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Original Article

Current practices and knowledge of home blood pressure monitoring among people with hypertension: Insights from a Multicentric study from North India

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ABSTRACT

Objectives: Hypertension (HTN) management guidelines recommend home blood pressure monitoring (HBPM) as an important tool for BP control. Limited data exists on HBPM epidemiology among people with HTN and their caregivers in the Indian context.

Methods: The current study was conducted across three North Indian centres to evaluate the prevalence, training and technique of HBPM among people with HTN and their caregivers. People with diagnosed HTN (>3 months duration) and their caregivers, were screened and their HBPM use was evaluated. HBPM practices were assessed by observing participants measuring BP using a pre-validated, structured 16-point observational checklist. HBPM knowledge was assessed using a 19-point self-administered questionnaire based on the most recent AHA guidelines. Responses were graded and classified based on quartiles.

Results: A total of 2750 participants were screened, of which 2588 (2070 from urban and 518 from rural areas) were included. A total of 468 (18.1 %) were using HBPM. The proportion of respondents using HBPM was 20.5 % (424/2070) in urban, and 8.5 % (44/518) in rural areas. Only 24.7 % (n = 116) of the 468 participants (236 patients and 232 caregivers) using HBPM at home recalled ever receiving training from any healthcare workers. The majority (75.2 %, 352/468) of participants reported learning HBPM themselves through observation, videos, and reading.

In HBPM practice assessment, 15.9 % of people with HTN (37/232) vs 5.9 % caregivers (14/236) scored excellent (score >75 %). In HPBM knowledge assessment, 0.4 % of people with HTN (1/232) vs no caregivers scored excellent. HPBM practices were better than knowledge, with mean scores of 62.3 ± 13.1 % and 40.1 ± 16.2 % respectively. Higher education level was associated with improved patient knowledge (p = 0.041), but not practices (p = 0.225).

Conclusions: There is need for more robust training on HBPM to enable people from all backgrounds to better manage their HTN, especially in rural areas. Education is not a barrier to learning good HBPM technique.

1. Introduction

Hypertension (HTN) is the primary cause of cardiovascular morbidity and mortality worldwide and globally accounts for roughly 9 million deaths annually.[1–3] Early and effective control of blood pressure (BP) is essential for improving outcomes and reducing its adverse cardiovascular impact in the form of cerebrovascular disease, coronary artery disease, arrythmia and heart failure.[4–6] However, less than 30 % of the people with HTN achieve satisfactory BP control largely due to poor medication adherence and BP monitoring.[4,7] Additionally, BP

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naturally fluctuates with time, making it a dynamic target that is challenging to control satisfactorily.

Variability in BP reading, either as exaggerated BP readings (white coat hypertension) or underestimation (masked hypertension) of true BP readings, is common and may hinder accurate assessment and diagnosis in office settings. Multiple BP readings in out-of-office or home setting, preferably taken during one's daily routine, are shown to most closely correlate with long-term outcomes and are the ones that should be preferably considered during BP management. Over the last few decades, home blood pressure monitoring (HBPM) has been successfully employed as an adjunct in clinical practice to improve overall BP control and optimize antihypertensive therapy. When used as per standard recommendations, HBPM, popularly known as self-measured BP, when used appropriately according to standard recommendations, not only identifies white coat and masked HTN but also has been well demonstrated to prevent cardiovascular events and reduce overall mortality.[3,5,8,9] Moreover, self-monitoring of BP promotes patient engagement in their care, improving medication adherence and BP control. As a result, leading cardiovascular societies around the globe recommend the incorporation of HBPM in routine clinical practice for better BP control.[7,10,11]

Though the uptake of HBPM has increased in the hypertensive community over the last few decades, it continues to be grossly underutilized, with less than 1 in 4 hypertensive patients using HBPM in routine.[12] Utilization rates are particularly low in the developing world and among Asians, where only about 15 % using HBPM to manage their BP.[13] The primary barriers to adoption include limited physician recommendations for its use, lack of knowledge about HTN and its impact on the cardiovascular system, little understanding of HBPM and its usage, financial constraints, and compliance issues. Notably, even when the physicians recommend using HBPM, only about 1/3rd of the physicians provide instructions to the patients regarding proper HBPM use and technique.[13,14] Since the minor mistakes that a patient makes while measuring their BP tend to replicate and substantially alter the BP measurements, the validity of these readings must be ensured to allow for appropriate medication titration. Hence, there is an urgent need is to educate people on its optimal HBPM techniques to minimize error and enhance treatment optimization.[15]

The ideal approach is to identify common errors while taking BP measurements at home using an automated BP apparatus, educating patients and subsequently reinforcing the correct technique through demonstration. In India, which has lower literacy rates compared to the Western population, elderly patients often rely on their younger family members for HBPM, and hence, education and training of these caregivers are equally important to ensure accurate BP readings.

