labelling was associated with poorer self-rated health in the Third US National Health and Nutrition Examination Survey. J Hum Hypertens 2006 Feb;20(2):117-23. PMID: 16267563. **KQ5E7a.**
52. Barlow CE, LaMonte MJ, Fitzgerald SJ, et al. Cardiorespiratory fitness is an independent predictor of hypertension incidence among initially normotensive healthy women. Am J Epidemiol 2006 Jan 15;163(2):142-50. PMID: 16293717. **KQ4aE4b, KQ4bE4b.**
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Appendix B. Excluded Studies

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1005. van der Wel MC, Buunk IE, van WC, et al. A novel approach to office blood pressure measurement: 30-minute office blood pressure vs daytime ambulatory blood pressure. Ann Fam Med 2011 Mar;9(2):128-35. PMID: 21403139. **KQ3aE4, KQ3bE5a, KQ3cE5a.**

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1017. Verdecchia P, Schillaci G, Reboldi G, et al. Different prognostic impact of 24-hour mean blood pressure and pulse pressure on stroke and coronary artery disease in essential hypertension. Circulation 2001 May 29;103(21):2579-84. PMID: 11382727. **KQ3bE4, KQ3cE4.**

1018. Verdecchia P, Schillaci G, Reboldi G, et al. Ambulatory monitoring for prediction of cardiac and cerebral events. Blood Press Monit 2001 Aug;6(4):211-5. PMID: 11805472. **KQ3aE10b, KQ3bE4, KQ3cE4.**

1019. Verdecchia P, Reboldi G, Porcellati C, et al. Risk of cardiovascular disease in relation to achieved office and ambulatory blood pressure control in treated hypertensive subjects. J Am Coll Cardiol 2002 Mar 6;39(5):878-85. PMID: 11869856. **KQ3aE4a, KQ3bE4, KQ3cE4.**

1020. Verdecchia P, Reboldi GP, Angeli F, et al. Short- and long-term incidence of stroke in white-coat hypertension. Hypertension 2005 Feb;45(2):203-8. PMID: 15596572. **KQ3aE7, KQ3bE7, KQ3cE7.**

1021. Verdecchia P, Angeli F, Gattobigio R, et al. Regression of left ventricular hypertrophy and prevention of stroke in hypertensive subjects. Am J Hypertens 2006 May;19(5):493-9. PMID: 16647622. **KQ3aE3, KQ3bE4d, KQ3cE4.**

1022. Verdecchia P, Angeli F, Borgioni C, et al. Ambulatory blood pressure and cardiovascular outcome in relation to perceived sleep deprivation. Hypertension 2007 Apr;49(4):777-83. PMID: 17261645. **KQ3aE3, KQ3bE4, KQ3cE4.**

1023. Verdecchia P, Angeli F, Borgioni C, et al. Prognostic value of circadian blood pressure changes in relation to differing measures of day and night. J Am Soc Hypertens 2008 Mar;2(2):88-96. PMID: 20409890. **KQ3aE3, KQ3bE5a, KQ3cE5a.**

1024. Viera AJ, Hinderliter AL, Kshirsagar AV, et al. Reproducibility of masked hypertension in adults with untreated borderline office blood pressure: comparison of ambulatory and home monitoring. Am J Hypertens 2010 Nov;23(11):1190-7. PMID: 20671718. **KQ3aE4, KQ3bE7f, KQ3cE7f.**

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1028. Vinyoles E, Rodriguez-Blanco T, de la Sierra A, et al. Isolated clinic hypertension: diagnostic criteria based on 24-h blood pressure definition. J Hypertens 2010 Dec;28(12):2407-13. PMID: 20852448. **KQ2aE3, KQ2bE3, KQ3aE4, KQ3bE10b, KQ3cE4.**

1029. Vollmer WM, Appel LJ, Svetkey LP, et al. Comparing office-based and ambulatory blood pressure monitoring in clinical trials. J Hum Hypertens 2005 Jan;19(1):77-82. PMID: 15361888. **KQ3aE1, KQ3bE1, KQ3cE1.**

1030. Volzke H, Ittermann T, Schmidt CO, et al. Subclinical hyperthyroidism and blood pressure in a population-based prospective cohort study. Eur J Endocrinol 2009 Oct;161(4):615-21. PMID: 19581285. **KQ4aE4d, KQ4bE4d.**

1031. Vreugdenhil G, Schrey G, de Leeuw PW. Comparison of office and serial automatic blood pressure readings in renovascular and essential hypertension. J Hum Hypertens 1992 Jun;6(3):189-91. PMID: 1629887. **KQ3aE4, KQ3bE4, KQ3cE4.**

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Appendix C. Evidence Tables

Table 1. Study design characteristics of included studies for Key Question 1

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Kaczorowski, 2011[104] Good	Canada	140642	Communities: Population of 10-60k based on 1996 & 2001 census, ≥ 5 physicians, ≥ 2 pharmacies, registered persons database to census population ratio < 10%, no recent geopolitical amalgamation into a major center. Participants: Aged ≥ 65 years	Communities: Townships, first nations reserves, dissolved and amalgamated townships and counties; initially test-piloted CHAP Participants: NR	1 (range, NR)	Screened Not Screened

Abbreviations: CHAP = Cardiovascular Health Awareness Program; k = thousand; NR = not reported

Table 2. Baseline characteristics of included studies for Key Question 1

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	BMI (kg/m^2), % BMI >30	% DM	% CVD	% HTN % Treated	Mean Office SBP/DBP (mm Hg)
Kaczorowski, 2011[104] Good	140642	74.8 (range, ≥ 65)	57.2	NR	NR	NR	21.7	12.3	0 NR	NR

Abbreviations: BMI = body mass index; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; kg = kilogram(s); m = meter; mm Hg = millimeters of mercury; NR = not reported; SBP = systolic blood pressure

Table 3. Intervention characteristics of included studies for Key Question 1

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements (min)	Method of BP Determination	Interventionist (training)
Kaczorowski, 2011[104] Good	Screened (i.e., provided with BP results on the same day)	BpTRU	O	A	NR	NR	NR	Peer health educator, nurse (nurses trained; no details about volunteer peer health educator)
	Not Screened	NA	NA	NA	NA	NA	NA	NA

Abbreviations: A = automated; BP = blood pressure; btwn = between; min = minute(s); NA = not applicable; NR = not reported; O = oscillatory

Appendix C. Evidence Tables

Table 4. Study design characteristics of included studies for Key Question 2a

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Kroke, 1998[107] Good	Germany	399	Women (aged 35-65 years) and men (aged 40-65 years)	Pregnant women	NR	Manual OBPM
						Automated OBPM
Lim, 2013[108] Good	Korea	454	Aged ≥ 20 years	Arm circumference < 20 cm; irregular pulse rate	NR	Manual OBPM
						Automated OBPM
Ostchega, 2010[105] Good	United States	509	Aged ≥ 13 years meeting the inclusion criteria set by the AAMI	NR	NR	Manual OBPM
						Automated OBPM
Pavlik, 2000[109] Fair	United States	1166	Patients presenting to the ER or medicine clinic during study days	NR	NR	Manual OBPM
						Automated OBPM

Abbreviations: AAMI = Association for the Advancement of Medical Instruments; ER = emergency room; NR = not reported; OBPM = office-based blood pressure measurement

Table 5. Baseline characteristics of included studies for Key Question 2a

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m^2), % w/ BMI > 30	% DM	% CVD	% HTN % Treated	Mean Office SBP/DBP (mm Hg)*
Kroke, 1998[107] Good	399	NR (range, 33-65)	64.4	NR	NR	NR	NR	NR	NR NR	139.2/86.4
Lim, 2013[108] Good	454	50.7 (range, 20-95)	52.8	100	NR	23.8, NR	NR	NR	NR NR	117.3/75.3
Ostchega, 2010[105] Good	509	49.4 (range, 13-91)	39.5	NR	NR	NR	NR	NR	NR NR	122.3/69.8
Pavlik, 2000[109] Fair	1166	48.5 (range, NR)	59.9	79.6	NR	NR	NR	NR	NR NR	129.5/79.6

*Manual office measurements reported; values as recorded from the automated device also available

Abbreviations: BMI = body mass index; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; kg = kilogram(s); m = meter; mm Hg = millimeters of mercury; NR = not reported; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 6. Intervention characteristics of included studies for Key Question 2a

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Kroke, 1998[107] Good	Automated OBPM	BOSO Oscilomat	O	A	3	2 minutes	NR	Right arm	✓	NR	12 x 23	Investigator (Trained)
	Manual OBPM	BOSO Roid II Aneroid	U	M	3	2 minutes	NR	Right arm	✓	NR	12 x 23	Investigator (Trained)
Lim, 2013[108] Good	Automated OBPM	A&D UA-767PC	NR	A	3	NR	NR	NR	NR	NR	14 x 52 (bladder, 12 x 23) for adults with arm circumference 25-33 cm; 11 x 41 (bladder, 9 x 18) for adults with arms circumference <25 cm	Observer (Trained)
	Manual OBPM	Mercury sphyg.	U	M	3	NR	NR	NR	NR	NR	NR	Observer (Trained)
Ostchega, 2010[105] Good	Automated OBPM	Omron HEM 907 XL	O	A	3	30 seconds	Averaged	Upper arm, forearm supported on level surface	✓	5	Appropriate according to mid-arm circumference	Technician (Standardized protocol used to train)
	Manual OBPM	Mercury sphyg.	U	M	6 (3 per technician)	30 seconds	Averaged	Upper arm, forearm supported on level surface	✓	5	Appropriate according to mid-arm circumference	Technician (Standardized protocol used to train)
Pavlik, 2000[109] Fair	Automated OBPM	Dinamap Plus Model 8710 or 1846SX	O	A	1	NA	NR	NR	NR	NR	NR	Research assistant (NR)
	Manual OBPM	Mercury sphyg.	U	M	1	NA	NA	NR	NR	NR	NR	Research assistant (Experienced)

Abbreviations: A = automated; cm = centimeter(s); M = manual; min = minute(s); NA = not applicable; NR = not reported; O = oscillatory; OBPM = office blood pressure measurement; sphyg = sphygmomanometer; U = auscultatory

Appendix C. Evidence Tables

Table 7. Study design characteristics of included studies for Key Question 2b

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Handler, 2012[106] Good	United States	22641	Adults aged ≥ 18 years in NHANES 1999-2008 w/ 3 BP measurements	NR	NR	1+2+3 Readings 2+3 Readings 1+2 Readings 1 Reading
Peters, 1999[110] Fair	Canada	50	Normotensives	NR	NR	Legs Uncrossed Legs Crossed
Pincomb, 1996[111] Fair	United States	48	Healthy white men aged 20-39 years, caffeine use (50-800 mg/day) w/in 30% of normal weight according to norms, no aerobic functional impairment during exercise	Caffeine intolerance, known CVD or chronic illness other than mild untreated HTN, smoking (>10 cigarettes/day), use of recreational/prescription drugs	NR	No Caffeine Caffeine

Abbreviations: BP = blood pressure; CVD = cardiovascular disease; HTN = hypertension; NHANES = National Health and Nutrition Examination Survey; NR = not reported

Table 8. Baseline characteristics of included studies for Key Question 2b

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m2), % w/ BMI > 30	% DM	% CVD	% HTN % Treated	Mean Office SBP/DBP (mm Hg)
Handler, 2012[106] Good	22641	45.3 (range, ≥ 18)	51.4	28.1	24.3	NR	7.3	7.5	NR 12.7	124.3/72.1
Peters, 1999[110] Fair	50	25.1 (range, NR)	54	NR	NR	NR	NR	NR	NR NR	105/59
Pincomb, 1996[111] Fair	48	NR (range, 20-35)	0	0	NR	NR	NR	0	NR NR	NR

Abbreviations: BMI = body mass index; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; kg = kilogram(s); m = meter; mm Hg = millimeters of mercury; NR = not reported; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 9. Intervention characteristics of included studies for Key Question 2b

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Handler, 2012[106] Good	1 Reading	Mercury sphyg.	U	M	3	NR	First measurement	NR	✓	5	"Appropriate sized"	Physician (Trained)
	1+2 Readings	Mercury sphyg.	U	M	3	NR	Mean of first and second measurement	NR	✓	5	"Appropriate sized"	Physician (Trained)
	1+2+3 Readings	Mercury sphyg.	U	M	3	NR	Mean of first, second and third measurement	NR	✓	5	"Appropriate sized"	Physician (Trained)
	2+3 Readings	Mercury sphyg.	U	M	3	NR	Mean of second and third measurement	NR	✓	5	"Appropriate sized"	Physician (Trained)
Peters, 1999[110] Fair	Legs Crossed	Omron HEM 706	O	A	3	1, 3, 5 minutes	NR	NR	✓	5	NR	Investigator (NR)
	Legs Uncrossed	Omron HEM 706	O	A	3	1, 3, 5 minutes	NR	NR	✓	5	NR	Investigator (NR)
Pincomb, 1996[111] Fair	Caffeine	Dinamap Vital Signs Monitor model 1896	O	A	3	2 minutes	Measurements at the end of each rest period averaged to obtain pre- and post-drug BP values (i.e., mean of 3 readings)	Left arm	✓	5	NR	NR (NR)
	No Caffeine	Dinamap Vital Signs Monitor model 1896	O	A	3	2 minutes	Measurements at the end of each rest period averaged to obtain pre- and post-drug BP values (i.e., mean of 3 readings)	Left arm	✓	5	NR	NR (NR)

Abbreviations: A = automated; cm = centimeter(s); M = manual; min = minute(s); NR = not reported; O = oscilloatory; sphyg = sphygmamonometer; U = auscultatory;

Appendix C. Evidence Tables

Table 10. Study design characteristics of included studies for Key Question 3a

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Asayama, 2006[112] Good	Japan	1766	Age ≥ 40 years; residents of 3 of the 4 regions of Ohasama; and measurement of home BP ≥ 3 times during 4-week BL study period	History of stroke (excluded from this analysis only); hospitalized, demented and bedridden individuals; individuals who worked outside of town	10.6 (IQR 8.9-13.9)	HBPM HBPM (morning) HBPM (evening) OBPM
Bobrie, 2004[113] Good	France	4939	Aged ≥ 60 years; primary permanent HTN defined by anti-HTN meds or in absence of treatment, office BP values > 140/90 mm Hg measured at 2 separate times during the year preceding inclusion (only treated analyzed)	Inability to perform an appropriate number of BP measurements at home w/ the study device; arm size not allowing the use of a standard cuff; any threatening disease or recent acute CV event (e.g., MI, stroke)	3.2 (range, NR)	HBPM OBPM
Celis, 2002[114] Fair	Belgium	419	Patients previously participating in APTH trial whose office DBP measured ≥ 95 mm Hg while off treatment (during 2 month placebo run-in phase); ≥ 18 years; effective contraception in women of reproductive age; possibility of F/U during study period	Contraindications to stopping anti-HTN meds, including: overt heart failure, unstable angina pectoris, HTN retinopathy stage III or IV, or history of MI or cerebrovascular accident w/in 1 year; severe non-CV disease such as cancer or liver cirrhosis; serum Cr >1.5 mg/dL; mental disorders; patients additions to narcotics or alcohol; patients working night shifts	5.3 (range, 0.1-7.5)	ABPM (daytime) OBPM
Clement, 2003[115] Good	Belgium	1963	Patients of either sex who were aged ≥ 18 years w/ documented HTN at 2 separate visits w/in a 2-year period before enrollment (visits 1 and 2). HTN diagnosed if the mean of 3 sphyg. readings of DBP (assessed as the 5th Korotkoff sound and obtained in the office, when the patient was sitting, after 5 minutes of rest) > 90 mm Hg in patients currently taking anti-HTN meds or > 95 mm Hg in patients not taking meds. Patients must be treated w/ anti-HTN meds for ≥ 3 months by the time of the inclusion visit (visit 3).	Suspicion of secondary HTN, insulin-treated DM, recent stroke (occurring w/in previous 3 months), recent acute MI, recent hospitalization for CHF, recent revascularization or planned CV intervention during succeeding 3 months, serum Cr > 2.5 mg per deciliter, COPD, any coexisting diseases that might seriously reduce life expectancy, heart transplantation, use of experimental drugs, pregnancy, and refusal to undergo repeated F/U visits and ambulatory BP monitoring.	5 (range, 0.8-5.5)	ABPM (24hr) ABPM (daytime) ABPM (nighttime) OBPM
Dolan, 2005[116] Fair	Ireland	5292	HTN patients who were untreated or had all anti-HTN meds discontinued for 1 week before their BL visit and demographic data and CV risk factors recorded in database	Insufficient ABPM (<10 daytime and 5 nighttime readings)	7.9 (IQR 5.6-10.6)	ABPM (24hr) ABPM (daytime) ABPM (nighttime) OBPM
Fagard,	Belgium	391	Registered patients at a general	Bedridden, demented, admitted in a	10.9 (range,	ABPM (daytime)

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
2005[117] Good			practice clinic aged ≥ 60 years w/ ≥ 2 types of BP measurement	home for sick elderly people or history of MI or stroke	0.04-13.0)	ABPM (nighttime) HBPM OBPM
Gasowski, 2008[118] Fair	Belgium	1167	Participants from a geographically defined area in Northern Belgium	1,646 were excluded because intentionally their nighttime ABP had not been measured (n = 1,596), or because their daytime (n = 27) or nighttime (n = 23) ABPs were based on the average of <10 or 5 readings, respectively	13 (range, 0.8-16)	ABPM (24hr) OBPM
Hansen, 2005[119] Fair	Denmark	1700	Men and women from 11 municipalities in southwestern part of Copenhagen country	Technical problems or unwillingness to participate in ABPM, too few ABPM readings (<14 readings of SBP and DBP during the day, < 7 SBP and DBP during the night), nighttime workers, previous diagnosis of MI or stroke, using digoxin or nitrates	9.5 (range, NR)	ABPM (24hr) ABPM (daytime) ABPM (nighttime) OBPM
Hermida, 2011[120] Good	Spain	3344	Aged ≥ 18 years of age, normotensive, untreated HTN or resistant to treatment (uncontrolled BP according to ABPM threshold while compliant to 3 optimally dosed HTN meds of different classes including diuretic unless contraindicated or intolerant or any subject treated w/ > 3 HTN meds)	Pregnancy, history of alcohol or drug abuse, night/shift-worker employment, AIDS, type 1 DM, secondary HTN, CVD disorders (unstable angina, HF, life-threatening arrhythmia, kidney failure, grade III/IV retinopathy), intolerance to ABPM, inability to communicate or comply w/ all of study requirements	5.6 (range, 0.5-8.6)	ABPM (48hr) ABPM (daytime) ABPM (nighttime) OBPM
Ingelsson, 2006[121] Good	Sweden	951	50-year-old men living in Uppsala in 1970-1973 who were reinvestigated 20 years later (now 70-year-old men) and had valid 24-h ambulatory BP recordings and data on all covariates	Previous diagnosis of CHF, valvular disease, ECG-LVH	9.1 (range, 0.1-11.4)	ABPM (24hr) ABPM (daytime) ABPM (nighttime) OBPM
Mesquita-Bastos, 2010[122] Fair	Portugal	1200	Consecutive HTN patients 18 years or older referred for ABPM w/ no history or clinical evidence of earlier CV events (including: CHF, cerebrovascular disease, MI, coronary bypass or angioplasty, cardiac valve disease, renal insufficiency, PAD, AF, other major arrhythmias, severe hepatic disease); no suspicion of secondary HTN or sleep apnea; treated patients needed to have treatment stabilized for >=3 months; and could be evaluated further (followup exam or death certificate)	NR	8.2 (range, 0.8-15.2)	ABPM (24hr) ABPM (daytime) ABPM (nighttime) OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Niiranen, 2010[123] Good	Finland	2081	The target population of the Health 2000 Survey consisted of individuals aged ≥ 18 years and living in mainland Finland. Subjects aged 45-74 years participated in the home BP measurement substudy.	The main reason for exclusions in the overall study was temporary residence abroad. Participation limited by home monitor availability.	6.8 (range, NR)	HBPM OBPM
Ohkubo, 1998[124] Good	Japan	1789	Age ≥ 40 years; residents of 3 of the 4 regions of Ohasama; and measurement of home BP ≥ 3 times during 4-week BL study period	Hospitalized, demented and bedridden individuals; individuals who worked outside of town	6.6 (range, 0.1-9.4)	HBPM (multiple) HBPM (initial) OBPM
Ohkubo, 2005[125] Good	Japan	1332	Age ≥ 40 years w/ casual BP measurement at annual health check-up; residents of 3 of the 4 regions of Ohasama	Hospitalized, demented and bedridden individuals; individuals who worked outside of town	10.2 (range, NR)	ABPM (24hr) ABPM (daytime) ABPM (nighttime) OBPM
Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	Men and women ≥ 60 years w/ isolated systolic HTN (sitting SBP 160 to 219 mm Hg and sitting DBP <95 mm Hg while on masked placebo during the run-in phase; standing SBP ≥ 140). BP measurements for entry based on the averages of 6 sitting and 6 standing readings–2 in each position at 3 BL visits, 1 month apart	Systolic HTN secondary to a disorder needing specific medical or surgical treatment; retinal hemorrhage or papilledema; CHF; dissecting aortic aneurysm; serum Cr concentration >=180 µmol/L; history of severe nose bleeds, stroke, or MI in the year before the study; dementia; substance abuse; any disorder prohibiting a sitting or standing position; and any severe concomitant CV or non-CVD	4.4 (range, 0.8 to 9)	ABPM (24hr) ABPM (daytime) ABPM (nighttime) OBPM

