

# Home Blood Pressure Monitoring (HBPM): The way forward for Sri Lanka; a review article

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## Abstract

Hypertension is a major preventable cause of cardiovascular and kidney related morbidity and mortality. It affects one third of the Sri Lankan population and is the single leading cause of death annually. Home blood pressure monitoring (HBPM) gained interest compared to office BP measurement (OBPM) after several studies demonstrated its superior prognostic value in predicting cardiovascular risk. White coat uncontrolled hypertension (WUCH) and masked uncontrolled hypertension (MUCH) may be overlooked in office BP measurement. Both of these phenomena are correctly identified in HBPM. Behavioural modification, patient involvement and initiation of antihypertensive medications at the right point are important in the management of hypertension. HBPM allows healthcare providers to make behavioural and pharmacological modification at the crucial point, because of the accuracy in BP measurement. Further it reduces health expenditure in the long run by reducing outpatient clinic visits and preventing adverse cardiovascular and kidney related outcomes. Given the challenges posed by the pandemic, HBPM is a better option in managing hypertension with the help of technology and telehealth. However further studies are needed on HBPM in Sri Lanka to analyse the efficacy in our own context.

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**Key words:** Home blood pressure monitoring, Office blood pressure, out-of-office blood pressure

## Introduction

Hypertension is a major modifiable risk factor in the prevention of cardiac events, stroke and kidney disease (1). It is a public health problem which has been a leading cause of premature death globally (2). It is estimated that as much as 7.6 million deaths occur due to hypertension in a calendar year worldwide (13.5% of total) which is more than that of any other cause (3). Its prevalence has been estimated to be 28.5 % and 31.5% in high and low middle income countries respectively (4). The prevalence of hypertension in Sri Lanka too, shows an increase, and it is estimated to be nearly one third of the adult population (1). According to WHO

statistics it was 26.2 % in 2014 (1). . Early accurate diagnosis, initiation of treatment and keeping the blood pressure within optimal targets are mandatory to prevent hypertension mediated target organ damage (HMOD) and improve the outcome (5).

This article is a narrative overview to emphasise the importance of home blood pressure monitoring in Sri Lanka. Articles related to HBPM were screened in EMBASE, SCOPUS, LILACS, PubMed and Google scholar electronic databases using "home based blood pressure monitoring" and "tele monitoring of blood pressure" as key words. Key articles were selectively reappraised for the synthesis of this review article.

### Accuracy of measurement and importance of longitudinal monitoring

Accuracy of BP measurement plays a pivotal role in initiating treatment and long term control (6). It depends on various factors including environment, diurnal changes, posture and emotional state of patient, equipment, presence of health care worker and presence of other non-communicable diseases (5). Minimising BP measurement errors through standardised technique would be necessary in the long-term management strategy (7). Though, there are few consensus reached regarding BP measurement technique by different associations such as American College of Cardiology (ACC), American Heart Association (AHA) and European Society of Cardiology (ESC), they have not been put forth into the practice, because multiple readings are time consuming and there's a lack of awareness regarding measurement accuracy.(8–10)

Blood pressure should be monitored by the patient or healthcare provider throughout the period of treatment to identify uncontrolled hypertension. Regular BP monitoring would help to determine the need for additional antihypertensive medication and assess treatment efficacy. Further, HBPM promotes active involvement of patients in the management which improves compliance (9,11). The monitoring frequency can be decided based on the risk of complications (5,11,12).

There are a few ways in which a BP measurement could be obtained. Making a BP recording at an office or screening setting is considered as office blood pressure measurement (OBPM) (2,10). Measuring BP at a healthcare or home setting other than office is known as out-of-office BP monitoring (OOBP). Ambulatory blood pressure measurement (ABPM) is taken while the patient performs routine daily activities (2,3,11). Home BP Measurement is done using automated devices by a healthcare worker (HCW) or the patient himself (4,7).

### White coat uncontrolled hypertension and Masked uncontrolled hypertension

White coat phenomenon is often encountered when blood pressure is measured in the clinic setting(13–15). It is further classified into white coat hypertension (WCH) and white coat effect (WCE) (13–16). A transiently high BP in the clinic setting with a normal OOBPM is considered to be a WCE, whereas a persistently high OOBPM with a normal OOBPM is labelled as white coat hypertension (13,14). Although it was considered as a clinically innocent phenomenon until recently, growing evidence suggests that the adverse metabolic and cardiovascular outcomes cumulating to morbidity and mortality are higher in WCH when compared to treated hypertensive individuals(14,15).