Accordingly, this prospective study aimed to assess the knowledge and practices of HBPM techniques among people with HTN and their caregivers who routinely measure BP at home. We also sought to identify the knowledge gaps, common errors in HBPM technique, and determine any correlation between sociodemographic parameters and participant knowledge and practices.

2. Methods

2.1. Study design and population

This observational, cross-sectional, and prospective study was started after ethics approval from the Institutional Ethics Committee (IEC approval no: 2022-800, dated 22nd November 2022; ref no: DMCH/R&D/2022/98). It was conducted according to good clinical practice (GCP) rules from November 2022 to February 2023.

Participants were recruited from 3 hospitals in North India- 1 tertiary care urban hospital and 2 community health centres in semi-urban and rural areas to account for differences in local practices and patient behaviours. People with HTN and their accompanying caregivers visiting various outpatient departments (OPDs) of these hospitals were screened. The eligible population included people with HTN (as per 2017 ACC/AHA guidelines, defined as an office systolic BP $\geq$ 130 and/or diastolic BP $\geq$ 80 mmHg) diagnosed >3 months ago and their accompanying caregivers, aged 18 years and above, who had a digital BP monitor at home and were able to provide written informed consent. Persons newly diagnosed with HTN, having a history of arrhythmias, and belonging to medical/paramedical backgrounds were excluded. Investigators confirmed patient inclusion and exclusion criteria status before enrolling eligible patients after written informed consent (Fig. 1 represents the STROBE diagram of patients recruited in the study).

2.2. Designing of checklist and questionnaire

The checklist and questionnaires (**Supplementary file 1**) were developed in three phases: the formative stage (developing preliminary documents in English), the acceptability stage (translating and refining the study documents with the help of stakeholders), and the implementation stage (feasibility study by pilot testing of the documents in each language).

In the formative stage, a 16-point observational checklist and a 19-point self-administered questionnaire were designed using the questionnaires by Nessler et al based on the AHA/AMA 2020 policy statement on Self-Measured Blood Pressure Monitoring at Home, the AHA 2019 Scientific Statement on Measurement of BP in humans, and the HOPE Asia network 2018 recommendations for home BP monitoring in Asia.[7,11,16–18] Baseline sociodemographic and medical history questions were included prior to the knowledge questions for both participant groups. In the acceptability stage, study documents, including the informed consent forms, were translated into 2 culturally appropriate regional languages to enable wider reach. These were then reviewed by independent experts from different fields and modified accordingly.

Fifty people with HTN and 50 caregivers were included in the implementation stage. The study documents in all 3 languages were pilot-tested among the eligible population after obtaining their consent, which established the reliability of the questionnaire. The documents were reviewed based on feedback and modified accordingly. The final Cronbach's alpha values were 0.660 for the checklist and 0.757 for the questionnaire among hypertensive patients, and 0.790 for the checklist and 0.809 for the questionnaire among caregivers, respectively.

2.3. Data collection

Five medical student volunteers were trained to screen eligible populations, obtain consent, observe their BP measurement technique without intervening or guiding, and provide the questionnaires to the participants to be filled out independently. To include illiterate people with HTN, the volunteers were trained to administer the questionnaire verbatim to minimize researcher bias. Pilot testing was done after they were adequately trained to identify and resolve implementation issues.

Eligible participants screened from OPDs were taken to a separate room equipped with a digital sphygmomanometer, table, chairs, and an examination table. Each person with HTN was observed while measuring their BP, followed by their caregiver. During the BP measurement by the person with HTN, the caregiver was asked to wait out of sight to prevent contamination bias, ensuring an independent assessment of each individual's technique. The techniques were evaluated using an observational checklist. Subsequently, participants' knowledge regarding various aspects of the BP measurement technique was assessed using a multiple-choice questionnaire in their preferred language. We included the option 'don't know' in the questionnaire to minimize the likelihood of false positives resulting from randomly correct guesses.