Abbreviations: ABP = ambulatory blood pressure; ABPM = ambulatory blood pressure monitoring; AF = atrial fibrillation; AIDS = acquired immunodeficiency syndrome; APTH = Ambulatory Blood Pressure and Treatment of Hypertension; BL = baseline; BP = blood pressure; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease; Cr = creatinine; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; dL = deciliter(s); DM = diabetes mellitus; ECG = electrocardiogram; F/U = followup; HBPM = home blood pressure monitoring; HF = heart failure; HTN = hypertension; hr = hour(s); IQR = interquartile range; LVH = left ventricular hypertrophy; mg = milligram(s); mm Hg = millimeter(s) of mercury; MI = myocardial infarction; NR = not reported; OBPM = office blood pressure measurement; PAD = peripheral artery disease; pts = participants; SBP = systolic blood pressure; sphyg = sphygmamonometer; w/ = with

Appendix C. Evidence Tables

Table 11. Baseline characteristics of included studies for Key Question 3a

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m^2), % w/ BMI > 30	% DM	% CVD	% HTN % Treated	Mean Office SBP/DBP (mm Hg)*
Asayama, 2006[112] Good	1766	60.1 (range, ≥ 40)	60	100	22.3	23.4, NR	12	0.9	54.3 28.5	NR
Bobrie, 2004[113] Good	4939	70 (range, 60-97)	51.1	NR	7.7	NR, 18.93	14.7	NR	100 100	152/85
Celis, 2002[114] Fair	419	52.6 (range, ≥ 18)	53.9	NR	18.4	28.8, NR	NR	NR	100 0	164.7/103.4
Clement, 2003[115] Good	1963	56.4 (range, ≥ 18)	48.6	NR	17.2	27.9, NR	11.0	5.9	100 100	155.01/93.06
Dolan, 2005[116] Fair	5292	53.3 (range, 16.2-92.4)	53.7	NR	23.8	27.4, NR	5.16	10.6	100 0	162.3/93.1
Fagard, 2005[117] Good	391	71 (range, 60-99)	59.9	NR	18.9	27.5, NR	8.44	NR	61.9 32.2	142.8/77.5
Gasowski, 2008[118] Fair	1167	48.8 (range, NR)	50.7	NR	31.7	25.9, NR	3.08	NR	22.9 14.8	126/77
Hansen, 2005[119] Fair	1700	NR (range, 41-72)	52.1	NR	44.3	25.3, NR†	2.18	NR	NR 9.4	128/82
Hermida, 2011[120] Good	3344	52.6 (range, ≥ 18)	48.6	NR	14.5	29.8, 42.3	18.15	0	NR NR	150.8/85.9
Ingelsson, 2006[121] Good	951	70 (assumed) (range, 50-70)	0	NR	20.4	26.2, NR	9.99	NR	49.2 32.6	146/84
Mesquita-Bastos, 2010[122] Fair	1200	50.7 (range, ≥ 18)	53.8	0	4.9	27.1, NR	10.17	0	100 52.4	154.85/95.27
Niiranen, 2010[123] Good	2081	50.3 (range, 45-74)	53.7	NR	19.6	27.4, NR	6.25	11	NR 22.7	137.4/83.7
Ohkubo, 1998[124] Good	1789	61.0 (range, ≥ 40)	60	100	22.5	NR	NR	4.1	NR 32.5	133.3/75.9
Ohkubo, 2005[125] Good	1332	61.0 (range, ≥ 40)	60	100	20.4	NR	17.42	5.6	15.2 30.4	131.2/74.1
Staessen, 1999[126] Good	808	69.6 (range, ≥ 60)	61.5	NR	8.5	26.1 in men; 27.0 in women, NR	NR	26.6	100 42.6	173.3/86.0

*Baseline BP measurements may also be available by ABPM or HBPM values
†Median

Abbreviations: BMI = body mass index; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; kg = kilogram(s); m = meter; mm Hg = millimeters of mercury; NR = not reported; SBP = systolic blood pressure

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Table 12. Intervention characteristics of included studies for Key Question 3a

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Asayama, 2006[112] Good	HBPM (AM)	Omron HEM 401C	O	A*	23.0 (mean)	1 day	Morning BP was average of all morning measures.	Heart level	✓	≥ 2	Standard; used for both casual and home BP measurements, because arm circumference of subjects was <34 cm	Self (Physicians and well-trained public health nurses conducted health education classes to inform the subjects on how to measure and record home BP. Subjects needed to demonstrate ability to measure home BP.)
	HBPM (AM+PM)	Omron HEM 401C	O	A*	23.0 (mean) daytime measures + 23.6 (mean) nighttime measures	After awakening to bedtime	Average of morning and evening BP measures	Heart level	✓	≥ 2	Standard; used for both casual and home BP measurements, because arm circumference of subjects was <34 cm	Self (Physicians and well-trained public health nurses conducted health education classes to inform the subjects on how to measure and record home BP. Subjects needed to demonstrate ability to measure home BP.)
	HBPM (PM)	Omron HEM 401C	O	A*	23.6 (mean)	1 day	Evening BP was average of all evening measures.	Heart level	✓	≥ 2	Standard; used for both casual and home BP measurements, because arm circumference of subjects was <34 cm	Self (Physicians and well-trained public health nurses conducted health education classes to inform the subjects on how to measure and record home BP. Subjects needed to demonstrate ability to measure home BP.)

Appendix C. Evidence Tables

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
	OBPM	USM700F	U	A*	2	NR	Mean of 2	NR	✓	≥ 2	Standard; used for both casual and home BP measurements, because arm circumference of subjects was <34 cm	Nurse or technician (NR)
Bobrie, 2004[113] Good	HBPM	Omron 705 CP	O	A*	24 (per protocol); actual mean 27 (SD 5)	3 measures each in morning (8 AM) and evening (8 PM) over 4 consecutive days	Mean of all available home measurements; outside of predefined morning and evening time frames (4-12 AM range or 4-12 PM range) were discarded	NR	✓	5	Standard	Self (NR)
	OBPM	Mercury sphyg.	U	M	6 (3 measures at each of 2 visits)	NR	Mean of 6 readings	NR	✓	5	Standard	Physician (No specific training)
Celis, 2002[114] Fair	ABPM (daytime)	Space Labs 90207 and 90239 A	O	A	40 (max)	q15min 8 AM - 10 PM; q30min at other times	Daytime defined as mean of all readings between 10:00 AM and 8:00 PM weighted for time interval between consecutive readings	NR	NR	NR	NR	NR (NR)
	OBPM	NR	NR	NR	6	NR	Average of 6 readings (3 each at 2 visits)	NR	✓	5	NR	NR (NR)

Appendix C. Evidence Tables

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Clement, 2003[115] Good	ABPM (24hr)	NR	NR	A	36	q30min 8 AM - 8 PM; q60min 8 PM - 8 AM	Raw data sent to coordinating center and visually inspected by a technician before being entered into the central database. No specific editing criteria were applied.	NR	NR	NR		NR (NR)
	ABPM (daytime)	NR	NR	A	24	30 minutes	8 am to 8 pm	NR	NR	NR		NR (NR)
	ABPM (nighttime)	NR	NR	A	6	60 minutes	Midnight to 6 am	NR	NR	NR		NA (NR)
	OBPM	NR	U	M	3	NR	3 measurements averaged	NR	✓	5		NR (NR)
Dolan, 2005[116] Fair	ABPM (24hr)	Space Labs 90202 or 90207	O	A	48 (max)	30 minutes	No editing criteria applied	NR	NR	NR	NR	NR (NR)
	ABPM (daytime)	Space Labs 90202 or 90207	O	A	24 (max)	30 minutes	Average of readings between 9 AM and 9 PM; no editing criteria applied	NR	NR	NR	NR	NR (NR)
	ABPM (nighttime)	Space Labs 90202 or 90207	O	A	10 (max)	30 minutes	Average of readings between 1 AM and 6 AM; no editing criteria applied	NR	NR	NR	NR	NR (NR)

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Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
	OBPM	Mercury sphyg. or Omron HEM 705 CP	U; O	M; A	NR, at least 3	NR	Mean of 3 measurements	Non-dominant	✓	5	NR	Nurse (NR)
Fagard, 2005[117] Good	ABPM (daytime)	Space Labs 90202 or 90207	O	A	40 (max)	q15min 8 AM - 10 PM	Weighted average of all measurements between 10 AM and 8 PM	NR	NR	NR	"Appropriate size"	NR (NR)
	ABPM (night-time)	Space Labs 90202 or 90207	O	A	12 (max)	q30min 10 PM - 6 AM; nighttime defined as 12 AM - 6 AM	Weighted average of all measurements between midnight and 6 AM	NR	NR	NR	"Appropriate size"	NR (NR)
	HBPM	Mercury sphyg.	U	M	3	NR	Average of 3 measurements	Right arm, used left when BP was lower by ≥10 mm Hg on right than left arm	✓	5	"Appropriately sized"	Physician; office and home BPs measured by same investigator (NR)
	OBPM	Mercury sphyg.	U	M	3	NR	Average of 3 measurements	same as above	✓	5	"Appropriately sized"	Physician; office and home BPs measured by same investigator (NR)

Appendix C. Evidence Tables

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Gasowski 2008[118] Fair	ABPM (24hr)	Space Labs 90207	O	A	50 (max)	q20min 8 AM - 10 PM; q45min 12 AM - 6 AM	Averaged over 24hrs while weighting for the time interval btwn consecutive readings	NR	NR	NR	"Standard", based on arm circumference: < 32 cm (22x12), ≥32 cm (35x15)	NR (NR)
	OBPM	NR	NR	NR	5	NR	Mean of five separate OBPM readings at each visit	NR	✓	5	"Standard", based on arm circumference: < 32 cm (22x12), ≥32 cm (35x15)	Observers (Trained)
Hansen, 2005[119] Fair	ABPM (24hr)	Takeda TM-2421	O	A	80 (max)	q15min 7 AM - 11 PM, q30min 11 PM - 7 AM	Means computed with weights according to time interval btwn successive readings; discrimination btwn day and nighttime based on diary. When info was inadequate, daytime interval btwn 6-12 AM and nightime from 12-6AM	NR	NR	NR	NR	NR (NR)
	ABPM (daytime)	Takeda TM-2421	O	A	64 (max)	q15min 7 AM - 11 PM	same as above	NR	NR	NR	NR	NR (NR)
	ABPM (night-time)	Takeda TM-2421	O	A	16 (max)	q30min 11 PM - 7 AM	same as above	NR	NR	NR	NR	NR (NR)
	OBPM	RZ sphyg.	U	M	NR, at least 2	NR	Mean of 2 measurements	NR	✓	5	"Appropriate"	NR (NR)

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Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Hermida, 2011[120] Good	ABPM (48hr)	Space Labs 90207	O	A	128 (max)	q20min 7 AM - 11 PM; q30min during night (assume 11 PM - 7 AM)	Editing criteria: BP invalid if ≥30% of measures were missing or if data were lacking for interval of >2 hr or if sleep period <6 hr or >12 hr; SBP readings >250 or <70 and DBP >150 or <40 automatically discarded	NR	NR	NR	NR	NR (NR)
	ABPM (daytime)	Space Labs 90207	O	A	NR	q20min 7 AM - 11 PM	Awake period determined by diaries and actigraph. Editing criteria: same as above	NR	NR	NR	NR	NR (NR)
	ABPM (nighttime)	Space Labs 90207	O	A	NR	q30min during night (assume 11 PM - 7 PM)	Awake period determined by diaries and actigraph. Editing criteria: same as above	NR	NR	NR	NR	NR (NR)
	OBPM	Omron HEM 705 IT	O	A	6	NR	NR	NR	✓	≥ 10	NR	Investigator; same investigator took all BP measurements (NR)

Appendix C. Evidence Tables

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Ingelsson 2006[121] Good	ABPM (24hr)	Accu-tracker II	NR	NR	42 or 72 (max)	q20 or 30min 6 AM - 11 PM; q20 or 60min 11 PM - 6 AM	All readings presumed to be erroneous excluded: readings of 0, SBP >270 or <80, DBP >170, and difference between readings <10 mm Hg	NR	NR	NR	NR	NR (NR)
	ABPM (daytime)	Accu-tracker II	NR	NR	20 to 30 (max)	q20 or 30min 10 AM - 8 PM	Same as above. Day-time defined as 10 AM to 8 PM.	NR	NR	NR	NR	NR (NR)
	ABPM (night-time)	Accu-tracker II	NR	NR	6 to 18 (max)	q20 or 60min 12 AM - 6 AM	Same as above. Night-time defined as Midnight to 6 AM.	NR	NR	NR	NR	NR (NR)
	OBPM	Sphyg.	U	M	2	NR	Mean of 2 measurements; recordings rounded to nearest 2 mm Hg	Right arm		10	"Appropriate"	NR (NR)
Mesquita-Bastos, 2010[122] Fair	ABPM (24hr)	Space Labs 90207	O	A	63 (max)	q20min 7 AM - 11 PM; q30min 11:30 PM - 6:30 AM	NR	Non-dominant	NR	NR	NR	NR (NR)
	ABPM (daytime)	Space Labs 90207	O	A	48 (max)	q20min 7 AM - 11 PM	NR	Non-dominant	NR	NR	NR	NR (NR)
	ABPM (nighttime)	Space Labs 90207	O	A	15 (max)	q30min 11:30 PM - 6:30 AM	NR	Non-dominant	NR	NR	NR	NR (NR)

Appendix C. Evidence Tables

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
	OBPM	Omron M6	O	A	3	2 minutes	Mean of last 2 readings; authors report that clinic BP recorded at 2 different visits but no indication if 1st, 2nd, or both visits used to determine BP	Non-dominant	NR	NR	NR	NR (NR)
Niiranen, 2010[123] Good	HBPM	Omron HEM 722C	O	A	28 (max); Actual, mean 26.7 (3.7)	2 minutes; 2 measurements every morning (6 AM - 9 AM) and every evening (6 PM - 9 PM) on 7 consecutive days	Mean of 14 duplicate measurements (28 measure-ments)	Right arm	✓	10	"Appropriate size"	Self (Subjects received written instructions and individual guidance on how to measure BP correctly.)
	OBPM	Mercury sphyg.	U	M	2	2 minutes	Mean of 2 measurements	Right arm	✓	10	"Appropriate size"	Nurse (NR)
Ohkubo, 1998[124] Good	HBPM (initial)	Omron HEM 401C	O	A*	2	1 day	Average of the initial 2 measurements at home (over 4 week measurement period)	NR	✓	≥ 2	Standard. Arm circumference was <34 cm in most cases, so a standard arm cuff was used for both BP measurement methods	Self (Physicians and public health nurses instructed subjects on how to perform home blood pressure measurements.)
	HBPM (multiple)	Omron HEM 401C	O	A*	20.8 (mean; range 3-38)	1 day	Mean of all daily measurements over 4 weeks	NR	✓	≥ 2	same as above	same as above
	OBPM	USM 700F	U	A	2	NR	Mean of 2	NR	✓	≥ 2	same as above	Nurse or technician (NR)

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Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Ohkubo, 2005[125] Good	ABPM (24hr)	ABPM-630	Oscillatory	A	48 (max)	30 minutes	Mean of measures calculated. ABP data included in analysis if monitoring period included >8 h during the daytime and >4 h during nighttime as estimated from patient diaries. Artifactual readings omitted from analysis.	NR	NR	NR	NR	Public health nurses attached monitors (Well-trained)
	ABPM (daytime)	ABPM-630	O	A	NR (day/night period estimated by patient diaries)	30 minutes	same as above	NR	NR	NR	NR	Public health nurses attached monitors (Well-trained)
	ABPM (nighttime)	ABPM-630	O	A	NR (day/night period estimated by patient diaries)	30 minutes	same as above	NR	NR	NR	NR	Public health nurses attached monitors (Well-trained)
	OBPM	USM 700F	U	A	2	NR	Mean of 2	NR	✓	2	NR	Nurse or technician (NR)

Author, Year Quality	Intervention	Device	Oscil or Ausc	Auto or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interventionist (training)
Staessen, 1999[126] Good	ABPM (24hr)	Space Labs 90202 or 90207	O	A	48	≤30 minutes	Ambulatory recordings were not edited but subjects excluded if <80% of required readings were available (3.5% of sample). Means of ambulatory measurements were weighted by the interval between consecutive readings.	NR	NR	NR	If arm circumference >31 cm, larger cuffs with a 35 × 15 cm bladder were used.	NR (NR)
	ABPM (daytime)	Space Labs 90202 or 90207	O	A	20	≤ 30 minutes 10 AM - 8 PM	same as above	NR	NR	NR	same as above	NR (NR)
	ABPM (nighttime)	Space Labs 90202 or 90207	O	A	12	≤30 minutes 12 AM - 6 PM	same as above	NR	NR	NR	same as above	NR (NR)
	OBPM	Conven-tional sphyg.	NR	NR	6 (2 at each of 3 visits)	NR	Mean of 6	NR	✓	NR	NR	NR (NR)

*Semi-automated device

Abbreviations: A = automated; ABP = ambulatory blood pressure; ABPM = ambulatory blood pressure monitoring; AM = ante meridiem; BP = blood pressure; btwn = between; cm = centimeter(s); DBP = diastolic blood pressure; HBPM = home blood pressure monitoring; hr = hour(s); M = manual; min = minute(s); mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; O = oscillatory; PM = post meridiem; q = every; SBP = systolic blood pressure; SD = standard deviation; sphyg = sphygmamonometer; U = auscultatory

Appendix C. Evidence Tables

Table 13. Ambulatory (24hr) vs. office, all-cause mortality, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean followup (y)	Cox regression model, BP variable increment	ABPM (24hr) HR (95% CI)	ABPM (24hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24hr)	Additional model covariates†
Systolic	Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	1 SD	1.18 (0.94 to 1.48)	1.03 (0.79 to 1.33)	1.40 (1.10 to 1.78)	NR	BMI, DM, cholesterol, CV complications at entry, use of lipid-lowering drugs
	Dolan, 2005[116] Fair	Ireland	5292	646	100 0	162.3/93.1	7.9	10 mm Hg	1.11 (1.07 to 1.16)	1.13 (1.08 to 1.19)	1.02 (0.99 to 1.05)	NR	BMI, DM, history of CV events
	Hansen, 2005[119] Fair	Denmark (population-based)	1700	174	NR 9.41	128/82	9.5	10 mm Hg	1.18 (1.06 to 1.31)*	NR, p=0.001	1.05 (0.96 to 1.14)*	NR, p=0.23	NR
	Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	68	100 42.6	173.3/86.0	4.4	10 mm Hg	1.16 (0.99 to 1.35)	1.09 (0.92 to 1.29)	1.24 (1.03 to 1.49)	NR	Previous CV complications, residence in western Europe
Diastolic	Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	1 SD	1.22 (0.96 to 1.55)	1.16 (0.90 to 1.49)	1.27 (0.98 to 1.64)	NR	BMI, DM, cholesterol, CV complications at entry, use of lipid-lowering drugs,
	Dolan, 2005[116] Fair	Ireland	5292	646	100 0	162.3/93.1	7.9	5 mm Hg	1.06 (1.02 to 1.09)	1.05 (1.02 to 1.09)	1.01 (0.99 to 1.04)	NR	BMI, DM, history of CV events
	Hansen, 2005[119] Fair	Denmark (population-based)	1700	174	NR 9.41	128/82	9.5	5 mm Hg	1.18 (1.09 to 1.28)*	NR, p<0.0001	1.06 (0.99 to 1.14)*	NR, p=0.17	NR

*Relative risk

†All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24hr) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; hr = hour; HR = hazard ratio; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 14. Ambulatory (24hr) vs. office, fatal and nonfatal CV events, results of included studies for Key Question 3a

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean followup (y)	Cox regression model, BP variable increment	ABPM (24hr) HR (95% CI)	ABPM (24hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24hr)	Addtl. model covariates‡
Systolic	MI or stroke, fatal or nonfatal	Clement, 2003[111] Good	Belgium	1963	77	100 100	155.01/ 93.06	5	10 mm Hg	1.30 (1.12 to 1.51)	1.30 (1.10 to 1.55)	1.10 (0.98 to 1.25)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
	CV events (CV death, MI or stroke)	Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	1 SD	1.72 (1.49 to 1.99)	1.52 (1.26 to 1.84)	1.68 (1.41 to 2.00)	NR	DM
	CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	10 mm Hg	1.19 (1.14 to 1.26)	1.19 (1.13 to 1.27)	1.06 (1.02 to 1.10)	NR	BMI, DM, history of CV events
		Gasowski, 2008[118] Fair	Belgium	1167	50	22.88 ‖ 14.82	126/77	13	10 mm Hg	1.38 (1.14 to 1.68)	1.42 (1.14 to 1.77)	1.10 (0.94 to 1.29)	0.96 (0.79 to 1.16)	BMI, anti-HTN treatment, TC, drinking
		Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	10 mm Hg	1.51 (1.28 to 1.77)*	NR, p=0.0003	1.25 (1.10 to 1.42)*	NR, p=0.96	NR
		Ohkubo, 2005 (2146) Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.27 (1.04 to 1.55)	NR	1.04 (0.91 to 1.19)	DM, history of CVD, anti-HTN treatment, hypercholest-erolemia
		Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	36	100 42.6	173.3/86.0	4.4	10 mm Hg	1.20 (0.98 to 1.49)	1.11 (0.88 to 1.40)	1.32 (1.03 to 1.68)	NR	Previous CV complications, residence in western Europe

Appendix C. Evidence Tables

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean followup (y)	Cox regression model, BP variable increment	ABPM (24hr) HR (95% CI)	ABPM (24hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24hr)	Addtl. model covariates‡
Diastolic	MI or stroke, fatal or nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/ 93.06	5	1 SD	1.41 (1.10 to 1.80)	1.41 (1.08 to 1.85)	1.14 (0.86 to 1.52)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
	CV events (CV death, MI or stroke)	Hermida, 2011[120]‖ Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	1 SD	1.50 (1.23 to 1.84)	1.40 (1.08 to 1.81)	1.35 (1.12 to 1.64)	NR	DM
	CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	5 mm Hg	1.07 (1.03 to 1.12)	1.09 (1.02 to 1.11)	1.03 (1.00 to 1.07)	NR	BMI, DM, history of CV events
		Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	5 mm Hg	1.43 (1.26 to 1.61)	NR, p<0.0001	1.21 (1.08 to 1.35)*	NR, p=0.49	NR
		Ohkubo, 2005 (2146) Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.27 (0.89 to 1.80)	NR	1.00 (0.80 to 1.25)	DM, history of CVD, anti-HTN treatment, hypercholes-terolemia

*Relative risk

‡All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24hr) or OBPM.