Prevalence of WCH varies in different populations in accordance with age, sex and ethnicity (7,16,17). It is not studied yet in the Sri Lankan setting. Of the available data, it is 15 % and 40% in the general and hypertensive population respectively (15). Recent guidelines on hypertension claim that WCH is found in more than 50% of the older population with hypertension (17). Considering the expenditure spent for adverse CV events, there is still an unmet need for research in WCH in Sri Lanka. (7,14,17).

Masked hypertension (MH) is diagnosed when high BP is detected in HBPM or ABPM while having normal OBPM.(13). Further, in treated patients, if they have normal OBPM with increased BP in HBPM or ABPM, it is considered as masked uncontrolled hypertension (MUCH) (13,18). Prevalence of MH ranges from 10-40% in the Caucasian population and it's not yet estimated in our country (13,14). Evidence suggests, MH can be identified in 14% and 11% people by ABPM and HBPM respectively (14,15,18). MH increases adverse CV events by 2 and 2.28 times in normotensive and treated hypertensive patients respectively (13). MH leads to high incidence of unfavourable outcomes and HBPM helps in identification of true hypertensive patients unidentified otherwise (19).

### ABPM or HBPM; which is better in Sri Lanka?

ABPM is the gold standard in the diagnosis of hypertension (20,21). Even though most of the guidelines recommend using ABPM as a tool to evaluate HMOD and CV outcomes, it is difficult to practise in the Sri Lankan setting for various reasons. Inability to afford ABPM devices in our state health sector is a major limiting factor. The inconvenience experienced by both the patients and healthcare workers when recording BP readings throughout a single day, consuming much time and needing a technician to handle ABPM are the other drawbacks in using ABPM. HBPM could be a better option in screening, diagnosis, long-term follow up and titration of drug therapy in management of hypertension in the Sri Lankan setting compared to ABPM (3,11,22).

### Measurement of BP at home

Patients are educated regarding hypertension, adherence to pharmacological management and lifestyle modification, together with the advice on measurement technique. Resting for five minutes before taking a reading is advised (24). Avoidance of tight clothing around the arm is preferred. Smoking, eating, consumption of tea or coffee and exercise should be avoided 30 minutes before the measurement. Supine position is preferable (18,24,25).

If BP measurement is taken in a seated position, the back should be supported with feet on the ground without crossing the legs(24). Alternatively, another family member can measure the BP if the patient is unable to measure. The cuff is placed on the arm with the lower edge of the cuff being kept 2 cm above the elbow joint. Also, the forearm is rested at chest level while the BP measurement is taken (24). Measurements have to be taken from both arms and the higher systolic BP reading is considered. Previously recorded BP readings are compared with new readings (25).

### Indications and Advantages of HBPM

The advantages of HBPM are that it identifies white coat hypertension, avoids white coat effect and unusual variations in between measurements

and also helps in diagnosing masked hypertension (21,26,27). It is used to assess the treatment efficacy (28). Doses of the medications can be titrated precisely to optimise long term control. It improves compliance, patient awareness and prognosis (20,22). It is a relative indication for screening in people with BP in prehypertension range. HBPM can also be used in certain groups of patients who require stringent control such as progressive kidney disease and preeclampsia (29,30). As the incidence of resistant hypertension (RH) is also on the rise for several reasons, HBPM plays a crucial role in precise monitoring of BP (31).

HBPM has been recommended in several hypertension guidelines for reducing cardiovascular morbidity and mortality over OBPM (23,29). It has a significant impact on achieving the desired BP targets. HBPM also has better correlation with identifying LVH early (14,32). In summary, deriving an average BP value from multiple readings helps to avoid errors and identify WCE, WCH and MH (14,18). It also helps to improve the long-term monitoring of hypertension and patient related factors such as compliance, convenience, and economic benefits (33,34).