2.4. Sample size calculation

The prevalence rate of Hypertension among the population in North

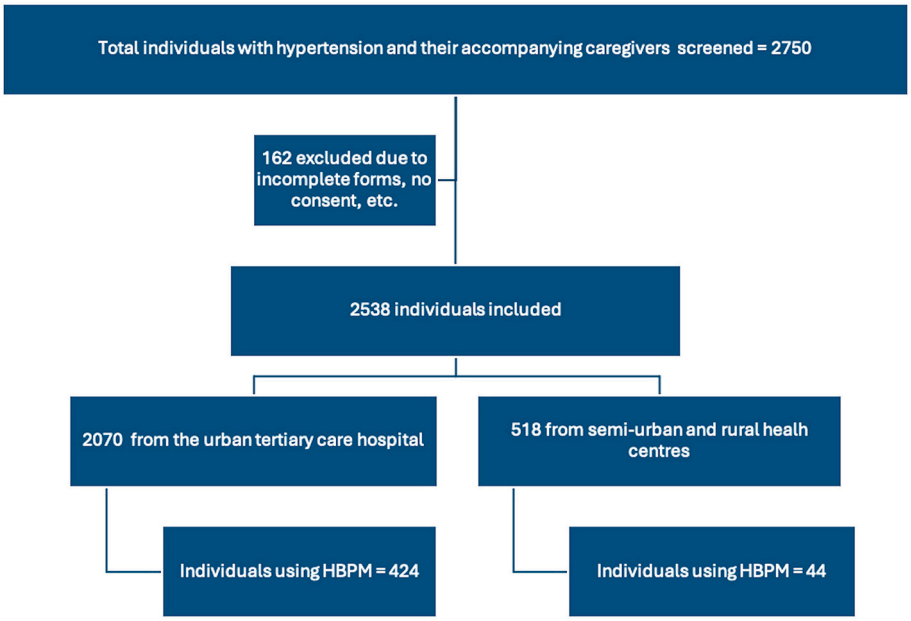

Fig. 1. STROBE diagram of the patients recruited in the study. HBPM: Home blood pressure monitoring.

India has been established as 40.1 %. [2017 STEPS survey Plos] Using this, the minimum sample size for assessment of knowledge and practices among people with HTN was calculated as 188, at a confidence level of 95 % and a 7 % margin of error. A similar number was used for caregivers. This number was increased to 200 per group (a total of 400 participants) to allow for predicted attrition. Screening was done until the required number of individuals using HBPM was achieved.

2.5. Statistical analysis

All responses to the checklist and questionnaire were scored equally, with 1 point for correct response and 0 for incorrect, "do not know" and "not sure." Total scores were calculated separately for the practice observations (checklist) and knowledge (questionnaire). These were then graded into quartiles as poor (<25 % correct), average (26–50 % correct), good (51–75 % correct) and excellent (>75 % correct).

Data collected was described in terms of range, mean ± standard deviation (±SD), frequencies, and relative frequencies (percentages) as appropriate. For comparing categorical data, the Chi-square ($\chi 2$) test was performed, and the Fisher exact test was used for expected frequency <5. A probability value (*p*-value) less than 0.05 was considered statistically significant. All statistical calculations were done using SPSS version 21.

3. Results

A total of 2750 people were screened, of which 2588 were included - 2070 from the urban tertiary care hospital and 518 from the semi-urban and rural community health centres. The remaining 162 responses were excluded due to either not meeting the inclusion criteria or being incomplete. Among those included, only 424 (20.5 %) participants in urban areas and 44 (8.5 %) in rural areas reported measuring BP at home.

3.1. Respondent characteristics

HBPM knowledge and practices were assessed for 468 respondents, of which 236 were people with HTN and 232 were caregivers who regularly measured the BP of their dependents at home. The mean ages for the two groups were 58 years (SD 12.4, range 21–87 years) and 44.7 years (SD 14.7, range 18–86 years), respectively.