‖ABPM 48 hours

Abbreviations: ABPM = ambulatory blood pressure measurement; addtl = additional; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 15. Ambulatory (24hr) vs. office, fatal and nonfatal strokes, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follo w-up (y)	Cox regression model, BP variable increment	ABPM (24hr) HR (95% CI)	ABPM (24hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24hr)	Additional model covariates†
Systolic	Clement, 2003[115] Good	Belgium	1963	36	100 100	155.01/93.06	5	1 SD	NR	NR, NS	1.50 (1.08 to 2.08)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry, OBPM
	Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79*	100 52.42	154.85/95.27	8.2	1 SD	NR	1.67 (1.35 to 2.06)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
	Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.40 (1.21 to 1.62)	NR	1.04 (0.94 to 1.15)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
	Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	30	100 42.6	173.3/86.0	4.4	10 mm Hg	1.40 (1.12 to 1.76)	1.36 (1.04 to 1.79)	1.29 (0.98 to 1.71)	NR	Previous CV complications, residence in western Europe
	Dolan, 2005[116] Fair	Ireland	5292	103†	100 0	162.3/93.1	7.9	10 mm Hg	1.27 (1.15 to 1.40)†	1.28 (1.15 to 1.43) †	1.07 (1.00 to 1.15) †	NR	BMI, DM, history of CV events, OBPM
Diastolic	Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79*	100 52.42	154.85/95.27	8.2	1 SD	NR	1.60 (1.20 to 2.14)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
	Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.73 (1.35 to 2.21)	NR	1.07 (0.90 to 1.27)	DM, history of CVD, anti-HTN treatment, hypercholesterolemia
	Dolan, 2005[116] Fair	Ireland	5292	103†	100 0	162.3/93.1	7.9	5 mm Hg	1.13 (1.05 to 1.22) †	1.12 (1.03 to 1.22) †	1.06 (0.99 to 1.12) †	NR	BMI, DM, history of CV events, OBPM

*Strokes also available by hemorrhagic, ischemic, and undetermined type

†Fatal strokes only

‡All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24hr) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure measurement; addtl = additional; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 16. Ambulatory (24hr) vs. office, congestive heart failure, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	Number of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment	ABPM (24hr) HR (95% CI)	ABPM (24hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24hr)	Additional model covariates
Systolic	Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	1 SD	1.13 (0.91 to 1.40)	1.01 (0.77 to 1.32)	1.25 (0.98 to 1.59)	1.23 (0.92 to 1.65)	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol
Diastolic	Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	1 SD	1.13 (0.90 to 1.42)	1.05 (0.79 to 1.39)	1.16 (0.91 to 1.49)	1.11 (0.82 to 1.51)	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol

Abbreviations: ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 17. Ambulatory (24hr) vs. office, fatal and nonfatal cardiac endpoints, results of included studies for Key Question 3a

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment	ABPM (24hr) HR (95% CI)	ABPM (24hr) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (24hr)	Addtl. model covariates‡
Systolic	Cardiac endpoint, fatal and nonfatal	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	69	100 42.6	173.3/86.0	4.4	10 mm Hg	1.12 (0.96 to 1.31)	1.11 (0.93 to 1.31)	1.11 (0.91 to 1.35)	NR	Previous CV complications, residence in western Europe
	Cardiac endpoints, fatal	Dolan, 2005 [116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	10 mm Hg	1.17 (1.09 to 1.24)	1.16 (1.07 to 1.25)	1.06 (1.01 to 1.10)	NR	BMI, DM, history of CV events
Diastolic	Cardiac endpoints, fatal	Dolan, 2005 [116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	5 mm Hg	1.05 (1.00 to 1.10)	1.05 (0.99 to 1.11)	1.02 (0.98 to 1.09)	NR	BMI, DM, history of CV events

‡All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24hr) or OBPM.

Abbreviations: Addtl = additional; ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 18. Ambulatory (nighttime) vs. office, all-cause mortality, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment‡	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional model covariates†
Systolic	Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	1 SD	1.18 (0.94 to 1.49)	1.06 (0.82 to 1.36)	1.40 (1.10 to 1.78)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry, OBPM
	Dolan, 2005[116] Fair	Ireland	5292	646	100 0	162.3/93.1	7.9	10 mm Hg	1.14 (1.10 to 1.18)	1.15 (1.11 to 1.20)	1.02 (0.99 to 1.05)	NR	BMI, DM, history of CV events, OBPM
	Hansen, 2005[119] Fair	Denmark	1700	174	NR 9.41	128/82	9.5	10 mm Hg	1.19 (1.08 to 1.30)*	NR	1.05 (0.96 to 1.14)*	NR	NR
	Staessen, 1999[126] Good	Multinational (western and eastern Europe)	808	68	100 42.6	173.3/86.0	4.4	10 mm Hg	1.17 (1.03 to 1.33)	1.14 (1.00 to 1.30)	1.24 (1.03 to 1.49)	NR	Previous CV complications, residence in western Europe
Diastolic	Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	1 SD	1.22 (0.96 to 1.56)	1.17 (0.91 to 1.50)	1.27 (0.98 to 1.64)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry, OBPM
	Dolan, 2005[116] Fair	Ireland	5292	646	100 0	162.3/93.1	7.9	5 mm Hg	1.07 (1.04 to 1.10)	1.08 (1.04 to 1.11)	1.01 (0.99 to 1.04)	NR	BMI, DM, history of CV events, OBPM
	Hansen, 2005[119] Fair	Denmark	1700	174	NR 9.41	128/82	9.5	5 mm Hg	1.16 (1.08 to 1.25)*	NR	1.06 (0.99 to 1.14)*	NR	NR

*Relative risk

†All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24hr) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; hr = hour; HR = hazard ratio; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 19. Ambulatory (nighttime) vs. office, fatal and nonfatal CV events, results of included studies for Key Question 3a

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment§	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Addtl. model covariates‡
Systolic	MI or stroke, fatal and nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	10 mm Hg	1.30 (1.03 to 1.65)	1.25 (0.97 to 1.62)	1.22 (0.95 to 1.59)	NR	BMI, smoking, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
	Major CV events	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	1 SD	1.42 (1.16 to 1.74)	1.43 (1.13 to 1.80)	1.13 (0.88 to 1.45)	0.96 (0.72 to 1.29)	BMI, smoking, DM, anti-HTN treatment, smoking, serum TC
		Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	10 mm Hg	1.84 (1.60 to 2.11)	1.69 (1.43 to 2.01)	1.68 (1.41 to 2.00)	NR	DM
	CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	10 mm Hg	1.21 (1.16 to 1.27)	1.21 (1.15 to 1.27)	1.06 (1.02 to 1.10)	NR	BMI, smoking, DM, history of CV events
		Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	10 mm Hg	1.41 (1.23 to 1.62)*	NR	1.25 (1.10 to 1.42)	NR	NR
		Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.33 (1.11 to 1.58)	NR	1.05 (0.92 to 1.20)	Smoking, DM, history of CVD, anti-HTN treatment, hyperchol-esterolemia
		Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	36	100 42.6	173.3/86.0	4.4	10 mm Hg	1.23 (1.03 to 1.46)	1.18 (0.98 to 1.42)	1.32 (1.03 to 1.68)	NR	Smoking, previous CV complications, residence in western Europe

Appendix C. Evidence Tables

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment§	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Addtl. model covariates‡
Diastolic	MI or stroke, fatal and nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	5 mm Hg	1.28 (0.99 to 1.65)	1.25 (0.96 to 1.64)	1.14 (0.86 to 1.52)	NR	BMI, smoking, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
	Major CV events	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	1 SD	1.40 (1.12 to 1.75)	1.49 (1.16 to 1.92)	1.04 (0.82 to 1.34)	0.81 (0.60 to 1.07)	BMI, smoking, DM, anti-HTN treatment, smoking, serum TC
		Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	5 mm Hg	1.65 (1.38 to 1.98)	1.61 (1.31 to 1.99)	1.35 (1.12 to 1.64)	NR	DM
	CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	5 mm Hg	1.09 (1.05 to 1.13)	1.09 (1.04 to 1.13)	1.03 (1.00 to 1.07)	NR	BMI, smoking, DM, history of CV events
		Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	5 mm Hg	1.36 (1.22 to 1.51)	NR	1.21 (1.08 to 1.35)	NR	NR
		Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.45 (1.05 to 1.99)	NR	0.99 (0.80 to 1.23)	Smoking, DM, history of CVD, anti-HTN treatment, hyperchol-esterolemia

*Relative risk

‡All adjusted for age and sex. All covariates are from the model adjusted for ABPM (nighttime) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure measurement; addtl = additional; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; night = nighttime; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 20. Ambulatory (nighttime) vs. office, fatal and nonfatal strokes, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional model covariates†
Systolic	Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79	100 52.42	154.85/95.27	8.2	1 SD	NR	1.87 (1.48 to 2.37)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
	Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.26 (1.10 to 1.43)	NR	1.08 (0.98 to 1.19)	DM, history of CVD, anti-HTN treatment, hypercholest-erolemia
	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	30	100 42.6	173.3/86.0	4.4	10 mm Hg	1.35 (1.11 to 1.65)	1.31 (1.06 to 1.62)	1.29 (0.98 to 1.71)	NR	Previous CV complications, residence in western Europe
	Dolan, 2005[116] Fair	Ireland	5292	103*	100 0	162.3/93.1	7.9	10 mm Hg	1.30 (1.19 to 1.40)	1.30 (1.19 to 1.42)	1.07 (1.00 to 1.15)	NR	BMI, DM, history of CV events
Diastolic	Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79	100 52.42	154.85/95.27	8.2	1 SD	NR	1.66 (1.27 to 2.16)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
	Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.46 (1.16 to 1.85)	NR	1.14 (0.96 to 1.34)	DM, history of CVD, anti-HTN treatment, hypercholest-erolemia
	Dolan, 2005[116] Fair	Ireland	5292	103*	100 0	162.3/93.1	7.9	5 mm Hg	1.14 (1.07 to 1.22)	1.14 (1.06 to 1.22)	1.06 (0.99 to 1.12)	NR	BMI, DM, history of CV events

*Fatal strokes only

†All adjusted for age, sex and smoking. All covariates are from the model adjusted for ABPM (nighttime) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure measurement; addtl = additional; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; night = nighttime; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 21. Ambulatory (nighttime) vs. office, congestive heart failure, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Additional model covariates
SBP	Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	1 SD	1.21 (0.98 to 1.49)	1.14 (0.89 to 1.44)	1.25 (0.98 to 1.59)	NR	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol
DBP	Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	1 SD	1.26 (1.02 to 1.55)	1.23 (0.97 to 1.58)	1.16 (0.91 to 1.49)	NR	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol

Abbreviations: ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; night = nighttime; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Table 22. Ambulatory (nighttime) vs. office, fatal and nonfatal cardiac endpoints, results of included studies for Key Question 3a

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment	ABPM (night) HR (95% CI)	ABPM (night) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (night)	Addtl. model covariates‡
Systolic	Cardiac endpoint, fatal and nonfatal	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	69	100 42.6	173.3/86.0	4.4	10 mm Hg	1.17 (1.03 to 1.33)	1.16 (1.02 to 1.33)	1.11 (0.91 to 1.35)	NR	Previous CV complications, residence in western Europe
	Cardiac endpoints, fatal	Dolan, 2005 [116] Fair	Ireland	529 2	254	100 0	162.3/93.1	7.9	10 mm Hg	1.16 (1.10 to 1.23)	1.15 (1.04 to 1.23)	1.06 (1.01 to 1.10)	NR	BMI, DM, history of CV events
Dias	Cardiac endpoints, fatal	Dolan, 2005 [116] Fair	Ireland	529 2	254	100 0	162.3/93.1	7.9	5 mm Hg	1.06 (1.01 to 1.11)	1.06 (1.01 to 1.11)	1.02 (0.98 to 1.09)	NR	BMI, DM, history of CV events

‡All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (daytime) or OBPM.

Abbreviations: Addtl = additional; ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; night = nighttime; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 23. Ambulatory (daytime) vs. office, all-cause mortality, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment‡	ABPM (day) HR (95% CI)	ABPM (day) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (day)	Additional model covariates†
Systolic	Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	1 SD	1.18 (0.94 to 1.50)	1.03 (0.79 to 1.34)	1.40 (1.10 to 1.78)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
	Dolan, 2005[116] Fair	Ireland	5292	656	100 0	162.3/93.1	7.9	10 mm Hg	1.09 (1.04 to 1.13)	1.07 (1.03 to 1.12)	1.02 (0.99 to 1.05)	NR	BMI, DM, history of CV events, OBPM
	Hansen, 2005[119] Fair	Denmark	1700	174	NR 9.41	128/82	9.5	10 mm Hg	1.15 (1.04 to 1.28)*	NR	1.05 (0.96 to 1.14)	NR	NR
	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	68	100 42.6	173.3/86.0	4.4	10 mm Hg	1.07 (0.91 to 1.24)	0.98 (0.83 to 1.17)	1.24 (1.03 to 1.49)	NR	Previous CV complications, residence in western Europe
Diastolic	Clement, 2003[115] Good	Belgium	1963	78	100 100	155.01/93.06	5	1 SD	1.22 (0.95 to 1.56)	1.15 (0.89 to 1.49)	1.27 (0.98 to 1.64)	NR	BMI, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
	Dolan, 2005[116] Fair	Ireland	5292	656	100 0	162.3/93.1	7.9	5 mm Hg	1.02 (0.99 to 1.06)	1.02 (0.99 to 1.05)	1.01 (0.99 to 1.04)	NR	BMI, DM, history of CV events, OBPM
	Hansen, 2005[119] Fair	Denmark	1700	174	NR 9.41	128/82	9.5	5 mm Hg	1.16 (1.08 to 1.26)*	NR	1.06 (0.99 to 1.14)	NR	NR

*Relative risk

†All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (24hr) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; hr = hour; HR = hazard ratio; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 24. Ambulatory (daytime) vs. office, fatal and nonfatal CV events, results of included studies for Key Question 3a

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment§	ABPM (day) HR (95% CI)	ABPM (day) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (day)	Addtl. model covariates‡
Systolic	MI or stroke, fatal or nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	1 SD	1.54 (1.21 to 1.96)	1.56 (1.19 to 2.05)	1.22 (0.95 to 1.59)	NR	BMI, smoking, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry
	Major CV events	Celis, 2002[114] Fair	Belgium	419	20	100 0	164.7/103.4	5.3	10 mm Hg	1.51 (1.19 to 1.88)	1.51 (1.13 to 2.01)	1.17 (0.94 to 1.42)	NR	Smoking, anti-HTN treatment
		Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	1 SD	1.33 (1.07 to 1.64)	1.40 (1.07 to 1.82)	1.13 (0.88 to 1.45)	0.92 (0.72 to 1.34)	BMI, smoking, DM, anti-HTN treatment, smoking, serum TC
		Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	1 SD	1.61 (1.39 to 1.88)	1.36 (1.12 to 1.65)	1.68 (1.41 to 2.00)	NR	DM
	CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	10 mm Hg	1.15 (1.10 to 1.21)	1.12 (1.06 to 1.18)	1.06 (1.02 to 1.10)	NR	BMI, smoking, DM, history of CV events
		Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	10 mm Hg	1.50 (1.27 to 1.76)*	NR	1.25 (1.10 to 1.42)*	NR	NR
		Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.17 (0.97 to 1.41)	NR	1.06 (0.93 to 1.21)	Smoking, DM, history of CVD, anti-HTN treatment, hypercholesterolemia
		Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	36	100 42.6	173.3/86.0	4.4	10 mm Hg	1.17 (0.96 to 1.44)	1.07 (0.85 to 1.34)	1.32 (1.03 to 1.68)	NR	Smoking, previous CV complications, residence in western Europe

Appendix C. Evidence Tables

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment§	ABPM (day) HR (95% CI)	ABPM (day) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (day)	Addtl. model covariates‡
Diastolic	MI or stroke, fatal or nonfatal	Clement, 2003[115] Good	Belgium	1963	77	100 100	155.01/93.06	5	1 SD	1.45 (1.13 to 1.86)	1.46 (1.11 to 1.92)	1.14 (0.86 to 1.52)	NR	BMI, smoking, DM, cholesterol, use of lipid-lowering drugs, CV complications at entry, OBPM
	Major CV events	Celis, 2002[114] Fair	Belgium	419	20	100 0	164.7/103.4	5.3	5 mm Hg	1.28 (1.07 to 1.53)	1.34 (1.07 to 1.68)	1.09 (0.87 to 1.36)	NR	Smoking, anti-HTN treatment
		Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	1 SD	1.26 (1.00 to 1.59)	1.44 (1.10 to 1.89)	1.04 (0.82 to 1.34)	0.81 (0.61 to 1.08)	BMI, smoking, DM, anti-HTN treatment, smoking, serum TC
		Hermida, 2011[120] Good	Spain	3344	NR	NR NR	150.8/85.9	5.6	1 SD	1.37 (1.11 to 1.69)	1.19 (0.91 to 1.56)	1.35 (1.12 to 1.64)	NR	DM
	CV mortality	Dolan, 2005[116] Fair	Ireland	5292	389	100 0	162.3/93.1	7.9	5 mm Hg	1.04 (1.00 to 1.08)	1.03 (0.99 to 1.07)	1.03 (1.00 to 1.07)	NR	BMI, smoking, DM, history of CV events
		Hansen, 2005[119] Fair	Denmark	1700	63	NR 9.41	128/82	9.5	5 mm Hg	1.40 (1.24 to 1.58)*	NR	1.21 (1.08 to 1.35)*	NR	NR
		Ohkubo, 2005[125] Good	Japan	1332	67	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.14 (0.83 to 1.58)	NR	1.02 (0.81 to 1.27)	Smoking, DM, history of CVD, anti-HTN treatment, hypercholesterolemia

*Relative risk

‡All adjusted for age and sex. All covariates are from the model adjusted for ABPM (daytime) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure measurement; addtl = additional; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; day = daytime; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 25. Ambulatory (daytime) vs. office, fatal and nonfatal strokes, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	Number of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment	ABPM (day) HR (95% CI)	ABPM (day) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (day)	Additional model covariates‡
Systolic	Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79*	100 52.42	154.85/95.27	8.2	1 SD	NR	1.58 (1.22 to 2.04)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
	Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.37 (1.19 to 1.57)	NR	1.03 (0.93 to 1.15)	DM, history of CVD, anti-HTN treatment, hypercholester-olemia
	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	30	100 42.6	173.3/86.0	4.4	10 mm Hg	1.30 (1.05 to 1.62)	1.25 (0.97 to 1.61)	1.29 (0.98 to 1.71)	NR	Previous CV complications, residence in western Europe
	Dolan, 2005[116] Fair	Ireland	5292	103†	100 0	162.3/93.1	7.9	10 mm Hg	1.18 (1.08 to 1.30)†	1.17 (1.05 to 1.30)†	1.07 (1.00 to 1.15)	NR	BMI, DM, history of CV events, OBPM
Diastolic	Mesquita-Bastos, 2010[122] Fair	Portugal	1200	79*	100 52.42	154.85/95.27	8.2	1 SD	NR	1.66 (1.18 to 2.34)	NR	NR	BMI, DM, anti-HTN treatment, OBPM
	Ohkubo, 2005[125] Good	Japan	1332	112	15.17 30.41	131.2/74.1	10.2	10 mm Hg	NR	1.67 (1.33 to 2.10)	NR	1.06 (0.90 to 1.26)	DM, history of CVD, anti-HTN treatment, hypercholesterol-emia
	Dolan, 2005[116] Fair	Ireland	5292	103†	100 0	162.3/93.1	7.9	5 mm Hg	1.09 (1.01 to 1.17)†	1.07 (0.99 to 1.16)†	1.06 (0.99 to 1.12)	NR	BMI, DM, history of CV events, OBPM

*Strokes also available by hemorrhagic, ischemic, and undetermined type

†Fatal strokes only

‡All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (daytime) or OBPM.

Abbreviations: ABPM = ambulatory blood pressure measurement; addtl = additional; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; day = daytime; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 26. Ambulatory (daytime) vs. office, congestive heart failure, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment	ABPM (day) HR (95% CI)	ABPM (day) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (day)	Additional model covariates
Systolic	Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	1 SD	1.08 (0.85 to 1.36)	0.94 (0.70 to 1.25)	1.25 (0.98 to 1.59)	NR	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol
Diastolic	Ingelsson, 2006[121] Good	Sweden	951	70	49.2 32.6	146/84	9.1	1 SD	0.99 (0.78 to 1.26)	0.87 (0.66 to 1.16)	1.16 (0.91 to 1.49)	NR	BMI, smoking, DM, prior MI, anti-HTN treatment, cholesterol

Abbreviations: ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; day = daytime; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 27. Ambulatory (daytime) vs. office, fatal and nonfatal cardiac endpoints, results of included studies for Key Question 3a

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment	ABPM (day) HR (95% CI)	ABPM (day) HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for ABPM (day)	Addtl. model covariates‡
Systolic	Cardiac endpoint, fatal and nonfatal	Staessen, 1999[126] Good	Multi-national (western and eastern Europe)	808	69	100 42.6	173.3/86.0	4.4	10 mm Hg	1.06 (0.91 to 1.23)	1.03 (0.87 to 1.21)	1.11 (0.91 to 1.35)	NR	Previous CV complications, residence in western Europe
	Cardiac endpoints, fatal	Dolan, 2005[116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	10 mm Hg	1.12 (1.06 to 1.19)	1.11 (1.04 to 1.19)	1.06 (1.01 to 1.10)	NR	BMI, DM, history of CV events
Diastolic	Cardiac endpoints, fatal	Dolan, 2005[116] Fair	Ireland	5292	254	100 0	162.3/93.1	7.9	5 mm Hg	1.03 (0.98 to 1.07)	1.02 (0.97 to 1.07)	1.02 (0.98 to 1.09)	NR	BMI, DM, history of CV events

‡All adjusted for age, sex, and smoking. All covariates are from the model adjusted for ABPM (daytime) or OBPM.