### Scope of HBPM in the pandemic

Since the emergence of COVID 19 infection, adverse cardiovascular thrombotic events are on the rise, mostly due to active or post COVID complications as evidenced by many studies. (26). Presence of multiple cardiovascular risk factors in addition to hypertension increases the risk for adverse cardiac outcomes (16,35). Thus, monitoring of blood pressure is important in post COVID patients with hypertension and multiple comorbidities (8). Telemonitoring, fine adjustments in management, reduction in clinic visits and maintenance of self-health records by patients themselves are all made possible through HBPM (34).

### Limitations and timely intervention

Measuring the blood pressure using an automated device is a matter of concern compared to the manual measurement as machine related errors

and interpersonal technique errors can occur (19). But, multiple measurements with an average value reduces the risk of inaccurate measurement (35). Inability to employ trained staff to supervise the measuring technique is a limitation of HBPM (11). Further, compliance may be affected by high or normal readings. Few normal readings may make them skip medications and higher readings may cause anxiety. Explaining to patients beforehand will help to overcome these problems. The main disadvantage of conventional HBPM is the high cost of purchasing and maintaining the equipment (replacement of batteries).

Patients with uncontrolled hypertension need timely intervention (13,14). Together with

behavioural modifications, antihypertensive medications need to be started or titrated (36). When patients maintain a self-health registry regarding their blood pressure, they can approach health providers without a delay when an alarming reading is noted (37). This indicates active participation of the patient in their management and allows health providers to identify people at high risk for adverse cardiovascular outcomes (37). Further, longitudinal monitoring of BP reduces the health expenditure that is spent for adverse coronary events, stroke and chronic renal disease (29,33,36). Research evidence regarding cost effectiveness of HBPM is scarce. Therefore, further studies are needed to assess the long-term effectiveness of HBPM.

**Table 1** - important Studies in Home Blood Pressure Monitoring

Author	Year	Type	Number of participants	Outcomes and Conclusion
McManus et al (4)	2011-2013	RCT	n=450	Among patients with hypertension at high risk of cardiovascular disease, self-monitoring with self-titration of antihypertensive medication compared to usual methods, resulted in lower SBPs.
Margolis et al (33)	2013	RCT	n=450	HBPM, telemonitoring and pharmacist case management achieved better than usual clinic care with intervention.
Bray et al (2010) (40)	2010	Meta-analysis	n=6038	Self-monitoring of BP reduces BP by small but significant amounts
Sega et al (2003-2004) (41)	2003-2004	Prospective cohort	n=2051	Cardiovascular mortality is increased in elevation in HBPM and ABPM than OBP
Fagard et al (1990-2003) (22)	1990-2003	Prospective cohort	n=391	Prognostic value of HBP is better than that of OBP in older patients in primary care.
Tsunoda et al (1993-1998) (42)	1993-1998	Prospective cohort	n=209	HBP was more effective than Clinic BP (CBP) as a predictor of changes in LVH in hypertensive patients who are on treatment.

**RCT**– Randomised controlled trial, **HBP** – Home based blood pressure, **OBP** – Office blood pressure, **CBP** – Clinic BP, **LVH** – Left ventricular hypertrophy

## Studies regarding HBPM

Ward et al conducted a systematic review and meta-analysis on home based blood pressure (HBP) in relation to all causes of CV outcomes in 2012. They have reviewed 8 prospective studies (n = 17698) for all causes of mortality and concluded that HBP remained a significant predictor of CV mortality and an important prognostic variable over office blood pressure (OBP) (38). A study conducted by Niiranen et al concluded that population based, outcome driven thresholds for HBP are slightly lower than OBP proposed in current hypertension guidelines (39).

The study conducted by Stergiou et al on the need for HBP on MH and WCH in patients suspected and treated for hypertension concluded that HBP had prognostic significance. (20)

## Conclusion

HBPM is a feasible, novel and cost-effective way of assessing BP control. Indications for HBPM are WCH, MH and monitoring of resistant hypertension. It has a prognostic superiority over clinic-based blood pressure measurement in predicting adverse CV endpoints and HMOD and shows a better correlation with LVH.

Further, longitudinal monitoring in people with WCH and MH yields better outcomes. The proactive role played by the patient in HBPM and self maintenance of health records optimises management of hypertension. Considering multiple factors such as work overload at clinics, limited access to new technology that contribute to suboptimal management of hypertension at the state hospital setup in Sri Lanka, HBPM appears to be an effective way forward.

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