There were more male persons with HTN (75.0 %) and caregivers (57.8 %) using HBPM than females (Table 1). Regarding education, 33.5 % of hypertensives had completed graduation, and 15.7 % had post-graduate degrees, whereas a higher percentage of caregivers had graduation (40.1 %) and post-graduate education (24.6 %), reflecting a relatively educated population. A significant proportion of patients (36.9 %) and caregivers (31.5 %) were also unemployed or retired. The occupational profile between the 2 groups was similar.

Regarding clinical characteristics, 34.3 % of people with hypertension had been diagnosed with hypertension for over 10 years, with 69.9 % currently on medication. There was no significant correlation between age, gender, education, occupation, or time since diagnosis of HTN and the use of anti-hypertensive medications. Family history of hypertension was reported by 65.7 % of people with HTN and 68.5 % of caregivers. For most of the caregivers using HBPM, their care recipient was either completely (47.4 %) or partially (34.1 %) dependent on them for measuring their BP.

3.2. HBPM use and training

The duration of HBPM use for most of the cohort was between 1 and 5 years, with 51.3 % of patients and 53.0 % of caregivers using their instruments. Age, gender, residence, education, and occupation did not significantly impact the length of time participants used HBPM. Calibration of these devices was infrequent, with 57.2 % of patients and 60.8 % of caregivers indicating their monitors had never been recalibrated. Additionally, the duration of HBPM use did not significantly affect the time of the last calibration of the home BP monitors. Importantly, only 22 % of hypertensive individuals and 27.6 % of caregivers recalled ever receiving training on BP measurement from healthcare workers, mostly doctors, followed by pharmacists and nurses. Most participants (75.2 %) reported learning BPM through observation, videos, and reading.

3.3. BP measurement practices

The majority of people with HTN and caregivers (80.9 % and 72.8 %, respectively) had good BP measurement practices (scores between 50 and 75 %). Caregivers demonstrated more accurate BPM technique than

Table 1
Sociodemographic profile of participants.

Socio-demographic parameter	Category	Patients (n = 236)	Care giver (n = 232)
		Frequency (%)	Frequency (%)
Gender	Male	177 (75.0 %)	134 (57.8 %)
	Female	59 (25.0 %)	98 (42.2 %)
Patient Education Level	Post Graduation	37 (15.7 %)	57 (24.6 %)
	Graduation	79 (33.5 %)	93 (40.1 %)
	Higher Secondary (10 + 2)	34 (14.4 %)	40 (17.2 %)
	High School (Class 10)	59 (25.0 %)	34 (14.7 %)
	Middle School (Class 8)	13 (5.5 %)	6 (2.6 %)
	Primary School (Class 5)	10 (4.2 %)	2 (0.9 %)
	Illiterate	4 (1.7 %)	0
Patient Occupation	Professional	27 (11.4 %)	59 (25.4 %)
	Semi-Professional	20 (8.5 %)	30 (12.9 %)
	Arithmatic skill jobs	61 (25.8 %)	52 (22.4 %)
	Skilled worker	13 (5.5 %)	7 (3.0 %)
	Semi skilled worker	27 (11.4 %)	8 (3.4 %)
	Unskilled worker	1 (0.4 %)	3 (1.3 %)
	Unemployed	87	73 (31.5 %)
Time Since diagnosis of Hypertension	<1 year	32 (13.6 %)	–
	1–5 years	78 (33.1 %)	–
	5–10 years	45 (19.1 %)	–
	>10 years	81 (34.3 %)	–
Are you taking medications for the high BP?	Yes	165 (69.9 %)	–
	No	71 (30.1 %)	–
Do you have any family history of Hypertension?	Yes	155 (65.7 %)	159 (68.5 %)
	No	78 (33.1 %)	71 (30.6 %)
	Unknown	3 (1.3 %)	2 (0.9 %)
To what degree is the hypertensive patient dependent on you?	Completely	–	110 (47.4 %)
	Partially/ occasionally	–	79 (34.1 %)
	Very limited	–	43 (18.5 %)
Duration of use of home BP monitor	<1 year	42 (17.8 %)	46 (19.8 %)
	1–5 years	121 (51.3 %)	123 (53.0 %)
	5–10 years	45 (19.1 %)	34 (14.7 %)
	>10 years	28 (11.9 %)	29 (12.5 %)
When was your BP monitor last calibrated?	<6 months ago	27 (11.4 %)	24 (10.3 %)
	6 months-1 year	10 (4.2 %)	7 (3.0 %)
	>1 year ago	5 (2.1 %)	5 (2.2 %)
	Never been recalibrated	135 (57.2 %)	141 (60.8 %)
	Don't remember	59 (25.0 %)	55 (23.7 %)
Have you ever received training/instruction on BP measurement technique?	Yes	79 (33.5 %)	99 (42.7 %)
	No	151 (64.0 %)	123 (53.0 %)
	Don't remember	6 (2.5 %)	10 (4.3 %)
Source of training on BPM technique	Doctor	31 (13.1 %)	38 (16.4 %)
	Nurse	9 (3.8 %)	8 (3.4 %)
	Chemist	12 (5.1 %)	18 (7.8 %)
	Internet	3 (1.3 %)	3 (1.3 %)
	Self-learnt by practice	181 (76.7 %)	165 (71.1 %)
Total		236 (100 %)	232 (100 %)