Abbreviations: Addtl = additional; ABPM = ambulatory blood pressure measurement; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; day = daytime; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 28. HBPM vs. office, all-cause mortality, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment§	HBPM HR (95% CI)	HBPM HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for HBPM	Additional model covariates‡
Systolic	Bobrie, 2004[113] Good	France	4939	205	100 100	152/85	3.2	1 mm Hg	1.00 (1.00 to 1.01)	NR	0.99 (0.99 to 1.00)	NR	NR
	Niiranen, 2010[123] Good	Finland	2081	118	NR 22.68	137.4/83.7	6.8	10 mm Hg	1.11 (1.01 to 1.23)	1.22 (1.09 to 1.37)	1.05 (0.96 to 1.15)	1.01 (0.92 to 1.12)	Age, sex, smoking, DM, history of CV events, anti-HTN treatment, hypercholest-erolemia
	Ohkubo, 1998[124] Good	Japan	1789	160	NR 32.53	133.3/75.9	6.6 (2.3)	1 mm Hg	1.014 (1.003 to 1.025)*	NR	1.001 (0.992 to 1.009)	NR	NR
									1.011 (1.002 to 1.021)†	NR	1.001 (0.992 to 1.009)	NR	
Diastolic	Bobrie, 2004[113] Good	France	4939	205	100 100	152/85	3.2	1 mm Hg	1.01 (0.99 to 1.02)	NR	0.99 (0.97 to 1.01)	NR	NR
	Niiranen, 2010[123] Good	Finland	2081	118	NR 22.68	137.4/83.7	6.8	5 mm Hg	1.08 (0.98 to 1.12)	1.15 (1.05 to 1.26)	0.95 (0.87 to 1.04)	1.06 (0.97 to 1.16)	Age, sex, smoking, DM, history of CV events, anti-HTN treatment, hypercholest-erolemia
	Ohkubo, 1998[124] Good	Japan	1789	160	NR 32.53	133.3/75.9	6.6 (2.3)	1 mm Hg	1.012 (0.995 to 1.028)*	NR	1.002 (0.989 to 1.016)	NR	NR
									1.013 (0.999 to 1.027)†	NR	1.002 (0.989 to 1.016)	NR	NR

*Multiple HBPM measurements

†Initial HBPM measurement only

‡All covariates are from the model adjusted for HBPM or OBPM.

Abbreviations: adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HBPM = home blood pressure measurement; HTN = hypertension; HR = hazard ratio; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 29. HBPM vs. office, fatal and nonfatal CV events, results of included studies for Key Question 3a

BP	Outcome	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment§	HBPM HR (95% CI)	HBPM HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for HBPM	Addtl. model covariates‡
Systolic	CV events (stroke, MI, CV death)	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	10 mm Hg	1.13 (1.03 to 1.24)	1.17 (1.02 to 1.33)	1.06 (0.94 to 1.18)	0.96 (0.83 to 1.11)	BMI, DM, serum TC
	CV mortality	Bobrie, 2004[113] Good	France	4939	85	100 100	152/85	3.2	1 mm Hg	1.01 (0.99 to 1.02)	NR	1.00 (0.98 to 1.01)	NR	NR
		Ohkubo, 1998[124] Good	Japan	1789	NR	NR 32.53	133.3/75.9	6.6 (2.3)	1 mm Hg	1.021 (1.001 to 1.041)*	1.012 (0.998 to 1.030)*	1.005 (0.990 to 1.02)	1.002 (0.987 to 1.018)	History of CVD
										1.013 (0.996 to 1.03)†	1.021 (1.000 to 1.042) †	1.005 (0.990 to 1.02)	1.000 (0.984 to 1.016)	
Diastolic	CV events (stroke, MI, CV death)	Fagard, 2005[117] Good	Belgium	391	86	61.89 32.23	142.8/77.5	10.9	1 SD	1.40 (1.14 to 1.72)	1.55 (1.23 to 1.97)	1.04 (0.82 to 1.34)	0.81 (0.62 to 1.07)	BMI, DM, serum TC
	CV mortality	Bobrie, 2004[113] Good	France	4939	85	100 100	152/85	3.2	1 mm Hg	1.02 (0.99 to 1.04)	NR	0.99 (0.97 to 1.02)	NR	NR
		Ohkubo, 1998[124] Good	Japan	1789	NR	NR 32.53	133.3/75.9	6.6 (2.3)	1 mm Hg	1.013 (0.989 to 1.038)*	1.012 (0.987 to 1.037)*	1.008 (0.984 to 1.033)	1.006 (0.981 to 1.031)	History of CVD
										1.015 (0.986 to 1.045)†	1.013 (0.982 to 1.044)†	1.008 (0.984 to 1.033)	1.005 (0.980 to 1.031)	

*Initial HBPM

†Multiple HBPM

‡All adjusted by age, sex, smoking, and anti-HTN treatment. All covariates are from the model adjusted for HBPM or OBPM.

Abbreviations: Addtl = additional; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HBPM = home blood pressure measurement; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 30. HBPM vs. OBPM, fatal and nonfatal strokes, results of included studies for Key Question 3a

BP	Study, Quality	Country	N BL	# of Events	% HTN at BL, % Treated	Mean BL Office SBP/DBP (mm Hg)	Mean follow-up (y)	Cox regression model, BP variable increment§	HBPM HR (95% CI)	HBPM HR (95% CI), adj. for OBPM	OBPM HR (95% CI)	OBPM HR (95% CI), adj. for HBPM	Additional model covariates‡
Systolic	Asayama, 2006[112] Good	Japan	1766	156	54.3, 28.54	NR/NR	10.6	10 mm Hg	NR	1.34 (1.18 to 1.51)*	NR	1.00 (0.91 to 1.10)*	Age, sex, BMI, smoking, DM, past history of CVD, hyperchol-esterolemia
									NR	1.36 (1.19 to 1.54)†	NR	1.00 (0.91 to 1.09)†	
									NR	1.39 (1.22 to 1.59)	NR	0.99 (0.90 to 1.09)	
Diastolic	Asayama, 2006[112] Good	Japan	1766	156	54.3, 28.54	NR/NR	10.6	5 mm Hg	NR	1.23 (1.12 to 1.36)*	NR	0.99 (0.92 to 1.07)	Age, sex, BMI, smoking, DM, past history of CVD, hyperchol-esterolemia
									NR	1.27 (1.14 to 1.40)†	NR	0.98 (0.91 to 1.06)†	
									NR	1.28 (1.15 to 1.41)	NR	0.98 (0.91 to 1.06)	

*Morning HBPM
†Evening HBPM
‡All covariates are from the model adjusted for HBPM or OBPM.
Abbreviations: Addtl = additional; adj = adjusted; BL = baseline; BMI = body mass index; BP = blood pressure; CI = confidence interval; CV = cardiovascular; DBP = diastolic blood pressure; DM = diabetes mellitus; HBPM = home blood pressure measurement; HTN = hypertension; HR = hazard ratio; MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 31. Study design characteristics of included studies for Key Question 3b and 3c

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Andreadis, 2012[128] Good	Greece	139	All pts referred for suspected HTN who had never taken or who had not received anti-HTN meds for ≥ the previous 6 months, OBPM ≥ 140/90 mm Hg	Arrhythmia, stroke, mental disorders, severe non-CVD (e.g., cancer, liver cirrhosis), chronic inflammatory disease, working night shifts, <80% of ABPM readings taken	NR (range, NR)	ABPM (24hr) HBPM OBPM
Celis, 2002[114] Fair	Belgium	419	Patients previously participating in APTH trial whose office DBP measured ≥ 95 mm Hg while off treatment (during 2 month placebo run-in phase); ≥ 18 years; effective contraception in women of reproductive age; possibility of F/U during study period	Contraindications to stopping anti-HTN meds, including: overt heart failure, unstable angina pectoris, HTN retinopathy stage III or IV, or history of MI or cerebrovascular accident w/in 1 year; severe non-CV disease such as cancer or liver cirrhosis; serum Cr >1.5 mg/dL; mental disorders; patients additions to narcotics or alcohol; patients working night shifts	5.3 (range, 0.1-7.5)	ABPM (daytime) OBPM
Cuspidi, 2011[129] Good	Italy	658	Grade 1 or 2 HTN (clinical SBP btwn 140-179 or DBP 90-109 mm Hg) diagnosed in the previous 12 months and confirmed during 2 visits at the outpatient clinic	Clinically overt CVD, secondary causes of HTN, DM, renal insufficiency, life threatening conditions preventing technically adequate ABPM (e.g., AF and major arrhythmias); history, symptoms, or clinical evidence of sleep apnea based on the Berlin Questionnaire	NR (range, NR)	OBPM ABPM
Fogari, 1996[130] Fair	Italy	221	Consecutive pts w/ newly diagnosed, never-treatment essential HTN (DBP > 90 mm Hg), men, aged 31-60 years	DM, autonomic neuropathy or cerebrovascular disease that might affect the circadian BP pattern, vascular of ISH, heart or renal failure, secondary causes of HTN, recordings that required removal of more than 20% of raw data (ABPM)	NR (range, NR)	ABPM (24hr) OBPM
Gerc, 2000[131] Fair	Switzerland	2373	Pts classified as having an elevated BP as measured in the physician's office using a mercury sphyg. and referred to HTN clinic for confirmation of diagnosis	Difference between OBPM and ABPM > 5 mm Hg even after repositioning of arm cuff	NR (range, NR)	Physician OBPM Nurse OBPM ABPM (daytime)
Graves, 2010[132]	United	313	Mild to moderate HTN	CVD	NR (range, NR)	ABPM (24hr)

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Fair	States		requiring therapy (SBP 140-179 mm Hg and DBP 90-109 mm Hg), aged 18-80 years old			Manual OBPM Automated OBPM
Gustavsen, 2003[133] Fair	Denmark	420	Aged 18-80 years, newly diagnosed grade I or II (mild-to-moderate) HTN based on ≥ 3 BP measurements taken ≥ a week apart (DBP ≥ 90 mm Hg)	Anti-HTN meds, CVD	NR (range, NR)	ABPM (24hr) OBPM
Hond, 2003b[134] Fair	Belgium	257	HTN whose sitting DBP ≥ 95 mm Hg on conventional measurement (mean of 2 visits during 1 month run-in period)	Treated w/ anti-HTN meds	NR (range, NR)	ABPM (24hr) HBPM OBPM
Hozawa, 2002[127] Fair	Japan	150	Aged ≥ 40 years, untreated	Worked out of town, hospitalized, bedridden, demented, did not monitor ABPM, did not complete OBPM, did not measure morning or evening HBPM > 3 days	NR (range, NR)	ABPM (24hr) HBPM OBPM
Aihara, 1998[293] (companion publication to Hozawa, 2002) Fair	Japan	706	Age ≥ 20 years, work near or stay at their own houses during daytime	Bedridden, staying in hospitals, receiving anti-HTN meds, arm circumference > 35 cm	NR (range, NR)	ABPM (24hr) OBPM
Inden, 1998[135] Fair	Japan	232	Essential HTN who visited the HTN clinic of Nagoya Daini Red Cross Hospital; SBP ≥ 140 or DBP ≥ 90 mm Hg in 3 separate measurements	NR	NR (range, NR)	ABPM (24hr) OBPM
Kario, 2013[136] Fair	Japan	462	Pts diagnosed as having HTN by a clinical practitioner	Pregnant or thought to be pregnant women; incomplete data	NR (range, NR)	ABPM (24hr) HBPM OBPM
Khoury, 1992[137] Fair	United States	131	≥ 2 previous BPs determinations showed DBP > 90 mm Hg but < 115 mm Hg.	Meds that could have an effect on BP	NR (range, NR)	ABPM (24hr) OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Licitra, 2012[138] Fair	Italy	107	All patients w/out a history of CVD or DM, confirmed OBPM ≥120-139/80-89 mm Hg (i.e., pre-HTN)	NR	8.25 (range, NR)	ABPM (24hr) OBPM
Manning, 1999[139] Fair	United Kingdom	186	Patients referred to outpatient HTN unit who were not currently receiving anti-HTN meds and had not been on anti-HTN meds in past year	Not meeting OBPM criteria, failing to attend appointments, intolerance to BP recorder	NR (range, NR)	ABPM (24hr) OBPM
Martinez, 1999[140] Fair	Spain	345	Aged 18-75 years, diagnosis of mild to moderate essential HTN according to JNC; no previous HTN treatment or none w/in 3 weeks	Steroid, NSAIDs, contraceptives, antidepressants or HRT w/in previous 3 weeks; HF, valvular defects, AF or significant concomitant disease, serum Cr < 2 mg/dL; agreement btwn manual and automated BP w/n 5 mm Hg in ≥3 consecutive visits; ≥2 valid ABPM readings/hour during day, ≥1 at night; psychophysical handicaps	NR (range, NR)	OBPM ABPM (24hr)
Myers, 2010[141] Good	Canada	254	Consecutive untreated pts referred to ABPM by physician	NR	NR (range, NR)	ABPM (24hr) Automated OBPM
Nasothimiou, 2012[142] Good	Greece	361	Referral for elevated BP, untreated or on stable anti-HTN meds for ≥ 4 weeks.	Severe renal, cardiac or other systemic diseases, sustained arrhythmia, evidence of secondary HTN, inadequate HBPM and/or ABPM readings, evaluation performed more than once, treatment change during study, acute disease during study	NR (range, NR)	ABPM HBPM OBPM
Pessanha, 2013[152] Fair	Portugal	336	Newly diagnosed HTN pts from July 2006 to November 2007 w/out anti-HTN treatment	NR	NR (range, NR)	ABPM OBPM
Pierdomenico, 1995[143] Fair	Italy	255	Untreated consecutive patients w/newly diagnosed arterial HTN (BP ≥140/90 mm Hg in 3 consecutive office visits over a 3 week period)	Ischemic or valvular heart disease, CHF, cerebrovascular accidents, DM, chronic renal insufficiency, known secondary HTN or anti-HTN meds, >20% of total ABPM readings deleted	NR (range, NR)	ABPM (24hr) OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Radi, 2004[144] Good	France	4263	Working in any sector besides agricultural	NR	NR	OBPM
Talleruphuus, 2006[145] Fair	Denmark	2806	Living persons born between April 1, 1916 and September 30, 1926; ISH based on average of clinic measurement at 3 visits	Treated for HTN, receiving any drugs known to influence BP	NR (range, NR)	OBPM ABPM (daytime)
Tanabe, 2008[146] Fair	United States	156	Aged ≥18 years, spoke English, initial and repeated ED BP ≥140/90 mm Hg, >=4 home BPs stored in the monitor	History of HTN, psychologically unstable on arrival (psychiatric or substance use-related reasons for visit), admitted to hospitals, homeless, unable to provide contact information or address, pregnant, unable to demonstrate correct use of HBPM, arms too large or small for cuff, prescribed anti-HTN meds at discharge	NR (range, NR)	HBPM OBPM
Toyama, 2008[147] Fair	Japan	87	Students of Tohoku University having screened positive at 3 previous BP screens (BP ≥140/90 mm Hg)	NR	NR (range, NR)	HBPM OBPM
Ungar, 2004[148] Good	Italy	388	Consecutive pts referred to HTN Center	NR	NR (range, NR)	OBPM ABPM (24hr)
Verdecchia, 1995[149] Fair	Italy	1333	Essential HTN w/sitting SBP ≥140 or DBP ≥90 mm Hg on ≥3 visits in last 3 weeks, previous anti-HTN meds withdrawn for ≥4 weeks; agreement w/in 5 mm Hg between mercury column and automatic recorder in ≥3 consecutive measurements taken simultaneously in each arm before ABPM, ≥1 valid ABPM reading per hour	HF, valvular defects, important concomitant disease, no ECG, inadequate tracing to determine LV mass	NR (range, NR)	ABPM (24hr) OBPM
Zabludowski, 1992[150] Fair	Israel	171	Untreated borderline HTN (DBP occasionally, but not consistently >90 mm Hg)	NR	NR (range, NR)	ABPM (24hr) OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Zawadzka, 1998[151] Fair	United Kingdom	410	Consecutive untreated pts w/ mean of 3 DBP measurements on different occasions by referring physician and clinic nurse exceeding 90 mm Hg	NR	NR (range, NR)	OBPM ABPM (24hr)

Abbreviations: ABPM = ambulatory blood pressure monitoring; AF = atrial fibrillation; APTH = Ambulatory Blood Pressure and Treatment of Hypertension; btwn = between; CHF = congestive heart failure; cm = centimeter(s); Cr = creatinine; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; dL = deciliter(s); DM = diabetes mellitus; ECG = electrocardiogram; ED = emergency department; F/U = followup; HBPM = home blood pressure monitoring; HF = heart failure; hr = hour(s); HTN = hypertension; ISH = isolated systolic hypertension; JNC = Joint National Committee; LV = left ventricular; mg = milligram(s); MI = myocardial infarction; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; pts = participants; w/ = with

Appendix C. Evidence Tables

Table 32. Baseline characteristics of included studies for Key Question 3b and 3c

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m^2), % w/ BMI >30	% DM	% CVD	% HTN, % Treated	Mean Office SBP/DBP (mm Hg)
Andreadis, 2012[128] Good	139	53 (range, NR)	49.6	NR	NR	NR	NR	NR	100 0	139.9/87.7
Celis, 2002[114] Fair	419	52.6 (range, ≥ 18)	53.9	NR	18.4	28.8, NR	NR	NR	100 0	164.7/103.4
Cuspidi, 2011[129] Good	658	46 (range, NR)	48	NR	23.0	25.4, 12.0	0	0	100 0	145.4/95.8
Fogari, 1996[130] Fair	221	NR (range, 31-60)	0	NR	NR	NR	0	NR	100 0	164.1/103.5
Gerc, 2000[131] Fair	2373	46.9 (range, 13-85)	41.6	NR	NR	NR	NR	NR	100 38.7	140.56/91.39
Graves, 2010[132] Fair	313	51† (range, 26-79)	42.1	NR	NR	NR	NR	0	100 0	156.1/99.2*
Gustavsen, 2003[133] Fair	420	47.7 (range, 18-80)	53.1	NR	52.4	25.7, NR	6.4	NR	100 0	156.0/99.6
Hond, 2003b[134] Fair	257	50.4 (range, NR)	54.1	NR	21.78	27.4, NR	NR	NR	100 0	155.4/100.0
Hozawa, 2002[127] Fair	150	NR (range, ≥ 40)	NR	100	NR	NR	NR	NR	100 0	153.9/83.9
Aihara, 1998[293] (companion publication to Hozawa, 2002) Fair	706	56.4 (range, ≥ 20)	69.4	100	NR	NR	NR	NR	19.7 0	NR/NR
Inden, 1998[135] Fair	232	54.2 (range, 18-80)	53.0	100	NR	NR	NR	NR	100 0	167/98
Kario, 2013[136] Fair	462	66.3 (range, NR)	46.8	100	NR	24.0, NR	10.4	13.2	100 48.3	157.1/89.0
Khoury, 1992[137] Fair	131	53.9 (range, NR)	47.3	0	NR	28.7, NR	NR	NR	0 0	155.4/93.1
Licitra, 2012[138] Fair	107	50 (range, NR)	42.1	NR	21.5	25, 55.1	0	0	0 0	132/82
Manning, 1999[139] Fair	186	46 (range, 18-71)	48.9	NR	NR	NR	NR	1.6	100 0	161/101
Martinez, 1999[140] Fair	345	51.8 (range, 18-75)	52.2	NR	NR	28.3, NR	3.8	NR	100 0	NR/NR
Myers, 2010[141] Good	254	56.8 (range, NR)	52.4	NR	NR	NR, NR	NR	NR	100 0	132.6/80.0*
Nasothimiou, 2012[142] Good	361	49 (range, NR)	41	NR	26.0	28, NR	3.1	2.5	100 0	143/94
Pessanha, 2013[152] Fair	336	51.2 (range, NR)	57.4	NR	19.9	26.6, 20.8	3.37	NR	100 0	158.3/93.2

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m^2), % w/ BMI >30	% DM	% CVD	% HTN, % Treated	Mean Office SBP/DBP (mm Hg)
Pierdomenico, 1995[143] Fair	255	49 (range, 33-65)	48.6	NR	NR	24.1, NR	0	NR	100 0	162.3/99.2
Radi, 2004[144] Good	4263	NR (range, NR)	NR	NR	NR	NR, NR	NR	NR	100 0	NR/NR
Talleruphuus, 2006[145] Fair	2806	75.2 (range, 69.6-82.3)	48.7	NR	32.8	26.2, NR	5.3	NR	NR 0	172.6/81.1
Tanabe, 2008[146] Fair	156	47.5 (range, ≥18)	51.9	37.8	NR	28.5, NR	3.9	3.2	100 0	153.0/92.5†
Toyama, 2008[147] Fair	87	21.6 (range, < 30)	0	100	NR	25.2, NR	NR	NR	0 NR	156.2/91.3
Ungar, 2004[148] Good	388	60 (range, 21-95)	51.2	NR	NR	26, NR	NR	NR	0 0	151/93
Verdecchia, 1995[149] Fair	1333	50.6 (range, NR)	51.0	NR	NR	26.7, NR	NR	NR	100 0	156.2/97.7
Zabludowski, 1992[150] Fair	171	48 (range, NR)	66.7	NR	NR	NR	NR	NR	100 0	159/91
Zawadzka, 1998[151] Fair	410	NR (range, NR)	NR	NR	NR	NR	NR	NR	100 0	168.4/106.8

*Automated OBPM, manual OBPM also reported

†Median

Abbreviations: BMI = body mass index; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; kg = kilogram(s); m = meter(s); mm Hg = millimeters of mercury; NR = not reported; SBP = systolic blood pressure; w/ = with

Appendix C. Evidence Tables

Table 33. Intervention characteristics of included studies for Key Question 3b and 3c

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Andreadis, 2012[128] Good	ABPM (24hr)	Microlife WatchBP	NR	A	96 (max)	q15min	Morning ABPM average of reading taken in the first hour of waking, first 2 hours of waking and in the first 3 hours of waking (based on diary)	Immobilize arm during measurement	NR	NR	22 x 32 or 32 x 42	NR (NR)
	HBPM	Omron 705 IT, Omron HEM 705 CP, Microlife BPA100Pluse	O	A	4 (2 per session)	1 minute w/in 1 hour after waking and in the evening before going to bed	Morning HBPM average of all morning recordings taken 1 hour after waking	NR	✓	5	13 x 23 or 15 x 30 (Omron 705); 12 x 23 or 14 x 28 (Omron 705CP); 22-42 (Microlife); according to arm circumference	Self (Shown how to use the devices and instructed)
	OBPM	Microlife WatchBP	NR	A	6	1 minute	Averaged, one calibration reading not included in the six readings.	Supported by adjustable armrests at heart level	✓	5	NR	NR (NR)
Celis, 2002[114] Fair	ABPM (daytime)	SpaceLabs 90207 and 90239A	O	A	40 (max)	q15min 8 AM - 10 PM; q30min at other times	Daytime defined as mean of all readings between 10:00 AM and 8:00 PM weighted for time interval between consecutive readings	NR	NR	NR	NR	NR (NR)
	OBPM	NR	NR	NR	6	NR	Average of 6 readings (3 each at 2 visits)	NR	✓	5	NR	NR (NR)

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Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Cuspidi, 2011[129] (4856) Good	ABPM	SpaceLabs 90207	O	A	88 (max)	q15min 7 AM - 11 PM; q20min 11 PM - 7 AM	Average 24hr	Still	NR	NR	NR	NR (NR)
	OBPM	Mercury sphyg.	U	M	3	1 minute	Mean of three measurements	NR	✓	5	NR	NR (NR)
Fogari, 1996[130] (13470) Fair	ABPM (24hr)	SpaceLabs 90207	O	A	96 (max)	q15min	Averaged BP measurements for daytime (6AM - 10 PM) and nighttime	NR	NR	NR	NR	NR (NR)
	OBPM	Mercury sphyg.	U	M	2 (first visit), 3 (remaining visits)	1 minute	Averaged	NR	✓	2, 10	NR	Physician (NR)
Gerc, 2000[131] (10194) Fair	ABPM (daytime)	Remler M200, Sandoz Pressure System, and the Profilomat	O	A*	36 (max)	q20min	Average	Stationary during cuff deflation	NR	NR	NR	NR (NR)
	Nurse OBPM	Mercury sphyg.	U	M	3	NR	Average	NR	✓	NR	NR	Nurse (NR)
	Physician OBPM	Mercury sphyg.	U	M	NR	NR	NR	NR	NR	NR	NR	Physician (NR)
Graves, 2010[132] Fair	ABPM (24hr)	SpaceLabs 90208	O	A	72 (max)	q15min 9 AM - 9 PM); q30min at night	Daytime average (median of 31 readings included in calculated averages)	NR	NR	NR	NR	NR (NR)
	Auto-mated OBPM	Omron 705 CP	O	A	3	1 minute	1. Average of the second and third readings; 2. Average of all three readings	At heart level	✓	5	Appropriate to arm size	NR (NR)

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
	Manual OBPM	Mercury sphyg.	U	M	3	1 minute	1. Average of the second and third readings 2. Average of all three readings	At heart level	✓	5	Appropriate to arm size	Registered nurses (Formal instruction in performing ausculatory BP measurements according to the American Heart Association Guidelines. Training was uniform across observers and full instructions were specified within the study protocol for the anti-hypertensive treatment trial.)
Gustavsen, 2003[133] Fair	ABPM (24hr)	A&D TM2420	U	A	80 (max)	q15min 7 AM - 11 PM, q30min 11 PM - 7 AM	Average daytime BP 8 AM - 10 PM, nighttime 12 - 6 AM	NR	NR	NR	NR	NR (NR)
	OBPM	Aneroid or mercury column sphyg.	NR	NR	NR	NA	NR	NR	✓	NR	NR	Physician (NR)
Hond, 2003b[134] Fair	ABPM (24hr)	SpaceLabs 90207	O	A	76 (max)	q15min 8AM - 10 PM, q30min 10 PM - 8 AM	Daytime time-weighted means 10AM - 8 PM, nighttime time weighted mean midnight - 6 AM	NR	NR	NR	24 x 14 or 32 x 15	NR (NR)
	HBPM	Omron HEM 705 CP	O	A	6 (3 per morning and evening)	NR (12 hours between sessions)	NR	NR	✓	5	24 x 14 or 32 x 15	Self (Instructed by physician or nurse)

Appendix C. Evidence Tables

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
	OBPM	Mercury sphyg.	U	M	3	NR	Last two measurements of the two visits were averaged	NR	✓	5	24 x 14 or 32 x 15	Physician (NR)
Hozawa, 2002[127] Fair	ABPM (24hr)	ABPM-630	O	A	48 (max)	q30min	Daytime BP average over 8 hours of waking time, nighttime BP average of 4 hours while subject in bed, average 24hr daytime and nighttime BP calculations over 24hr; time calculated from diaries	NR	NR	NR	NR	NR (NR)
	HBPM	Omron HEM 401C	O	A*	2 (morning and evening)	NR	Average of all measurements	NR	✓	2	NR	Self (Health education classes)
	OBPM	USM700F	U	A	2	NR	Average	NR	✓	2	NR	Nurse or technician (NR)
Aihara, 1998[293] (companion publication to Hozawa, 2002) *Fair*	*ABPM (24hr)*	*ABPM-630*	O	A	*48 (max), 46.9 (mean)*	*q30min*	*Daytime BP average over 8 hours of waking time, nighttime BP average of 4 hours while subject in bed, average 24hr daytime and nighttime BP calculations over 24hr*	*NR*	*NR*	*NR*	*Standard*	*NR (Household representatives attended classes for ABPM)*

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
	OBPM	*USM 700F*	*U*	*A*	*2*	*NR*	*NR*	*NR*	✓	*2*	*Standard*	*Nurse or technician (NR)*
Inden, 1998[135] Fair	ABPM (24hr)	ABPM-630	O	A	50 (max)	q30min	Average during daytime (7 AM - 11:30 PM) and nighttime (11:00 PM - 6:30 AM) and 24hrs after removing the first 2 measurements	NR	NR	NR	NR	NR (NR)
	OBPM	Mercury sphyg.	U	M	2	NR	Average	NR	✓	15	NR	NR (NR)
Kario, 2013[136] Fair	ABPM (24hr)	NR	O	NR	48 (max)	q30min	Average data during 24hr, daytime and nighttime periods	NR	NR	NR	NR	Physician (Trained participant as recommended by JSH guidelines)
	HBPM	NR	O	NR	2	NR, once in morning and once in evening	Average of morning and evening	NR	NR	NR	NR	Self (Trained by physician as recommended by JSH guidelines)
	OBPM	NR	NR	NR	1	NA	One BP measurement	NR	NR	NR	NR	Clinical practitioner (NR)

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Khoury, 1992[137] Fair	ABPM (24hr)	SpaceLabs 90207	O	A	96 (max)	q10min 7 AM - 8 PM; q15min 8 PM - 10 PM; q30 min 10 PM - 11 PM; q60min 11 PM - 7 AM	Mean hourly blood pressure	NR	NR	NR	NR	NR (NR)
	OBPM	NR	NR	NR	1	NA	Previous office casual blood pressures from the last 12 months were used for analysis. One measurement was made on the day ABPM was applied. Average of office measurements used.	NR	✓	NR	NR	Nurses (NR)
Licitra, 2012[138] Fair	ABPM (24hr)	SpaceLabs 90207	O	A	Not enough information to calculate	q15min during daytime, q20min during nighttime	NR	NR	NR	NR	NR	NR (NR)
	OBPM	NR	NR	NR	2	NR	Averaged	NR	✓	NR	NR	Physician ()

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Manning, 1999[139] Fair	ABPM (24hr)	Medilog ABP	U	NR	48 or 70	q30min for 24 hours, or q15min from 7 AM - 6 PM and q30min 6 PM - 7 AM	Mean of daytime and nighttime BPs as determined by diary; recordings in which >=20% of recordings failed were rejected and those patients asked to return for repeat measurement	NR	NR	NR	NR	NR (NR)
	OBPM	Mercury sphyg.	U	M	3 measures per visit, 3 visits	1 minute	Mean of 3 readings per visit and then mean of 3 visits	NR	✓	5	NR	NR (NR)
Martinez, 1999[140] Fair	ABPM (24hr)	SpaceLabs 90207	O	A	NR	q15min during daytime; q30min all other hours	Daytime average of BP between 10 AM and 8 PM; nighttime average 12 AM and 6 AM; 24hr average over entire period	Still	NR	NR	NR	NR (NR)
	OBPM	TRIMline (mercury sphyg.)	U	M	2 or more	1 minute	Mean of two BP values, mean of 3 visits	NR	✓	NR	NR	Nurse and doctor (Trained with video-taped technique, re-trained every 3 months)

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Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Myers, 2010[141] Good	ABPM (24hr)	SpaceLabs 90207	O	A	76 (max)	q15min 8AM - 10 PM, q30min 10PM - 8 AM	Mean awake ABP calculated according to the awake period as reported in each diary	NR	NR	NR	NR	Technician (Instructed participant)
	Auto-mated OBPM	BpTRU model 100	O	A	5	1 minute or 2 minutes	Mean of 5 measurements	NR	✓	NR	NR	NR (NR)
Nasothimiou, 2012[142] Good	ABPM	SpaceLabs 90207 or 90217	O	A	72 (max)	q20min	At least 20 valid awake readings required. Average awake and asleep BP calculated.	Forearm extended	NR	NR	12 x 23 or 14 x 30 where appropriate	NR (Instructions given)
	HBPM	Omron HEM 705 CP, Omron IC, Omron 705IT	O	A	4 (2 per morning, 2 per evening)	1 minute	All HBP readings averaged.	NR	✓	5	12 x 23 cm, 14 x 28 cm (HEM0705 and IC); 13 x 23, 15 x 30 (705IT)	Self (Instructions given)
	OBPM	Mercury sphyg.	U	M	3	≥ 1 minute	Average of the second and third clinic BP reading of the three visits averaged to give clinic BP.	NR	✓	5	12 x 23 or 15 x 35 where appropriate	Physician (Met British Hypertension Society Protocol criteria for observer agreement in BP measurement.)
Pessanha, 2013[152] Fair	ABPM	SpaceLabs 90207	O	A	62 (max)	q20min 7 AM - 11 PM; q30 min 11:30 PM - 6:30 AM	Average daytime	Non-dominant arm	NR	NR	NR	NR (NR)
	OBPM	OMRON M6	U	A	3	5 minutes	Average of 3 recordings	Left arm	✓	10	"Appropriate"	NR

Appendix C. Evidence Tables

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Pierdomenico, 1995[143] Fair	ABPM (24hr)	SpaceLabs	NR	A	84 (max)	q15min 6 AM - 12 AM; q30min 12 AM - 6 AM	Average over 24 hours	NR	NR	NR	NR	NR (NR)
	OBPM	Mercury sphyg.	U	M	3	NR	Averaged	Same arm	✓	10	NR	NR (NR)
Radi, 2004[144] Good	OBPM	Omron 805 CP	O	A	3	1 minute	Mean of three measurements	NR	✓	5	NR	NR (NR)
Talleruphuus, 2006[145] Fair	ABPM (daytime)	QuietTrak and TM 2421 monitor	NR	NR	≥ 32; 64 (max)	q15min 7 AM - 11 PM	Median of accepted values	Still arm	NR	NR	NR	NR (NR)
	OBPM	Standard sphyg.	U	M	5 (7 if necessary)	NR	Average of 3 consecutive measurement on arm with highest BP	Each arm	NR	10	12 x 35	Technician (Trained by authors)
Tanabe, 2008[146] Fair	HBPM	LifeSource UA 787EJ	NR	A*	14 (max)	NR, on waking and before going to bed	Average after deleting highest and lowest readings	NR	NR	NR	NR	Self (NR)
	OBPM	NR	NR	NR	2	30 minutes (minimum)	NR	NR	NR	NR	NR	Research assistant (NR)
Toyama, 2008[147] (7003) Fair	HBPM	Omron HEM 7471C	O	A	14	1 day	Mean of at least 7 morning measurements	NR	NR	NR	NR	Self (NR)
	OBPM	BP-203RVII	NR	A	1	NA	Had to be above threshold in three screens, but only including the third screen here as the study entry OBP.	NR	✓	30	NR	Physician (NR)

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Ungar, 2004[148] Good	ABPM (24hr)	SpaceLabs 90207	O	A	97 (max)	q15min 7 AM - 10 PM; q20min 10 PM - 7 AM	Average across entire 24 hour period, daytime and nighttime periods	Non-dominant arm, relaxed and stable during measurements	NR	NR	Most appropriate of three cuff sizes encircling 80% of arm: 17 x 26, 24 x 32, 32 x 42	NR (NR)
	OBPM	Mercury sphyg.	U	M	2 (3 if necessary)	NR	All measurements averaged	Suspended at approximately heart level	✓	10	Standard, larger cuff used when arm circumference > 32 cm	Physician (NR)
Verdecchia, 1995[149] Fair	ABPM (24hr)	SpaceLabs 5200, 90202 or 90207	O	A	96 (max)	q15min	Daytime: 6 AM - 10 PM; Nightime: 10 PM - 6 AM). Averages in each time period used. Editing performed by software; SBP <70 or >260, DBP <40 and >150 discarded.	NR	NR	NR	NR	NR (NR)
	OBPM	Mercury sphyg.	U	M	3	1 minute	Mean of 3	Non-dominant arm at heart level, relaxed and supported	✓	5	NR	Physician (NR)
Zabludowski, 1992[150] Fair	ABPM (24hr)	Accutracker I	NR	A	84 (max)	q15min during daytime, q30m 12 AM - 6 AM	Average of readings	NR	NR	NR	NR	NR (NR)
	OBPM	Accutracker I	NR	M	3	NR	Average	NR	✓	5	NR	Physician or nurse (NR)
Zawadzka, 1998[151]	ABPM (24hr)	A&D TM2420	U	A	20 (minimum)	30 minutes during waking day	Mean daytime diastolic BP	Supported	✓	NR	NR	NR (NR)

Author, Year Quality	Inter-vention	Device	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measurements	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Fair	OBPM	NR	NR	NR	3	NR	Mean	NR	NR	NR	NR	Physician, clinic nurse (NR)

*Semi-automated device

Abbreviations: A = automated; ABP = ambulatory blood pressure; ABPM = ambulatory blood pressure monitoring; AM = ante meridiem; BP = blood pressure; btwn = between; cm = centimeter(s); DBP = diastolic blood pressure; HBPM = home blood pressure monitoring; hr = hour(s); M = manual; min = minute(s); mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; O = oscillatory; PM = post meridiem; q = every; SBP = systolic blood pressure; sphyg = sphygmamonometer; U = auscultatory

Appendix C. Evidence Tables

Table 34. Diagnostic accuracy results of included studies for Key Questions 3c

Category	Subgroup	Author, Year	N	Comparison	PPV (calc)	Diagnostic Threshold
BMI	BMI > 29.9	Pessanha, 2013[152]	336	OBPM vs. ABPM (daytime)	0.671	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime ≥135/85 mm Hg
	BMI ≤ 29.9	Pessanha, 2013[152]	336	OBPM vs. ABPM (daytime)	0.598	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime ≥135/85 mm Hg
Race/Ethnicity	Asian	Tanabe, 2008[146]	156	OBPM vs. HBPM	0.5	OBPM: ≥140/90 mm Hg HBPM: ≥140/90 mm Hg (≥130/80 mm Hg for diabetics)
	Black	Tanabe, 2008[146]	156	OBPM vs. HBPM	0.654	OBPM: ≥140/90 mm Hg HBPM: ≥140/90 mm Hg (≥130/80 mm Hg for diabetics)
	Latino, Hispanic	Tanabe, 2008[146]	156	OBPM vs. HBPM	0.286	OBPM: ≥140/90 mm Hg HBPM: ≥140/90 mm Hg (≥130/80 mm Hg for diabetics)
	Native Hawaiian	Tanabe, 2008[146]	156	OBPM vs. HBPM	1	OBPM: ≥140/90 mm Hg HBPM: ≥140/90 mm Hg (≥130/80 mm Hg for diabetics)
	Non-Latino, Hispanics	Tanabe, 2008[146]	156	OBPM vs. HBPM	0.517	OBPM: ≥140/90 mm Hg HBPM: ≥140/90 mm Hg (≥130/80 mm Hg for diabetics)
	White	Tanabe, 2008[146]	156	OBPM vs. HBPM	0.423	OBPM: ≥140/90 mm Hg HBPM: ≥140/90 mm Hg (≥130/80 mm Hg for diabetics)
Baseline BP Level	Borderline Hypertensives	Manning, 1999[139]	186	OBPM vs. ABPM (daytime)	0.673	OBPM: ≥140/90 mm Hg ABPM (24hr): Daytime BP >136/86 mm Hg
	Hypertensives	Inden, 1998[135]	232	OBPM vs. ABPM (24hr)	0.7	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime BP ≥ 135/85 mm Hg, nighttime BP ≥120/75 mm Hg
		Inden, 1998[135]	232	OBPM vs. ABPM (daytime)	0.65	OBPM: ≥140/90 mm Hg ABPM (24hr): Daytime BP ≥135/85 mm Hg, nighttime BP ≥120/75 mm Hg
		Manning, 1999[139]	186	OBPM vs. ABPM (daytime)	0.909	OBPM: ≥140/90 mm Hg ABPM (24hr): Daytime BP >136/86 mm Hg
	Masked Hypertension	Nasothimiou, 2012[142]*	361	HBPM vs. ABPM (daytime)	0.78	HBPM: ≥ 135/85 mm Hg ABPM: ≥ 135/85 mm Hg
	Stage I	Inden, 1998[135]	232	OBPM vs. ABPM (24hr)	0.808	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime BP ≥ 135/85 mm Hg, nighttime BP ≥ 120/75mm Hg
		Inden, 1998[135]	232	OBPM vs. ABPM (daytime)	0.731	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime BP ≥ 135/85 mm Hg, nighttime BP ≥ 120/75mm Hg
		Verdecchia, 1995[149]	1333	OBPM vs. ABPM (daytime)	0.667	OBPM: ≥140/90 mm Hg on at least 3 visits in last 3 weeks ABPM (24hr): Daytime ABPM ≥131/86 mm Hg (women) or ≥136/87 mm Hg (men)
	Stage II	Inden, 1998[135]	232	OBPM vs. ABPM (24hr)	0.905	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime BP ≥ 135/85 mm Hg, nighttime BP ≥ 120/75mm Hg

Appendix C. Evidence Tables

Category	Subgroup	Author, Year	N	Comparison	PPV (calc)	Diagnostic Threshold
		Inden, 1998[135]	232	OBPM vs. ABPM (daytime)	0.832	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime BP ≥ 135/85 mm Hg, nighttime BP ≥ 120/75mm Hg
		Verdecchia, 1995[149]	1333	OBPM vs. ABPM (daytime)	0.882	OBPM: ≥140/90 mm Hg on at least 3 visits in last 3 weeks ABPM (24hr): Daytime ABPM ≥131/86 mm Hg (women) or ≥136/87 mm Hg (men)
	Stage III	Inden, 1998[135]	232	OBPM vs. ABPM (24hr)	0.958	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime BP ≥ 135/85 mm Hg, nighttime BP ≥ 120/75mm Hg
		Inden, 1998[135]	232	OBPM vs. ABPM (daytime)	0.887	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime BP ≥ 135/85 mm Hg, nighttime BP ≥ 120/75mm Hg
		Verdecchia, 1995[149]	1333	OBPM vs. ABPM (daytime)	0.97	OBPM: ≥140/90 mm Hg on at least 3 visits in last 3 weeks ABPM (24hr): Daytime ABPM ≥131/86 mm Hg (women) or ≥136/87 mm Hg (men)
	Stage IV	Verdecchia, 1995[149]	1333	OBPM vs. ABPM (daytime)	1	OBPM: ≥140/90 mm Hg on at least 3 visits in last 3 weeks ABPM (24hr): Daytime ABPM ≥131/86 mm Hg (women) or ≥136/87 mm Hg (men)
	Sustained Hypertension	Nasothimiou, 2012[142]*	361	HBPM vs. ABPM (daytime)	0.90	HBPM: ≥ 135/85 mm Hg ABPM: ≥ 135/85 mm Hg
	Isolated Clinic Hypertensives	Nasothimiou, 2012[142]*	361	HBPM vs. ABPM (daytime)	0.52	HBPM: ≥ 135/85 mm Hg ABPM: ≥ 135/85 mm Hg
Smoking Status	Non-Smokers	Celis, 2002[114]	419	OBPM vs. ABPM (daytime)	0.76	ABPM (daytime): SBP ≥140 mm Hg and/or DBP ≥90 mm Hg OBPM: DBP 95 mmHg+
		Gustavsen, 2003[133]	420	OBPM vs. ABPM (daytime)	0.76	OBPM: ≥ 90 mm Hg ABPM (24hr): Daytime BP ≥ 135/90 mm Hg or Daytime DBP ≥ 135/85 mm Hg
		Pessanha, 2013[152]	336	OBPM vs. ABPM (daytime)	0.584	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime ≥135/85 mm Hg
	Smokers	Celis, 2002[114]	419	OBPM vs. ABPM (daytime)	0.857	OBPM: DBP 95 mmHg+ ABPM (daytime): SBP ≥140 mm Hg and/or DBP ≥90 mm Hg
		Gustavsen, 2003[133]	420	OBPM vs. ABPM (daytime)	0.873	OBPM: ≥ 90 mm Hg ABPM (24hr): Daytime BP ≥ 135/90 mm Hg or Daytime DBP ≥ 135/85 mm Hg
		Pessanha, 2013[152]	336	OBPM vs. ABPM (daytime)	0.731	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime ≥135/85 mm Hg
Sex	Men	Celis, 2002[114]	419	OBPM vs. ABPM (daytime)	0.824	OBPM: DBP 95 mmHg+ ABPM (daytime): SBP ≥140 mm Hg and/or DBP ≥90 mm Hg
		Gustavsen, 2003[133]	420	OBPM vs. ABPM (daytime)	0.883	ABPM (24hr): Daytime BP ≥ 135/90 mm Hg or Daytime DBP ≥ 135/85 mm Hg OBPM: ≥ 90 mm Hg
		Khoury, 1992[137]	131	Second OBPM vs. ABPM (24hr)	0.654	OBPM: ≥ 90 mm Hg DBP ABPM (24hr): DBP ≥ 85 mm Hg