Abbreviations: BP: Blood pressure; BPM: blood pressure monitoring.

people with HTN, with mean scores of 10.2 ± 2.3 (63.8 % ± 14.1 %; range = 4–16) vs. 9.7 ± 1.9 (60.8 % ± 13 %; range = 4–14) out of 16, respectively. Only 5.9 % of people with HTN (14/236) and 15.9 % of caregivers (37/232) had an excellent score (>75 %) on measurement practices (Table 2 and Fig. 2).

Despite more than 90 % of participants in both groups being able to correctly interpret the BP reading displayed on the monitor, only 7 (3 %) people with HTN and 11 (4.7 %) caregivers took the average of two BP measurements to obtain the final BP reading (Supplementary Table 1a).

Table 2
HBPM practice and knowledge scores among hypertensive patients and their caregivers.

CATEGORY (% score)	OVERALL PRACTICES		OVERALL KNOWLEDGE	
	Patients	Caregivers	Patients	Caregivers
Poor (< 25 %)	0	0	44 (18.6 %)	38 (16.4 %)
Average (25–50 %)	31 (13.1 %)	26 (11.2 %)	132 (55.9 %)	117 (50.4 %)
Good (50–75 %)	191 (80.9 %)	169 (72.8 %)	60 (25.4 %)	76 (32.8 %)
Excellent (75–100 %)	14 (5.9 %)	37 (15.9 %)	0	1 (0.4 %)
Total	236	232	236	232

Abbreviations: HBPM: Home blood pressure monitoring.

The most common mistakes, made by nearly three-quarters of participants, included not resting for at least 5 min after entering the office before taking BP reading (by 90.7 % of patients, 60.3 % of their caregivers) and not supporting their backs while measuring BP (by 79.2 % patients, 69.8 % caregivers).

3.4. Knowledge of BP measurement technique

Knowledge about the correct BP measurement technique was lacking, with the majority of people with HTN (55.9 %) and caregivers (50.4 %) achieving only average scores (ranging between 25 and 50 %), with mean scores of 7.4 ± 3.0 (38.9 % ± 15.8 %; range = 1–14) and 7.8 ± 3.2 (41.2 % ± 16.6 %; range = 1–15) out of 19 respectively. While 25.4 % of hypertensives and 32.8 % of caregivers had good scores (score between 50 and 75 %), only 1 caregiver scored excellent with >75 % correct responses (Table 2 and Fig. 3).

Supplementary Table 1b lists the frequency of responses to individual knowledge questions. Regarding BP measuring technique, two-thirds of participants in both groups (66.1 % patients and 66.4 % caregivers) knew that the tube of the BP cuff should lie on the centre/inner side of the elbow bend, and a similar number (60.6 % patients and 59.5 % caregivers) knew to measure it in sitting position using a table and chair. However, only 2 (0.8 %) patients and 3 (1.3 %) caregivers knew that the reading should be taken on the arm with the higher BP. Almost half of the participants knew the common reasons for inaccuracies in BP measurement: checking BP within 30 min of drinking tea/coffee (61.9 % patients, 60.3 % caregivers), keeping the arm taut (50.8 % patients, 56.9 % caregivers), talking while taking the BP reading (56.4 % patients, 58.6 % caregivers), having the urge to urinate (40.3 % patients, 41.8 % caregivers), measuring BP after smoking or consuming tobacco (38.6 % patients, 47.4 % caregivers), and sitting with legs crossed (38.1 % patients, 46.1 % caregivers). Significant gaps in knowledge about correct BP measurement techniques were observed in questions regarding the frequency of recalibration of BP monitors (5.9 %, 7.3 % corrects), the minimum time gap between successive readings (13.1 %, 11.6 % corrects), and the best time of day to measure BP (13.1 %, 18.5 % corrects).