Appendix C. Evidence Tables

Category	Subgroup	Author, Year	N	Comparison	PPV (calc)	Diagnostic Threshold
		Martinez, 1999[140]	345	OBPM vs. ABPM (daytime)	0.691	OBPM: 140-179/90-109 mm Hg ABPM (24hr): Daytime ≥ 135/85 mm Hg
		Pessanha, 2013[152]	336	OBPM vs. ABPM (daytime)	0.706	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime ≥135/85 mm Hg
		Pierdomenico, 1995[143]	255	OBPM vs. ABPM (24hr)	0.809	OBPM: ≥ 140/90 mm Hg ABPM (24hr): ≥ 135/85 mm Hg
		Tanabe, 2008[146]	156	OBPM vs. HBPM	0.387	OBPM: ≥140/90 mm Hg HBPM: ≥140/90 mm Hg (≥130/80 mm Hg for diabetics)
		Verdecchia, 1995[149]	1333	OBPM vs. ABPM (daytime)	0.795	OBPM: ≥140/90 mm Hg on at least 3 visits in last 3 weeks ABPM (24hr): Daytime ABPM ≥131/86 mm Hg (women) or ≥136/87 mm Hg (men)
		Zabludowski, 1992[150]	171	Second OBPM vs. ABPM (daytime)	0.714	OBPM: DBP > 90 mm Hg ABPM (24hr): Daytime DBP > 90 mm Hg
	Women	Celis, 2002[114]	419	OBPM vs. ABPM (daytime)	0.739	OBPM: DBP 95 mmHg+ ABPM (daytime): SBP ≥140 mm Hg and/or DBP ≥90 mm Hg
		Gustavsen, 2003[133]	420	OBPM vs. ABPM (daytime)	0.762	OBPM: ≥ 90 mm Hg ABPM (24hr): Daytime BP ≥ 135/90 mm Hg or Daytime DBP ≥ 135/85 mm Hg
		Khoury, 1992[137]	131	Second OBPM vs. ABPM (24hr)	0.458	OBPM: ≥ 90 mm Hg DBP ABPM (24hr): DBP ≥ 85 mm Hg
		Martinez, 1999[140]	345	OBPM vs. ABPM (daytime)	0.528	OBPM: 140-179/90-109 mm Hg ABPM (24hr): Daytime ≥ 135/85 mm Hg
		Pessanha, 2013[152]	336	OBPM vs. ABPM (daytime)	0.544	OBPM: ≥ 140/90 mm Hg ABPM (24hr): Daytime ≥135/85 mm Hg
		Pierdomenico, 1995[143]	255	OBPM vs. ABPM (24hr)	0.234	OBPM: ≥ 140/90 mm Hg ABPM (24hr): ≥ 135/85 mm Hg
		Tanabe, 2008[146]	156	OBPM vs. HBPM	0.617	OBPM: ≥140/90 mm Hg HBPM: ≥140/90 mm Hg (≥130/80 mm Hg for diabetics)
		Verdecchia, 1995[149]	1333	OBPM vs. ABPM (daytime)	0.826	OBPM: ≥140/90 mm Hg on at least 3 visits in last 3 weeks ABPM (24hr): Daytime ABPM ≥131/86 mm Hg (women) or ≥136/87 mm Hg (men)
		Zabludowski, 1992[150]	171	Second OBPM vs. ABPM (daytime)	0.519	OBPM: DBP > 90 mm Hg ABPM (24hr): Daytime DBP > 90 mm Hg

*Kappas also reported

Abbreviations: ABPM = ambulatory blood pressure monitoring; BMI = body mass index; DBP = diastolic blood pressure; HBPM = home blood pressure monitoring; mm Hg = millimeters of mercury; OBPM = office-based blood pressure measurement; SBP = systolic blood pressure; vs. = versus

Appendix C. Evidence Tables

Table 35. Study design characteristics of included studies for Key Question 4a and 4b

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Apostolides, 1982[153] Fair	United States	2738	Aged 30-69 years and normotensive, controlled HTN or masked HTN during HDFP trial screening	All members of households w/ an HDFP randomized participant, households previously selected for mortality surveillance among normotensives	3 (range, NR)	OBPM
Arima, 2002[154] Fair	Japan	1133	Residents of Hisayama aged 40-79 years w/ normotension	Under insulin therapy, HTN, DM, AF, w/out insulin values	5 (range, NR)	OBPM
Bakx, 1987[155] Fair	The Netherlands	1953	First registered as overweight at aged 20-50 years; could be followed in the morbidity registry for ≥ 5 subsequent years; were still registered patients in the practice in 1983	NR	NR (range, 0.5-5.5 years)	OBPM
Boyko, 2008[156] Fair	Australia	4306	Adults aged ≥ 25 years who attended BL and F/U exams	HTN, missing BP values at BL or F/U, inadequate fasting (<9 hour) prior to the oral glucose tolerance test, pregnancy	5 (range, NR)	OBPM
Brantsma, 2006[157] Good	Netherlands	4635	Groningen inhabitants aged 28-75 participating in first and second surveys	HTN, self-reported renal disease	4.2 (range, NR)	OBPM
Cacciolati, 2013[158] Fair	France	275	Aged ≥ 73 years and noninstitutionalized who participated in office and home BP screenings at F/U and 1 year	HTN (assumed based on study aim and Ns); only used untreated participants for our analysis but treated participants not excluded from study	1 (range, NR)	OBPM confirmed with HBPM
Cheung, 2012[159] Fair	China (Hong Kong)	1115	Hong Kong Chinese subjects aged 25-74 years and normotensive at BL	NR	5.3 (range, NR)	OBPM
Dernellis, 2005[160] Fair	Greece	2512	Men and women age 35-94 examined in outpatient cardiology department	HTN (SBP ≥140 or DBP ≥90 mm Hg or use of anti-HTN meds), overt CVD or symptoms, history of MI, CHF	4 (range, NR)	OBPM
Everson, 2000[161] Good	Finland	616	Normotensive middle-aged men (ages 42, 48, 54, and 60) from Eastern Finland w/ complete data for BP and hopelessness scale at BL and followup	NR	4.2 (range, 3.8-5.2)	OBPM
Fagot-Campagna, 1997[162] Fair	France	4149	Aged 43-54 years at time of first screening, born in France, attending the second examination	HTN or DM at BL, missing values for BL BPs, fasting and 2-hour insulin and glucose, BMI, iliac circumference, excessive alcohol consumption, and FHH	3.16 (range, NR)	OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Fitchett, 2009[163] Fair	United States	1658	Women aged 42-52 years, pre- or early perimenopausal (≥ 1 menstrual period w/in the past 3 months), intact uterus and ≥ 1 ovary, self-identified as Caucasian or African-American	Recent use of reproductive hormones, missing complete data on all variables from the 4th annual SWAN interview	2 (range, NR)	OBPM
Giubertoni, 2013[164] Fair	Italy	1000	Women < 65 who presented to Ben Essere Donna Clinic from 1998 to 2011 who reached ≥ 2 years of followup between October 2009-April 2011	HTN excluded from subanalysis of incident HTN	5.25 (range, IQR 3.6-8.7)	OBPM
Juhaeri, 2002[165] Good	United States	9319	White and African-American men and women living in designated communities aged 45-65 years	HTN at BL, self-reported history of anti-HTN meds use in past 2 weeks at BL, did not complete visits 2 and 3, other ethnicities other than black and white, pts from Washington Country and Minneapolis field centers, missing SBP, DBP, weight or other pertinent BL variables, implausible weight or height	NR (use 4.5) (range, 3-6)	OBPM
Player, 2007[294] (companion publication to Juhaeri, 2002) Good	United States	2334	Men and women aged 45-64 years at BL, pre-HTN (SBP 120-139 mm Hg, DBP 80-89 mm Hg)	Told by a physician they had HBP, taking anti-HTN meds, SBP ≥140 or DBP ≥90 mm Hg, CVD defined as having history of MI, stroke/TIA, or cardiac revascularization procedures or electrocardiographic evidence of MI	NR (range, 3-6 [use midpoint 4.5])	OBPM
Jung, 2014[187] Good	South Korea	1553	Adults aged 40-70 years	HTN, without BL adiponectin measurements	2.6 (range, NR)	OBPM
Kim, 2006[166] Good	Korea	5889	Adults aged 40-69 years	Died during followup, refused to participate or failed to be contacted, HTN, on anti-HTN meds at BL	1.8 (range, NR)	OBPM
Kim, 2011[167] Fair	Korea	49228	Received a medical examination in 1992, w/ optimal BP in 1992, w/ optimal BP or pre-HTN btwn 1994 and 1996	Over 55 years of age, having high BP (SBP ≥120 mm Hg or DBP ≥80 mm Hg)	NR (range, 2-4 years)	OBPM
Kivimaki, 2009[168] Fair	United Kingdom	6704	London-based office staff working in 20 civil service departments aged 35-55 years, attended 2 consecutive screenings between Phase 1 and Phase 1 (1995/1988-2003/2004)	Prevalent HTN, CVD, DM, or missing data on risk factors	5.6 (range, NR)	OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Klein, 2006[169] Good	United States	1878	Aged 43-84 years	Ungradeable retinal photographs (central of branch retinal venous or arterial occlusions, macular edema), DM (prevalence, suspected or no DM information), HTN including missing HTN information	5 (range, NR)	OBPM
Kubo, 2013[188] (22167) Fair	Japan	10173	Age <30 years w/out HTN whose work schedule remained constant during followup	NR	27.5 (estimated from digitizer for years 1-5)	OBPM
Lakoski, 2011[170] Good	United States	3543	Women and men ages 45-84 years w/out known CVD	HTN at BL (BP ≥140/90, history of HTN and use of BP meds)	5 (range, NR)	OBPM
Muntner, 2010[295] (companion publication to Lakoski, 2011) Good	United States	3013	Men and women; white, black, Hispanic, and Asian-primarily Chinese decent; aged 45-84 years; living in 1 of 6 selected communities	History of clinically evident CVD, under cancer treatment, pregnant, weight >300 lbs, significant cognitive deficits, living in/on waiting list for nursing home, plans to leave community w/in 5 years, did not speak English, Spanish, Cantonese, or Mandarin, had chest CT in previous year, any serious medical conditions that would prevent long term participation, existing HTN or DM	6 (range, 2-6)	OBPM
Lee, 2004a[171] Good	Korea	8170	Male workers between 25-50 years old w/out definite HTN (SBP ≥ 160 mm Hg, DBP ≥ 95 mm Hg, and/or taking anti-HTN meds)	Mild HTN (SBP between 140 to < 160 or DBP between 90 to < 95), hypercholesterolemia, DM, other known CVD and other diseases requiring continuous meds, incomplete or inconsistent data	4 (range, NR)	OBPM
Lee, 2001[292] (companion pubication to Lee, 2004a) Good	Japan	8170	Male workers aged 25-50 years w/out definite HTN (SBP 16 mm Hg, DBP ≥95 mm Hg, or on any anti-HTN meds.	Mild HTN (BL levels of SBP between 140 and <160 mm Hg or of DBP between 90 and < 95 mm Hg); existing hypercholesterolemia, DM, other known CVD, and other diseases requiring continuous meds; incomplete or inconsistent information	4 (range, NR)	OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Lee, 2004b[173] Fair	Japan	5840	Men and women aged 30-69 years during BL year (1987), who could be followed for 10 years (until 1996), who had annual health check-ups ≥ 6 times during these 10 years; absence of CVD diseases, DM and hyperlipidemia during first 5 years from BL (1987)	SBP ≥160 and/or DBP ≥95 and/or taking anti-HTN meds during the first 5 years from BL (1987)	5 (range, NR)	OBPM
Lee, 2011[172] Fair	Korea	730	Non-HTN residents aged ≥ 20 years living in rural area covered by community health primary health care posts	NR	5 (range, NR)	OBPM
Levine, 2011[174] Good	United States	3436	Black and white men and women aged 18-30 years	HTN at BL, not attending 20 year examination, w/in ≥ 1 followup examinations	2 and 5 years (range, NR)	OBPM
Matsuo, 2011[175] Fair	Japan	5201	Men aged 30-59 years working in the central region of Japan who had completed an annual health check-up in 2002	History of stroke, CHD, or DM. Pre-existing HTN (SBP ≥140 mm Hg, DBP ≥90 mm Hg), current or past history of anti-HTN meds, incomplete data, could not be followed after first checkup	2.9 (range, NR)	OBPM
Morikawa, 1999[176] Good	Japan	1551	Manual male workers aged 18-49 years	High BP in BL (SBP ≥140 mm Hg and DBP ≥90 mm Hg), history of CVD, DM, CKD, or any other chronic diseases.	5 (range, NR)	OBPM
Nakanishi, 2003[177] Good	Japan	3784	Japanese male office workers from a large building contractor corporation aged 23-59 years who completed CV risk surveys	HTN, did not participating in consecutive annual health exams	5 (range, NR)	OBPM
Okubo, 2004[178] Fair	Japan	2107	Japanese male steelworkers aged 40-54 years and showed normal BP (SBP < 140 mm Hg, DBP < 90 mm Hg) in examination in 1990	Diagnosed HTN or undergoing anti-HTN meds in 1990 or before	5 (range, NR)	OBPM
Okubo, 2014[189] (21855) Fair	Japan	115736	Men and women aged 40-79 years living in Ibaraki prefecture who completed an annual health checkup btwn 1993 and 2004	Uncompleted followup health checkups from 1994-2005; history of heart disease or stroke; ceased consuming alcohol; HTN; incomplete data	3.9 (range, 1-18)	OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Radi, 2004[144] Fair	France	17465	Aged 15-96 years, received annual mandatory work-site visit between January 1997-May 1998 from 1 of 48 included physicians, aged 15-69 years	HTN, under current treatment for HTN	1.1 (range, NR)	OBPM
Satoh, 2010[179] Fair	Japan	2278	Male employees ages 35-55 years of a single local government agency who had an annual health checkup between April 2003 and March 2004	Past history of coronary artery disease or stroke, under treatment for HTN, low ankle/brachial index (<0.9), triglyceride values >400 mg/dL	3 (range, NR)	OBPM
Schulz, 2005[180] Fair	Germany	12362	Caucasian men ages 22-69 and women ages 19-70	Self-report of HTN diagnosis, being on anti-HTN meds, mean of second and third BP readings exceeding 140/90 mm Hg; missing of implausible values in the exposure and major covariates	2.2 (range, 1.4-5.0)	OBPM
Schulze, 2003[296] (companion publication to Schulz, 2005; women only) Fair	Germany	8552	Women aged 35-64 years	Previous diagnosis of HTN, intake of anti-HTN meds w/in 4 weeks prior to BL exam, missing information on dietary intake, estimated BMR, physical activity, lifestyle characteristics, anthropometric measurements, pregnancy, breastfeeding, outlying total energy intake, no followup, possible HTN w/ no verification, secondary HTN	NR (range, 2-4 (bin on 3))	OBPM
Shook, 2012[181] Fair	United States	6278	Men and women aged 20-80 years, able to achieve an exercise test to ≥85% of of their age-predicted maximal heart rate (220-age), reported diagnosis of HTN by a physician and had a resting BP of <140/90 mm Hg at BL	Known CVD, cancer, abnormal resting or exercise ECG, and DM	4.7 (range, NR)	OBPM
Sung, 2014[186] Fair	South Korea	11448	Pts who had a comprehensive health examination at BL and were re-examined 5 years later	HTN, missing data at BL (glucose, insulin, alcohol, smoking, exercise); missing followup data on fatty liver status and HTN	5 (range, NR)	OBPM
Tozawa, 2002[182] Fair	Japan	4857	18 or over w/ normotensive BP measurements at BL and attended 2-year rescreening	HTN (SBP >=140/90 mm Hg or taking anti-HTN meds)	2 (range, NR)	OBPM
Vasan, 2001[183] Good	United States	9845	Men and women aged 35-94 years	HTN, history of MI or CHF	4 (range, NR)	OBPM

Appendix C. Evidence Tables

Author, Year Quality	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Leitschuh, 1991[202] (companion publication to Vasan, 2001) Fair	United States	2099	Men and women	Pre-existing CHD (clinical or electrocardiographic evidence of angina pectoris or MI), CVD (claudication or cerebrovascular disease), current or prior LVH on ECG, cardiomegaly on chest radiograph, conditions requiring anti-HTN meds, preexisting CAD, PVD	NR (range, 2-4)	OBPM
Volzke, 2013[191] Good	Germany	1605	Aged 20-79 years and normotensive	Did not complete 5-year followup	5.3 (range, NR)	OBPM
Yamada, 1991[184] Good	Japan	1492	Received annual check-up in October or November of 1983, aged 35-54 years	Workers older than 54 years (required to retire on 60th birthday)	5 (range, NR)	OBPM
Yambe, 2007[185] Good	Japan	1758	Male employees who received a health check-up exam in 2000	Ankle/brachial SBP index (ABI) of < 0.95, AF, and/or those undergoing regular hemodialysis, receiving HTN meds, dyslipidemia, DM, heart disease and/or stroke, FPG >125 mg/dL, and age at first examination > 64 years old; HTN	3 (range, NR)	OBPM
Zambrana, 2014[190] Fair	United States	3145	Postmenopausal Hispanic women aged 50-79 years who participated in the WHI observational and clinical trial studies at BL (1994-1998) and at the third year followup for whom BP was measured; with complete data; ability and willingness to provide written informed consent and expectation of being resident in study recruitment area ≥ 3 years following enrollment	Medical conditions predictive of a survival time <3 years, conditions or characteristics inconsistent w/ study participation and adherence (e.g., mental illness); active participant in another RCT	3 (range, NA)	OBPM

Abbreviations: ABI = ankle brachial index; AF = atrial fibrillation; BL = baseline; BMI = body mass index; BP = blood pressure; CAD = coronary artery disease; CHD = coronary heart disease; CHF = congestive heart failure; CKD = chronic kidney disease; CT = computer topography; CV = cardiovascular; CVD = cardiovascular disease; DBP = diastolic blood pressure; dL = deciliter(s); DM = diabetes mellitus; ECG = electrocardiogram; FHH = family history of hypertension; FPG = fasting plasma glucose; F/U = followup; HBPM = home blood pressure; monitoring; HDFP = Hypertension Detection and Followup Program; HTN = hypertension; LVH = left ventricular hypertrophy; mg = milligram(s); MI = myocardial infarction; OBPM = office blood pressure measurement; pts = participants; PVD = peripheral vascular disease; SBP = systolic blood pressure; TIA = transient ischemic attack; TSH = thyroid stimulating hormone; w/ = with; WHI = Women's Health Initiative

Appendix C. Evidence Tables

Table 36. Baseline characteristics of included studies for Key Question 4a and 4b

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m^2), % w/ BMI > 30	% DM	% CVD	% HTN % Treated	Mean Office SBP/DBP (mm Hg)
Apostolides, 1982[153] Fair	2738	NR (range, 30-69)	52.7	44.6	NR	NR	NR	NR	0 0	NR
Arima, 2002 [154] Fair	1133	56 (range, 40-79)	64.3	100	20.6	22.7, NR	0	NR	0 0	124.7/74.4
Bakx, 1987[155] Fair	1953	NR (range, 20-50)	61.0	NR	NR	NR	NR	NR	NR NR	NR
Boyko, 2008[156] Fair	4306	47.6 (range, ≥ 25)	57	NR	12.6	26.1, NR	3.2	NR	0 0	120.2/67.0
Brantsma, 2006[157] Good	4635	45.2 (range, 28-75)	54.4	4.9	39.3	25.1, NR	NR	NR	0 NR	119.1/69.6
Cacciolati, 2013[158] Fair	275	77.8 (range, ≥ 73)	67.6	NR	NR	24.4, NR	1.45	1.82	0 0	133.0/72.8
Cheung, 2012[159] Fair	1115	48.3 (range, 25-74)	56.6	100	16.3	23.6, NR	NR	2.15	0 0	113.9/72.2
Dernellis, 2005[160] Fair	2512	64.6 (range, 35-94)	57.3	NR	21	26.8, NR	7.32	0	0 0	119.8/77.2
Everson, 2000[161] Good	616	50.4 (range, 42-60)	0	NR	33.1	25.9, NR	NR	NR	0 0	126.4/83.2
Fagot-Campagna, 1997[162] Fair	4149	49.3* (range, 43-54)	0	NR	NR	25.3, NR	0	NR	0 NR	130/80
Fitchett, 2009[163] Fair	1658	50.0 (range, 42-52)	100	36.1	NR	30.1, NR	5.1	NR	29.0 20.9	118.4/NR
Giubertoni, 2013[164] Fair	1000	55.2 (range, < 65)	100	0	17.7	26.3, NR	2.3	NR	36 NR	NR
Juhaeri, 2002[165] Good	9319	53.4 (range, 46-65)	55.1	16.8	25.9	26.7, NR	NR	NR	0 0	113.6/70.0
Player, 2007[294] (companion publication to Juhaeri, 2002) Good	2334	NR (range, 48-67)	51.7	20.2	21.5	NR, 28.41	5.0	0	0 0	NR
Jung, 2014[187] Good	1553	53.9 (range, 40-70)	62.4	100	16.7	NR, 32.5% BMI ≥25	5.67	NR	0 NR	116.9/73.8
Kim, 2006[166] Good	5889	50.8 (range, 40-69)	52.4	100	26.1	24.2, NR	9.49	NR	0 0	113.1/75.3
Kim, 2011[167] Fair	49228	37.9 (range, 30-54)	32.7	100	40.3	22.3, NR	NR	NR	NR NR	112.4/72.8
Kivimaki, 2009[168] Fair	6704	44.6 (range, 35-55)	31.1	8.2	15.7	24.3, NR	0	0	0 NR	118.9/74.6

Appendix C. Evidence Tables

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m^2), % w/ BMI > 30	% DM	% CVD	% HTN % Treated	Mean Office SBP/DBP (mm Hg)
Klein, 2006[169] Good	1878	57.6 (range, 43-84)	56.8	NR	NR	27.6, NR	0	8.0	0 NR	119/74
Kubo, 2013[188] Fair	10173	23.6 (range, <30)	0	100	49.4	21.7, NR	NR	NR	0 NR	118.9/67.2
Lakoski, 2011[170] Good	3543	59 (range, 45-84)	51.2	56.2	14.6	27.4, NR	8.2	0	0 0	NR
Muntner, 2010[295] (companion publication to Lakoski, 2011) *Good*	*3013*	*58.5 (range, 45-84)*	*53*	*55.1*	*15*	*27.2, 24*	*0*	*0*	*NR* *NR*	*114/69*
Lee, 2004a[171] Good	8170	38.7 (range, 25-50)	0	100	NR	22.5, NR	0	0	0 NR	114.9/72.7
Lee, 2001[292] (companion publication to Lee, 2004a) *Good*	*8170*	*34.7 (range, 25-50)*	*0*	*100*	*65.8*	*22.5, NR*	*0*	*0*	*0* *NR*	*114.9/72.7*
Lee, 2004b[173] Fair	5840	48.6 (range, 30-69)	41.3	100	35.6	22.9, 1.18	0	0	0 0	110.5/69.8
Lee, 2011[172] Fair	730	56.6 (range, ≥ 20)	63.7	100	24.7	23.2, NR	8.5	NR	0 NR	119.8/75.8
Levine, 2011[174] Good	3436	25.1 (range, 18-30)	57.1	46.0	26.3	24.3, 10.62	NR	NR	NR NR	109.5/68.1
Matsuo, 2011[175] Fair	5201	41.2 (range, 30-59)	0	100	41.9	23.7, NR	0	NR	NR 0	121.8/73.8
Morikawa, 1999[176] Good	1551	34.7 (range, 18-49)	0	100	66.2	22.2, NR	0	0	0 NR	117.7/69.4
Nakanishi, 2003[177] Good	3784	42.0 (range, 23-59)	0	100	49	23.0, NR	NR	NR	0 NR	121.3/72.9
Okubo, 2004[178] Fair	2107	45.8 (range, 40-54)	0	100	60.1	23.1, NR	NR	NR	NR 0	122.10/73.29
Okubo, 2014[189] Fair	115736	54.5 (range, 40-79)	67.8	100	21.6	22.8, NR	2.6	0	0 NR	120.9/73.3
Radi, 2004[144] Fair	17465	38.2 (range, 15-69)	44.5	NR	33.5	23.9, 5.95	NR	NR	NR NR	119.5/75.3
Satoh, 2010[179] Fair	2278	46 (range, 35-55)	0	100	51.1	23.7, NR	1.8	0	0 0	117/74
Schulz, 2005[180] Fair	12362	47.5 (range, 19-69)	69.1	0	22.2	24.9, 8.51	NR	NR	NR 0	119/78

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m^2), % w/ BMI > 30	% DM	% CVD	% HTN % Treated	Mean Office SBP/DBP (mm Hg)
Schulze, 2003[296] (companion publication to Schulz, 2005; women only) Fair	*8552*	*NR (range, 35-64)*	*100*	*NR*	*NR*	*NR*	*NR*	*NR*	*NR* *0*	*NR*
Shook, 2012[181] Fair	6278	44.7 (range, 20-80)	23.9	NR	11.6	25.2, NR	0	0	0 NR	115.1/76.9
Sung, 2014[186] Fair	11448	40.6 (range, NR)	30.6	100	48.9	23.6, NR	2.14	NR	0 NR	111.4/72.0
Tozawa, 2002[182] Fair	4857	46 (range, ≥ 18)	36.0	100	30	NR	4	NR	0 0	115/71
Vasan, 2001[183] Good	9845	52.1 (range, 35-94)	57.3	NR	26.4	25.8, NR	4.1	NR	0 0	118.5/74
Leitschuh, 1991[202] (companion publication to Vasan, 2001) Fair	*2099*	*NR (range, NR)*	*57.0*	*NR*	*NR*	*NR*	*NR*	*0*	*0* *0*	*118.3/75.0*
Volzke, 2013[191] Good	1605	42.9 (range, 20-79)	63.1	NR	30.3	25.4, NR	2.1	NR	0 NR	120.5/76.8
Yamada, 1991[184] Good	1492	42.4 (range, 35-54)	0	100	NR	23.1, NR	NR	NR	NR NR	119.2/73.5
Yambe, 2007[185] Good	1758	40.6 (range, < 64)	0	100	41.1	23.3, NR	0	NR	NR NR	117.9/73.6
Zambrana, 2014[190] Fair	3145	NR (range, 50-79)	100	100	7.2	NR, 30.5	NR	8.7	0 0	NR/NR

*Median

Abbreviations: BMI = body mass index; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; kg = kilogram(s); m = meter; mm Hg = millimeters of mercury; NR = not reported; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 37. Intervention characteristics of included studies for Key Question 4a and 4b

Author, Year Quality	Device*	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measure-ments	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Apostolides, 1982[153] Fair	Mercury sphyg.	U	M	3	NR	Average of 2nd and 3rd reading	Right arm	✓	NR	"Appropriately sized"	NR (NR)
Arima, 2002[154] Fair	Mercury sphyg.	U	M	3	NR	Mean of three measurements	NR	✓	5	Standard	NR (NR)
Bakx, 1987[155] Fair	Mercury sphyg.	U	M	≥ 3	NR	NR	NR	NR	NR	16 x 57 cm	NR (NR)
Boyko, 2008[156] Fair	Mercury sphyg. or Dinamap	U; O	M; A	3	1 minute	Mean of first 2 readings unless difference was >10 mm Hg in which the mean of the two closest of the 3 BP measurements used. Based on a comparison study of 469 participants using the sphygmomanometer and the Dinamap, an adjustment was made to all DBP readings recorded in the state that used the mercury device.	Arm not used during blood draw	✓	5	"Appropriate"; arm circumference was measured to select cuff size	NR (NR)
Brantsma, 2006[157] Good	Dinamap XL Model 9300	NR	A	10 (first visit), 8 (second visit) [only 4 measures contributed to mean]	1 minute	Mean of last 2 BP recordings of both visits (each screen is based on 2 visits)	Right		NR	NR	NR (NR)

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Author, Year Quality	Device*	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measure-ments	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Cacciolati, 2013[158] Fair	Omron M6	O	A	18 (max) [6 measures per day for 3 days]	3 in morning, 3 at night (2 minutes apart) over 3 consecutive days	Mean of all measurements; patients recorded measurements in logbook and measures considered successful when at least 12 measures out of 18 performed correctly (when values recorded in device matched logbook).	Left	NR	5	Adaptable sized	Self (Provided with booklet and had one individually supervised demonstration from trained lay interviewer)
	Omron M6 Simple	O	A	3	2 minutes	Mean of 3	Left arm	✓	5	Adaptable sized	Lay interviewers (Trained)
Cheung, 2012[159] Fair	Mercury sphyg.	U	M	3	5 minutes	Mean of second and third readings	Right arm, forearm resting on desk	✓	≥ 10	Standard (12 to 14 cm)	Nurse (Trained)
Dernellis, 2005[160] Fair	NR	U	NR	Unclear (1 measure at each of 3 visits or 2 measures at each of 3 visits)	1 screen consisted of 3 visits, with 15 days between visits; time between measurements within a visit NR (if even applicable - unclear)	Average value of BP measurements over three occasions	Supported at heart level	✓	5	Encircled at least 80% of arm	NR (NR)

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Author, Year Quality	Device*	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measure-ments	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Everson, 2000[161] Good	Hawksley RZ sphyg.	U	M	6	5 min (first 3), 1 min (standing), 5 min (sitting)	Last 2 supine and last 2 seated measurements averaged	NR	✓	1-15	NR	Observer (Trained)
Fagot-Campagna, 1997[162] Fair	NR	NR	NR	1	NA	1 measurement, rounded to the nearest 10 mm Hg	Right arm	✓	5	NR	Team member (Trained)
Fitchett, 2009[163] Fair	Mercury sphyg.	U	M	2	≥ 2 minutes	Average of two BP measurements	Right arm	✓	5	Appropriate sized based on measurement of arm circumference	NR (NR)
Giubertoni, 2013[164] Fair	NR	NR	NR	≥ 3 (per ESH guideline)	1-2 minutes (per ESH guideline)	NR; measurement method "in accordance to current guidelines"	Heart level	✓	NR	NR	NR (NR)
Juhaeri, 2002[165] Good	Hawksley RZ sphyg.	U	M	3	NR	Average of second and third measurements	NR	✓	5	NR	Technician (Training with Korotkoff sound tapes and double stethoscope)
Player, 2007[294] (companion publication to Juhaeri, 2002) *Good*	*Hawksley RZ sphyg.*	*U*	*M*	*3*	*30 seconds*	*Average of second and third readings*	*Right arm, on table at heart level*	✓	*5*	*Determined by arm circumference*	*Technician (Certified and working knowledge of ARIC BP manual of procedures)*

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Author, Year Quality	Device*	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measure-ments	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Jung, 2014[187] (21881) Good	Mercury sphyg.	U	M	2	≥ 5 minutes	Mean of 2 BP measurements	Right arm, at heart level	✓	≥ 5	Appropriate, based on mid-arm circumference	NR (NR)
Kim, 2006[166] Good	Mercury sphyg.	U	M	2	30 seconds	Average of all readings	NR	NR	5	Appropriate	Technician (Trained)
Kim, 2011[167] Fair	Mercury sphyg. or automatic manometer	U	M	1	NR	NR	NR	NR	NR	NR	Nurse or technician (Trained)
Kivimaki, 2009[168] Fair	Hawksley RZ sphyg.	U	M	2	5 minutes	Mean of two measurements	NR	✓	5	NR	NR (NR)
Klein, 2006[169] Good	Mercury sphyg.	U	M	3	NR	Average of second and third readings	NR	✓	NR	NR	NR (NR)
Kubo, 2013[188] (22167) Fair	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR (NR)
Lakoski, 2011[170] Good	Dinamap Pro 100	O	A	3	NR	Average of second and third readings	NR	✓	NR	NR	NR (NR)

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Author, Year Quality	Device*	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measure-ments	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Muntner, 2010[295] (companion publication to Lakoski, 2011) *Good*	*Dinamap Monitor Pro 100, GE Healthcare*	*O*	*A*	*3*	*2 minutes*	*Average of second and third readings*	*NR*	✓	*5*	*Appropriate sized*	*NR (NR)*
Lee, 2004a[171] Good	A&D TM-2650A	O	A	1 (2, if necessary)	NA (5 minutes if 2 measurements required)	1st measurement used, unless SBP ≥ 160mmHg or DBP ≥ 95mmHg, BP was measured again using ordinary sphygmomanometer by experienced nurse after 5 minutes of rest, then 2 measurements averaged.	NR	✓	≥ 5	NR	Investigator, nurse (NR)
Lee, 2004b[173] Fair	Mercury sphyg.	U	M	NR	NR	NR	NR	✓	≥ 30	NR	NR (NR)
Lee, 2001[292] (companion publication to Lee, 2004a) *Good*	*A&D TM-2650A*	*O*	*A*	*1 (2, if necessary)*	*NA (5 minutes if 2 measurements required)*	*NR*	*NR*	✓	*≥ 5*	*NR*	*Nurse (NR)*
Lee, 2011[172] Fair	NR	NR	NR	2	NR	Average of 2 BP measurements	NR	✓	5	NR	Investigator (NR)
Levine, 2011[174] Good	RZ sphyg.	U	M	3	1 minute	Mean of last two measurements	Right arm	✓	5	Appropriately sized	NR (NR)

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Author, Year Quality	Device*	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measure-ments	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Matsuo, 2011[175] Fair	Mercury sphyg.	U	M	2	NR	NR	Right arm	✓	5	Based on upper arm girth and lengths	Nurse (Trained)
Morikawa, 1999[176] Good	Mercury sphyg.	U	M	NR	NR	NR	Right arm	✓	5	NR	NR (NR)
Nakanishi, 2003[177] Good	Standard sphyg.	U	M	NR	NR	NR	Right	✓	5	NR	Technician (Properly trained for measuring BP for epidemiological surveys)
Okubo, 2004[178] Fair	BP103 II	NR	A	1 (up to 4, if necessary)	NR	One measurement, unless multiple measurement taken, then lowest BP reading used	NR	✓	5	NR	Nurse (NR)
Okubo, 2014[189] Fair	Mercury sphyg. N-300 or U-300; automated device Q9920 or Q106 starting in 2004	U, O	M, A	1 (2, if BP elevated)	Second BP taken "after several deep breaths" if BP elevated	One measurement (unless 2 taken due to elevated BP, then lower of the two measurements)	Right arm	✓		NR	Nurse (Trained)
Radi, 2004[144] Fair	Omron 705 CP	O	A	3	5, 6, 7 minutes	Mean of 3 measurements	NR	✓	5, 6, 7	Appropriate sized	Physician (NR)

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Author, Year Quality	Device*	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measure-ments	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Satoh, 2010[179] Fair	Mercury sphyg.	U	M	1	NR	NR	NR	✓	5	NR	Nurse (Trained)
Schulz, 2005[180] Fair	NR	NR	NR	3	2 minutes	NR	Right	✓	NR	12cm x 23cm	Technician (Trained)
Schulze, 2003[296] (companion pulication to Schulz, 2005; women only) Fair	BOSO Oscillomat	O	A	3	2 minutes	Mean of second and third BP measurements	Elevated at heart level	✓	15-30	14x37, 17x41 (for arm circumference > 40 cm)	Physician (NR)
Shook, 2012[181] Fair	Mercury sphyg.	U	M	2	1 minute	2 readings separated by 1 minute were averaged, unless first two readings differed by >5 mmHg, in which case additional readings were obtained.	NR	✓	≥ 5	NR	Technician (Trained)
Sung, 2014[186] Fair	Mercury sphyg.	U	M	1 (3 if BP elevated)	5 minutes (if additional measures taken due to BP elevation)	One measurement, unless BP ≥ 140/90 mm Hg, then average of two subsequent measurements	NR	✓	5	NR	Nurse (Trained)
Tozawa, 2002[182] Fair	Standard sphyg.	U	M	2	NR	Lower of two BP measurements used	NR	✓	15	"Appropriate-size"	Nurse (Trained)
Vasan, 2001[183] Good	Mercury sphyg.	U	M	2	NR	Mean of two readings	NR	✓	5	"Appropriate"	Physician (NR)

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Author, Year Quality	Device*	Oscil Or Ausc	Auto Or Man	# of Measure-ments	Time Btwn Measure-ments	Method of BP Determination	Arm Position	Sitting	Resting Time (min)	Cuff Size (cm)	Interven-tionist (training)
Leitschuh, 1991[202] (companion publication to Vasan, 2001) *Fair*	*Mercury sphyg.*	*U*	*M*	*2*	*NR*	*Averaged*	*Left arm*	✓	*NR*	*NR*	*Physician (NR)*
Volzke, 2013 [191] Good	Omron HEM-705CP	O	A	3	3 minutes	Mean of second and third readings	Right arm	✓	5	NR	NR (NR)
Yamada, 1991[184] Good	Sphyg.	U	M	NR	NR	NR	NR	✓	5	According to WHO recommendations (1978)	Physician (NR)
Yambe, 2007[185] Good	Mercury sphyg.	U	M	2	5 minutes	Mean of two measurements	NR	✓	≥ 5	Conventional cuff	physician (NR)
Zambrana, 2014[190] Fair	Mercury sphyg.	U	M	2	30 seconds	Average of 2 measurements	Right arm	✓	5	"Appropriately sized"	Staff (Certified)

*All OBPM

Abbreviations: A = automated; ABP = ambulatory blood pressure; ABPM = ambulatory blood pressure monitoring; AM = ante meridiem; BP = blood pressure; btwn = between; cm = centimeter(s); DBP = diastolic blood pressure; HBPM = home blood pressure monitoring; hr = hour(s); M = manual; min = minute(s); mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; O = oscillatory; PM = post meridiem; q = every; SBP = systolic blood pressure; sphyg = sphygmamonometer; U = auscultatory

Appendix C. Evidence Tables

Table 38. Study design characteristics of included studies for Key Question 5

Author, Year Quality	Study Design	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Ameling, 1991[192] Fair	RCT	Netherlands	331	All subjects visiting their doctor for some reason if their BP level was not known or had not been measured for > 1 year; HTN was never diagnosed before and who had a mean DBP of 2 measurements in sitting position > 95 mm Hg	Age <20 years, age >70 years, use of meds affecting BP, SBP >190 and/or DBP >125 mm Hg, pregnancy, possibility of pregnanvy during study period, use of oral contraceptives, heart failure, bradycardia (< 50 bpm), chronic hepatic, renal or metabolic disease, bronchial asthma, or COPD	0.04 (range, NR)	All participants told they were hypertensive by their physician
Haynes, 1978[193] Fair	Cohort	Canada	230	Men, average 5th-phase DBP >95 mm Hg (average of 2nd and 3rd of 3 readings taken w/patient sitting quietly on each of 2 separate occasions over 3 months); no anti-HTN meds for ≥6 months before screening; no other daily meds; no remediable secondary form of HTN	NR	1 (range, NR)	Unaware of hypertensive status
							Aware of hypertensive status
Taylor, 1981 (companion publication to Haynes, 1978)[204] *Fair*	*Cohort*	*Canada*	*230*	*Men, average 5th-phase DBP >95 mm Hg (average of 2nd and 3rd of 3 readings taken w/patient sitting quietly on each of 2 separate occasions over 3 months); no anti-HTN meds for ≥6 months before screening; no other daily meds; no remediable secondary form of HTN*	*NR*	*4 (range, NR)*	*Unaware of hypertensive status*
							Aware of hypertensive status
Mann, 1977[194] Fair	RCT	United Kingdom	699	Age 35-64 years attending MRC clinics for a BP check	Mean of 4 readings, SBP ≥200 or DBP ≥110 mm Hg, known underlying cause of HTN, anti-HTN meds in previous 3 months, normally accepted indications for treatment, previous MI or stroke w/in last 3 months, angina or intermittent claudication, concurrent serious disease, pregnancy, DM, gout, bronchial asthma, history of psychiatric disorder, serum K ≤3.4 mmol/L, blood urea ≥8.3 mmol/L	1 (range, NR)	Recalled controls (recalled on account of initially elevated BP but were reassured on second visit BP was < 200/90 mm Hg)
							Normal controls (normotensive)
							Trial participants (hypertensive)

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Author, Year Quality	Study Design	Country	N	Inclusion Criteria	Exclusion Criteria	Mean Followup and Range (years)	Interventions
Manning, 2000[199] Fair	Cohort	United Kingdom	79	Aged 18-70 years	Currently receiving anti-HTN meds; treated w/ HTN meds in the previous year	NR	ABPM (24hr)
Nasothimiou, 2013[200] Fair	Cohort	Greece	104	Consecutive adults attending an outpatient HTN clinic; untreated or if treated for <2 weeks, washed out for 4 weeks	NR	NR (range, NR)	HBPM ABPM (24hr)
Spruill, 2013[195] Good	RCT	United States	100	Healthy adults who were previously unaware of having an elevated BP, resting BP (average as the last 2/3 BP measurements taken by research assistant on an automated device) in the pre-HTN range (JNC 7: 120-139/80-89 mm Hg)	Ever having been informed of having an elevated BP by physician, ever having been prescribed anti-HTN meds, history of CVD, DM or CKD	0.25 (range, NR)	Labelled hypertensives Unlabeled hypertensives
Verdecchia, 2007[196] Fair	Cohort	Italy	2934	Office SBP ≥ 140 and DBP ≥ 90 mm Hg on ≥ 3 visits; absences of secondary causes of HTN, previous CVD and life-threatening conditions	Shift workers	7 (range, NR)	ABPM (24hr)
Viera, 2010[197] Fair	RCT	United States	97	Aged ≥ 24 years, recently had a SBP between 120-139 mm Hg and a DBP 80-89 mm Hg, spoke and read English, able to be contacted by telephone	Diagnosis of hypertension, use of anti-HTN meds, diagnosis of DM or CKD, pregnancy, most recent BP or average of 2 BP measurements during the initial study visit not in the pre-HTN range	0.25 (range, NR)	Unlabeled hypertensives Labelled hypertensives
Viera, 2011[198] Fair	Cohort	United States	60	Aged ≥ 30 years, no diagnosis of HTN and be on no meds to lower BP	Pregnancy, dementia, any condition that would preclude wearing the monitor (including an arm circumference > 46 cm), persistent AF or other arrhythmia	NR	ABPM (24hr)