3.5. Overall BPM knowledge and practices and their correlations

Overall, HPBM practices were better than knowledge, with mean scores of 62.3 ± 13.1 % (range = 25.0–100 %) and 40.1 ± 16.2 % (range = 5.3–79.0 %) respectively. Nevertheless, practices were found to be significantly more accurate with improving grades of knowledge among the total participants (Table 3). Notably, higher education was associated with improved patient knowledge ($p = 0.041$), but not practices ($p = 0.225$). Although caregivers' education level did not influence their knowledge of BPM, those in more skilled occupations demonstrated better knowledge. There was no significant correlation between knowledge and technique of BP measurement with other recorded participant demographics, time since diagnosis of HTN,

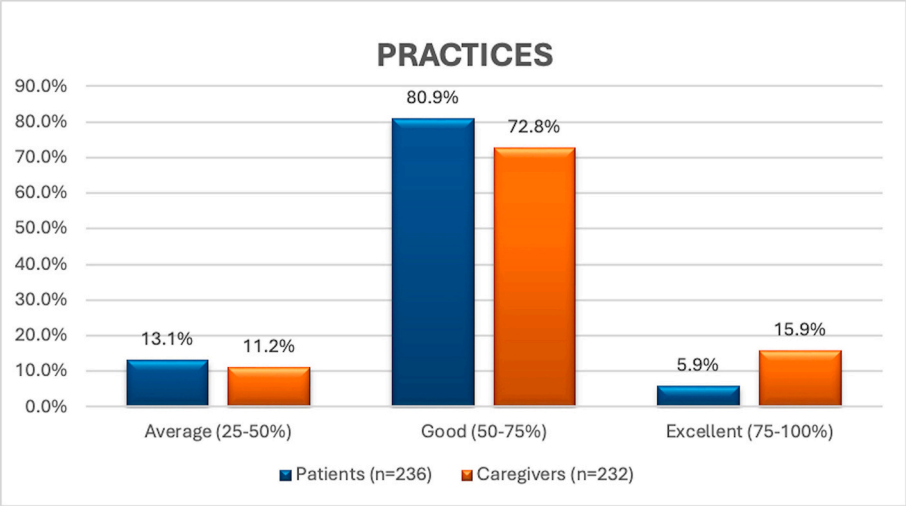

Fig. 2. Overall HBPM practice grades among hypertensive patients and their caregivers. HBPM: Home blood pressure monitoring.

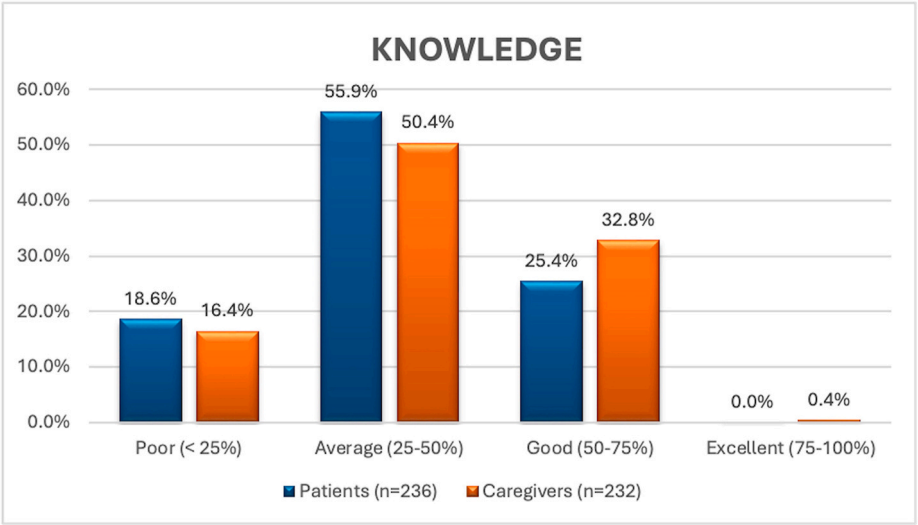

Fig. 3. Overall HBPM knowledge grades among hypertensive patients and their caregivers. HBPM: Home blood pressure monitoring.

Table 3
Correlation between overall knowledge and practices amongst all the participants combined.

		OVERALL KNOWLEDGE			Total	Chi-square value	*p*-value
	GRADE	Poor	Average	Good			
OBSERVED PRACTICES	Average	13	11	7	31	14.208	0.007
	Good	30	111	50	191		
	Excellent	1	10	3	14		
Total		44	132	60	236		

duration of HBPM use, or the presence of other family members with HTN.

Individuals who received training on BPM consistently demonstrated better knowledge of the correct BPM technique compared to those without training (p=<0.001 for both groups), with doctors being the most effective source of education. However, while this reflected in improved practices among caregivers (p<0.001), it did not significantly impact the BPM technique of hypertensive individuals using HBPM (p = 0.062) (Supplementary Tables 2a and 2b & tables 3a and 3b).

4. Discussion

Recent evidence supports a significant role of HBPM in the management of hypertensive patients, showing improved BP control and a reduction in major adverse cardiovascular events among hypertensive patients using HBPM.[11,12] Proper knowledge of BP measurement technique is key to effective HBPM as its success depends largely on the accuracy of BP readings obtained by the patients or their caregivers. However, ensuring accurate and appropriate HBPM technique among hypertensive individuals has remained a major challenge worldwide, with inaccuracies often arising from lack of proper

knowledge/education on HBPM procedure, use of faulty or non-calibrated BP measuring apparatus, and above all, the lack of appropriate training imparted to those routinely performing HBPM.[19–21]

Globally, knowledge of BP measurement technique remain dismal, with only around 10–15 % individuals demonstrating satisfactory knowledge of HTN and BP measurement based on dedicated questionnaires or checklists.[11,22] Further, less than 1/5th of all hypertensive patients performing HBPM receive proper training from qualified medical professionals, raising concerns about the validity of these unsupervised BP readings.[12,13,18] This was reiterated in a recent observational study by Nessler et al which found significant difference in systolic and diastolic BP readings obtained by the patients, which were 8.36 and 2.16 mm Hg higher, respectively, as compared to those obtained by trained personnel. This discrepancy was attributed to factors like education status below high school, age over 65 years, and lack of adequate training. Improper positioning of BP cuff emerged as the most common error among patients with inaccurate readings, underscoring the need for structured patient education and training on proper HBPM technique.[17] Similar results were reported by Stryker et al in their independent prospective study which demonstrated that improper HBPM technique was largely attributable to a lack of training.[23] Additional evidence from Muntner et al and Dwarz et al supports the critical importance of patient education and training on improving the accuracy of BP measurement and, ultimately, clinical outcomes.[24,25] Together, these findings emphasize the importance of standardized BP measurement protocols to enhance HTN management worldwide.

It is noteworthy, however, that most of these studies had small sample sizes (80–100 participants), appearing underpowered to draw meaningful conclusions, and were mostly carried out in Western populations, with scant data from Asian or developing regions. The last 3 decades have seen a massive surge in the prevalence of hypertension and other non-communicable diseases in the developing world, including India, where HTN has overtaken infectious diseases as the leading cause of mortality.[26,27] A recent report demonstrated that nearly a third of adults in India have HTN, making it the most common chronic non-communicable disease.[28,29] This creates a 'double jeopardy' in the developing world, with rising rates of HTN getting compounded by healthcare infrastructure constraints. Hence, HBPM has immense potential to provide effective patient care for patients with HTN while reducing burden on the thin healthcare systems.