Abbreviations: ABPM = ambulatory blood pressure monitoring; AF = atrial fibrillation; BP = blood pressure; bpm = beats per minute; CKD = chronic kidney disease; COPD = chronic obstructive pulmonary disease; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; hr = hour(s); JNC = Joint National Committee; K = potassium; L = liter(s); MI = myocardial infarction; mm Hg = millimeters of mercury; mmol = millimole(s); MRC = medical research clinic; NR = not reported; SBP = systolic blood pressure; w/ = with

Appendix C. Evidence Tables

Table 39. Baseline characteristics of included studies for Key Question 5

Author, Year Quality	N	Mean Age and Range (years)	% Female	% Non-White	% Smokers	Mean BMI (kg/m^2), % BMI > 30	% DM	% CVD	% HTN % Treated	Mean Office SBP/DBP (mm Hg)
Ameling, 1991[192] Fair	331	50.0 (range, NR)	43.2	NR	33.8	NR	NR	1.8	NR NR	167.4/104.7
Haynes, 1978[193] Fair	230	NR	0	NR	NR	NR	NR	NR	NR 0	NR
Taylor, 1981 (companion publication to Haynes, 1978)[204] *Fair*	*230*	*NR*	*0*	*NR*	*NR*	*NR*	*NR*	*NR*	*NR* *0*	*NR*
Mann, 1977[194] Fair	699	NR (range, 35-64)	NR	NR	NR	NR	0	NR	NR 0	NR
Manning, 2000[199] Fair	79	45 (range, 18-70)	57.0	NR	NR	NR	NR	NR	NR 0	144/93
Nasothimiou, 2013[200] Fair	104	51 (range, NR)	42	NR	23.1	28.9, NR	NR	NR	NR 0	NR
Spruill, 2013[195] Good	100	40.0 (range, 19-82)	54	64	NR	26.7, NR	0	0	0 0	126.4/79.9
Verdecchia, 2007[196] Fair	2934	50.9 (range, NR)	45.8	NR	23.6	26.8, NR	8.49	0	100 0	157/97
Viera, 2010[197] Fair	97	41 (range, 24-67)	44.3	62.9	28.9	NR	0	NR	0 0	129.0/81.9
Viera, 2011[198] Fair	60	47.6 (range, ≥ 29)	51.7	43.3	16.7	NR	NR	NR	0 0	NR

Abbreviations: BMI = body mass index; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HTN = hypertension; kg = kilogram(s); m = meter; mm Hg = millimeters of mercury; NR = not reported; SBP = systolic blood pressure

Appendix C. Evidence Tables

Table 40. Intervention characteristics of included studies for Key Question 5

Author, Year Quality	Intervention	Device	Oscil Or Ausc	Auto Or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Sitting	Resting Time (min)	Interventionist (training)
Ameling, 1991[192] Fair	All participants told they were hypertensive by their physician	NA	NA	NA	NA	NA	NA	NA	NA	NA (NA)
Haynes, 1978[193] Fair	Aware of hypertensive status	NA	NA	NA	NA	NA	NA	NA	NA	NA (NA)
	Unaware of hypertensive status	NA	NA	NA	NA	NA	NA	NA	NA	NA (NA)
Taylor, 1981 (companion publication to Haynes, 1978)[204] *Fair*	*Aware of hypertensive status*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA (NA)*
	Unaware of hypertensive status	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA*	*NA (NA)*
Mann, 1977[194] Fair	Normal controls (normotensive)	Hawksley RZ or London School of Hygiene	U	M	2	NR	NR	✓	10	Nurse (Trained)
	Recalled controls (recalled on account of initially elevated BP but were reassured on second visit BP was < 200/90 mm Hg)	Hawksley RZ or London School of Hygiene	U	M	2	NR	Mean of first four measurements	✓	10	Nurse (Trained)
	Trial participants (hypertensive)	Hawksley RZ or London School of Hygiene	U	M	2	NR	Mean of first four measurements	✓	10	Nurse (Trained)

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Author, Year Quality	Intervention	Device	Oscil Or Ausc	Auto Or Man	# of Measurements	Time Btwn Measurements	Method of BP Determination	Sitting	Resting Time (min)	Interventionist (training)
Manning, 2000[199] Fair	ABPM (24hr)	Medilog ABP	U	NR	64 (max)	q15min 7 AM - 3 PM; q30min thereafter	NR	NR	NR	NR (NR)
Nasothimiou, 2013[200] Fair	ABPM (24hr)	Space-Labs 90207 or 90217; MicroLife Watch BP O3	O	A	72 (max)	q20min	NR	NR	NR	12x32 or 14x30; 12-22 or 15-30
	HBPM	Microlife Watch BP Home	O	A	4 per day for 7 days (28 max)	1 minute (2 measurements in morning 6:00 AM - 9:00 AM; 2 measurements in evening 6:00 PM - 9:00 PM)	NR	NR	5	12-24 or 15-32
Spruill, 2013[195] Good	Labelled hypertensives	NR	NR	NR	NR	NR	NR	NR	NR	Physician (NR)
	Unlabelled hypertensives	NR	NR	NR	NR	NR	NR	NR	NR	Physician (NR)
Verdecchia, 2007[196] Fair	ABPM (24hr)	Space-Labs 5200, 90202, or 90207	O	A	96 (max)	15 minutes	NR	NR	NR	NR (NR)
Viera, 2010[197] Fair	Labelled hypertensives	NA	NA	NA	NA	NA	NA	NA	NA	Research assistant (Trained)
	Unlabelled hypertensives	NA	NA	NA	NA	NA	NA	NA	NA	Research assistant (Trained)
Viera, 2011[198] Fair	ABPM (24hr)	Oscar 2	O	A	41 (max)	q30min during daytime; q60min during nighttime	NR	NR	NR	NR (NA)

Abbreviations: A = automated; ABP = ambulatory blood pressure; AM = ante meridiem; BP = blood pressure; btwn = between; hr = hour; min = minute(s); NA = not applicable; NR = not reported; q = every; O = oscillometry; PM = post meridem; RZ = random zero; U = auscultatory

Appendix C. Evidence Tables

Table 41. Results of included studies for Key Question 5

Outcome Category	Author, Year Quality	Outcome	F/U (m)	Intervention Group	N	BL Mean (SE) or Number (%)	Follow-up Mean (SE) or Number (%), p-value vs. BL	Difference between groups
Absentee-ism	Haynes, 1978[193] Fair	Absenteeism due to illness (days/year)	12	Aware	70	5.4 (1.4)	6.1 (1.9), NS	p<0.05
				Unaware	138	2.7 (0.61)	8.4 (1.6), p<0.01	
		Duration of illness episodes (days)	12	Aware	70	1.9 (0.38)	2.7 (0.68), NS	p<0.05
				Unaware	138	1.1 (0.17)	4.0 (1.0), p<0.05	
		Number of illness episodes (number/year)	12	Aware	70	1.6 (1.9)	1.6 (1.9), NS	NSD
				Unaware	138	1.2 (0.14)	1.6 (0.18), p<0.05	
		Total absenteeism (days/year)	12	Aware	70	7.0 (1.4)	11.1 (3.7), NS	NSD
				Unaware	138	6.6 (1.6)	12.3 (2.7), p<0.05	
	Taylor, 1981 (companion publication to Haynes, 1978)[204] *Fair*	*Total absenteeism (days/year)*	*12*	*Aware*	*72*	*6.18 (1.606)*	*6.16 (1.952)*	*NR*
				Unaware	*149*	*3.49 (0.711)*	*9.45 (1.630), p<0.01*	
		Total absenteeism (days/year)	*24*	*Aware*	*69*	*6.18 (1.606)*	*6.06 (1.430)*	*NR*
				Unaware	*141*	*3.49 (0.711)*	*9.15 (2.524), p<0.01*	
		Total absenteeism (days/year)	*36*	*Aware*	*66*	*6.18 (1.606)*	*10.89 (3.063)*	*NR*
				Unaware	*137*	*3.49 (0.711)*	*12.14 (2.447), p<0.01*	
		Total absenteeism (days/year)	*48*	*Aware*	*66*	*6.18 (1.606)*	*7.84 (2.515)*	*NR*
				Unaware	*136*	*3.49 (0.711)*	*9.07 (2.486), p<0.01*	
Quality of Life	Ameling, 1991[192] Fair	Angry, AML (score)	0.5	Hypertensives	331	4.6 (NR)	3.9‡ (NR), p<0.05	NA
		Anxious, AML (score)	0.5	Hypertensives	331	7.5 (NR)	6.9‡ (NR), NS	NA
		Arrogant, AML (score)	0.5	Hypertensives	331	2.8 (NR)	2.8‡ (NR), NS	NA
		Depressive, AML (score)	0.5	Hypertensives	331	4.6 (NR)	4.0‡ (NR), p<0.05	NA
		Elated, AML (score)	0.5	Hypertensives	331	12.8 (NR)	12.2‡ (NR), NS	NA
		Indifferent, AML (score)	0.5	Hypertensives	331	5.9 (NR)	5.2‡ (NR), p<0.05	NA
		Moody, AML (score)	0.5	Hypertensives	331	5.2 (NR)	4.8‡ (NR), NS	NA
		Physical symptoms (score)	0.5	Hypertensives	331	15.1 (NR)	14.4‡ (NR), p<0.05	NA
		Sexual function (score)	0.5	Hypertensives	331	3.5 (NR)	3.4‡ (NR), NS	NA
		Shy, AML (score)	0.5	Hypertensives	331	4.6 (NR)	4.0‡ (NR), p<0.05	NA
		Sleep dysfunction (score)	0.5	Hypertensives	331	3.5 (NR)	3.1‡ (NR), p<0.05	NA
		Tired, AML (score)	0.5	Hypertensives	331	5.9 (NR)	5.3‡ (NR), p<0.05	NA
	Mann, 1977[194] Fair	GHQ, deteriorated (number of participants)	0.25	Normal controls	215	NR (NR)	21 (9.8%)	NSD
				Recalled controls	204	NR (NR)	17 (8.3%)	
				Trial participants	235	NR (NR)	26 (11.1%)	
		GHQ, improved (number of participants)	0.25	Normal controls	215	NR (NR)	16 (7.4%)	NSD
				Recalled controls	204	NR (NR)	18 (8.8%)	
				Trial participants	235	NR (NR)	10 (4.3%)	
		GHQ, negative response (number of participants)	0.25	Normal controls	215	175 (81.4%)	180 (83.7%)	NR
				Recalled controls	204	169 (82.8%)	168 (82.4%)	
				Trial participants	235	191 (81.3%)	207 (88.1%)	
		GHQ, positive response (number of participants)	0.25	Normal controls	215	40 (18.6%)	35 (16.3%)	NR
				Recalled controls	204	35 (17.2%)	36 (17.6%)	
				Trial participants	235	44 (18.7%)	28 (11.9%)	

Appendix C. Evidence Tables

Outcome Category	Author, Year Quality	Outcome	F/U (m)	Intervention Group	N	BL Mean (SE) or Number (%)	Follow-up Mean (SE) or Number (%), p-value vs. BL	Difference between groups
	Spruill, 2013[195] Good	Mental health, SF-12 (score)	3	Labelled	47	46.9 (6.1)*	-0.2 (95% CI, -2.9 to 2.5)†	p=0.56
				Unlabeled	50	46.3 (9.2)*	2.1 (95% CI, -0.9 to 5.1)	
		Physical health, SF-12 (score)	3	Labelled	47	50.5 (3.6)*	-1.7 (95% CI, -2.8 to -0.6)†	p=0.23
				Unlabeled	50	47.8 (6.9)*	-0.6 (95% CI, -2.4 to 1.2)†	
	Viera, 2010[197] Fair	Deteriorated (number of participants)	3	Labelled	38	NR (NR)	0 (0%)	Overall change in health, p=0.78
				Unlabeled	32	NR (NR)	1 (3.1%)	
		Improved (number of participants)	3	Labelled	38	NR (NR)	16 (42.1%)	
				Unlabeled	32	NR (NR)	13 (40.6%)	
		No change (number of participants)	3	Labelled	38	NR (NR)	22 (57.9%)	
				Unlabeled	32	NR (NR)	18 (56.3%)	
		SF-36 (one question), excellent health (number of participants)	3	Labelled	38	NR (NR)	10 (26.3%)	Overall self-reported health, p=0.30
				Unlabeled	32	NR (NR)	4 (12.5%)	
		SF-36 (one question), very good health (number of participants)	3	Labelled	38	NR (NR)	14 (36.8%)	
				Unlabeled	32	NR (NR)	14 (43.8%)	
		SF-36 (one question), good health (number of participants)	3	Labelled	38	NR (NR)	11 (29.0%)	
				Unlabeled	32	NR (NR)	11 (34.4%)	
		SF-36 (one question), fair health (number of participants)	3	Labelled	38	NR (NR)	3 (7.9%)	
				Unlabeled	32	NR (NR)	3 (9.4%)	
		SF-36 (one question), poor health (number of participants)	3	Labelled	38	NR (NR)	0 (0%)	
				Unlabeled	32	NR (NR)	0 (0%)	
Sleep Disturbance	Manning, 2000[199] Fair	Poor sleep quality (number of participants)	Post	ABPM	79	NR (NR)	29 (37%)	NA
	Verdecchia, 2007[196] Fair	Sleep duration < 2 hours < usual (number of participants)	Post	ABPM	2924	NR (NR)	807 (27.6%)	NA
		Sleep duration 2-4 hours < usual (number of participants)	Post	ABPM	2924	NR (NR)	281 (9.6%)	NA
		Sleep duration >4 hours < usual (number of participants)	Post	ABPM	2924	NR (NR)	117 (4.0%)	NA
		Sleep duration as usual (number of participants)	Post	ABPM	2924	NR (NR)	1711 (58.5%)	NA
		Sleep duration 2+ < usual (number of participants)	Post	ABPM (Space-Labs Model 90207 only)	1849	NR (NR)	239 (12.9%)	p=0.037 between devices
		Sleep duration 2+ < usual (number of participants)	Post	ABPM (Space-Labs Model 90202 only)	772	NR (NR)	104 (13.5%)	p=0.037 between devices
		Sleep duration 2+ < usual (number of participants)	Post	ABPM (Space-Labs Model 5200 only)	313	NR (NR)	57 (18.3%)	p=0.037 between devices

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Outcome Category	Author, Year Quality	Outcome	F/U (m)	Intervention Group	N	BL Mean (SE) or Number (%)	Follow-up Mean (SE) or Number (%), p-value vs. BL	Difference between groups
	Viera, 2011[198] Fair	Disturbed significantly to remove it during night (number of participants)	0.25	ABPM	60	5 (8.8%)	5 (8.8%), p=1.0	NA
		Interfered with normal sleep pattern (score)	0.25	ABPM	60	4.2 (3.3)*	4.3 (3.5)*, p=0.84	NA
		Stopped from falling asleep (number of participants)	0.25	ABPM	60	12 (19.6%)	10 (16.1%), p=0.48	NA
		Woke up after falling asleep (number of participants)	0.25	ABPM	60	42 (70.2%)	39 (64.9%), p=0.41	NA
Adverse Effects and Tolerability of ABPM	Viera, 2011[198] Fair	Disturbed significantly to remove it during day (number of participants)	0.25	ABPM	60	3 (5.1%)	5 (8.5%), p=0.32	NA
		Bruising (number of participants)	0.25	ABPM	60	4 (6.8%)	12 (20.3%), p=0.02	NA
		Pain (number of participants)	0.25	ABPM	60	20 (33.9%)	21 (35.6%), p=0.76	NA
		Skin irritation (number of participants)	0.25	ABPM	60	23 (39.0%)	27 (45.8%), p=0.35	NA
		Found monitor embarrassing (score)	0.25	ABPM	60	1.7 (2.8)*	2.2 (3.0)*, p=0.04	NA
	Nasothimiou, 2013[200] Fair	Daily restriction, moderate to severe (number of participants)	NR	ABPM (24hr)	104	NR (NR)	31 (30)	NR
			NR	HBPM	104	NR (NR)	7 (7)	
		Daily restriction, moderate to severe (points on Likert scale)	NR	ABPM (24hr)	104	NR (NR)	1.6 (1.5)	p<0.001
			NR	HBPM	104	NR (NR)	0.6 (1.0)	
		Discomfort, moderate to severe (number of participants)	NR	ABPM (24hr)	104	NR (NR)	57 (55)	NR
			NR	HBPM	104	NR (NR)	14 (13)	
		Discomfort, moderate to severe (points on Likert scale)	NR	ABPM (24hr)	104	NR (NR)	2.7 (1.3)	p<0.001
			NR	HBPM	104	NR (NR)	1.5 (0.8)	

*SD
†Mean difference
‡Decrease in value signifies an improvement.
Abbreviations: ABPM = ambulatory blood pressure monitoring; AML = Amsterdam Mood List; BL = baseline; CI = confidence interval; F/U = followup; GHQ = General Health Questionnaire; NA = not applicable; NR = not reported; NS = not significant; NSD = no significant different; SE = standard error; SF = Short Form

Appendix D. Prognosis of Isolated Clinic Hypertension From Included Studies in Key Question 3a

Study	N	Definition of Isolated Clinic Hypertension	Risk for CV Events: Isolated Clinic Hypertensives vs. Normotensives	Risk for CV Events: Sustained Hypertensives vs. Isolated Clinic Hypertensives	Risk for CV Events: Sustained Hypertensives vs Normotensives
Fagard, 2005[117]	391	OBPM ≥140/90 mm Hg and daytime ABPM <135/85 mm Hg	HR* (95% CI): NR; p=0.85	HR* (95% CI): 2.16 (1.16 to 4.01; p=0.01) (Similar results whether all participants or untreated only)	NR
Ohkubo, 2005[125]	1332	OBPM ≥140/90 mm Hg and daytime ABPM <135/85 mm Hg	HR* (95% CI) CVD Mortality: 1.54 (0.73 to 3.21) Stroke: 1.07 (0.58 to 2.07) CVD Mortality/Stroke: 1.28 (0.76 to 2.14)	NR	HR* (95% CI): CVD Mortality: 1.94 (1.04 to 3.61) Stroke: 2.83 (1.77 to 4.54) CVD Mortality/Stroke: 2.26 (1.49 to 3.41)
Ingelsson, 2006[121]	951	OBPM ≥140/90 mm Hg and daytime ABPM <135/85 mm Hg	HR for CHF (95% CI): 2.01 (0.82 to 4.91)	NR	NR HR* (95% CI) for CHF: 1.75 (0.80 to 3.85)
Celis, 2002[114]	419	Office DBP ≥95 mm Hg and daytime ABPM <140/90 mm Hg	NR	All 22 major CV events occurred in sustained hypertensives with none among white coat hypertensives; between-group difference p=0.02	NR
Clement, 2003[115]	1963	NR	NR	Patients with baseline office SBP 140-159 mm Hg: RR* (95% CI): 1.82 (0.92 to 3.56) Patients with baseline office SBP ≥160 mm Hg: RR* (95% CI): 2.31 (1.26 to 4.22)	NR
Bobrie, 2004[113]	4939	OBPM ≥140/90 mm Hg and HBPM <135/85 mm Hg	NR	Incidence of CV events in ICH patients (12.1 [7.3 to 16.9] per 1000 patient-years) same as patients with controlled HTN (11.1 [6.5 to 15.6] per 1000 patient-years) and lower than patients with uncontrolled HTN (25.6 [22.4 to 28.9] per 1000 patient-years)	NR
Khattar, 1998[201] *Excluded study*	479	Office SBP 140-180 mm Hg and 24-hour intra-arterial ABPM <140/90 mm Hg	NR	Events among isolated clinic hypertensives significantly lower than in sustained hypertensives (1.32 vs. 2.56 events per 100 patient-years; p <0.001)	NR

* Adjusted for baseline covariates

Abbreviations: ABPM = ambulatory blood pressure monitoring; CHF = congestive heart failure; CI = confidence interval; CV = cardiovascular; CVD = cardiovascular disease; HBPM = home blood pressure monitoring; HTN = hypertension; HR= hazard ratio; mm Hg = millimeters of mercury; NR = not reported; OBPM = office blood pressure measurement; RR = relative risk; SBP = systolic blood pressure; ICH=isolated clinic hypertension.

Appendix E. Ongoing Studies

We identified two potentially relevant ongoing or recently completed trials through four registries: ClinicalTrials.gov (http://clinicaltrials.gov), Current Controlled Trials (http://www.controlled-trials.com), Australian New Zealand Clinical Trials Registry (http://www.anzctr.org.au), and the World Health Organization's International Clinical Trials Registry Platform (http://www.who.int/ictrp). We restricted our searches to high blood pressure screening and diagnostic studies only; intervention studies were not examined.

We identified one trial, the Viborg Vascular (VIVA) screening trial, in 50,000 men ages 65 to 74 years from Denmark who were randomized to vascular screening (i.e., screening for hypertension, lower limb atherosclerosis, and abdominal aortic aneurysm) or not.[297] Nurses used a blood pressure cuff to screen for high blood pressure. All-cause mortality is the primary outcome; secondary outcomes include cardiovascular-related deaths, hospital services related to cardiovascular condition, health-related quality of life, and cost effectiveness. Followup will be performed at 3, 5, 10, and 15 years. The anticipated study completion date is December 2023.

We also identified a recently completed trial examining the harms of diagnostic labeling of prehypertension.[298] One hundred adults age 18 years or older were randomized to labeled or unlabeled diagnostic groups. Physicians informed the labeled group of their blood pressure level after screening and those in the unlabeled group were not informed of their blood pressure status. Investigators examined changes in blood pressure and health-related quality of life after 3 months of followup. No publications were identified as of March 2013.

Study details provided by the trial registries are limited; many of the identified ongoing studies may be excluded for a variety of reasons upon publication of the methods and/or results.