Yet, assessment of the HBPM knowledge and practices amongst users is vital for realizing these benefits. To date, there is little data from India on the HBPM practices amongst hypertensive patients. Most of the available data stems from the Indian cohort of the large Asia HBPM survey 2020, which primarily provided insights from the physician's perspective. This survey revealed that despite almost 90 % of the physicians recommending the use of HBPM, only around 30 % of the patients actually measure their BP at home.[13,14] This makes a strong case for exploring patient-related barriers to HBPM adoption. Our study, therefore, sought to evaluate patient knowledge and practices surrounding HBPM in India and to provide real-world data that would allow the identification of key target areas to improve HBPM practices.

The key findings from our research were the extremely low proportion of HBPM usage among our Indian cohort, at around 18 %, compared to 53.8 % of people with HTN in the Western population who utilize HBPM according to the most recent AHA survey.[30] However, the usage pattern was similar with more older individuals (>65 years) engaging in HBPM than their younger counterparts. This disparity in HBPM usage can possibly be attributed to differences in economies, education status, and health awareness between the two populations. Education status did have a bearing on the HBPM knowledge scores, with only 1 (0.2 %) hypertensive patient having an excellent score on the scale, and overall mean knowledge score at only around 40 %.

Despite the low knowledge scores, many patients did well on the HBPM practices, with 51(10.8 %) participants having an excellent HBPM technique and an overall score of around 62 %. Interestingly, although improved education was associated with higher knowledge scores ($p = 0.041$, <0.05), it did not significantly impact HBPM practices ($p = 0.225$). This divergence suggests that people, regardless of their educational background, can be effectively trained in accurate BP measurement, emphasizing that limited education does not preclude patients from being meaningfully involved in their HTN management and control. These findings are pivotal in the Indian context, and imply that with appropriate education, counselling, and demonstrations, healthcare providers can empower these individuals to accurately monitor their BP, thereby reducing the strain on healthcare resources.

Another key strength of our study was the inclusion of caregivers of hypertensive patients, which is common especially in the developing countries where elderly patients often require assistance for BP measurement. This again highlights the critical importance of training hypertensive patients and their caregivers on accurate HBPM using standardized protocols, limiting the scope for errors. A recent observational study from Poland, where patients were recorded while measuring their BP, revealed that only around 3 % do so accurately without errors, while over 60 % made 3 or more errors while taking a BP reading, the most common being improper positioning of the cuff. Only 29 % of the entire cohort had ever received instruction by medical personnel on HBPM techniques and precautions.[18] These results, along with our findings, highlight the significant lacunae in our current HBPM practices and emphasize the urgent need for education and training of patients and their caregivers on HBPM.

While our study offers valuable insights into HBPM practices, certain limitations must also be acknowledged. First, this study was conducted across 3 sites within the Ludhiana district of Punjab, India, and hence, the results may require validation in other settings in India and abroad. Secondly, we did not compare the actual readings obtained by the patients/caregivers to those of trained personnel, which would have given us direct insights on the impact of lack of knowledge on accuracy of BP measurement. We did not evaluate this because we wanted to focus primarily on HBPM practices and how to bring about positive change via this knowledge. Lastly, the proportion of rural population included in our study was rather low. Given that rural population is the most ignorant and least formally educated in India, special attention is needed to raise awareness and improve outcomes within these communities.

5. Conclusions

Substantial evidence underscores the significant role of HBPM in the management of hypertensive patients. However, ensuring accurate and appropriate HBPM techniques among hypertensive individuals has remained a major challenge worldwide. In our prospective study, only 18 % of the people with HTN used HBPM, and fewer than 1/4th of those measuring BP at home recalled ever receiving training from any healthcare professionals. HBPM practices were better than knowledge in our cohort. Higher education level was associated with improved patient knowledge but not practice. This gap between the impact of education on knowledge versus practices is critical, highlighting that with proper training and support, patients and caregivers—regardless of educational background—can be empowered to accurately monitor BP and contribute to positive health outcomes.

Ethics approval and consent to participate

The study protocol conformed to the ethical guidelines of the recent declaration of Helsinki updated in October 2013 and was reviewed and cleared by the ethical committee of the institute ((IEC approval no: 2022-800, dated 22nd November 2022; ref no: DMCH/R&D/2022/98).

Consent for publication

Written informed consent was obtained directly from the patients for inclusion in this study.

Availability of data and materials

All data and materials will be upload as per the needs of the editor/ reviewer or the readers as per their request.

Authors' contributions

Equal contributions.

Funding

None.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ihj.2024.11.249.

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