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ORIGINAL ARTICLE

Effectiveness of a family nurse-led programme on accuracy of blood pressure self-measurement: A randomised controlled trial

Valentina Simonetti PhD, MSN, RN, Nurse Teacher[1] | Dania Comparcini PhD, MSN, RN, Ward Manager[2] | Marco Tomietto PhD, MSN, RN, Docent[3,4] | Daniele Pavone MD, Biostatistician[5] | Maria Elena Flacco MD, PhD, Associate Professor[6] | Giancarlo Cicolini PhD, MSN, RN, Assistant Professor[7]

[1]Politecnica delle Marche University, Ascoli Piceno, Italy

[2]Azienda Ospedaliera Universitaria "Ospedali Riuniti" di Ancona, Ancona, Italy

[3]Regional Taskforce for Healthcare System Assessment, Direzione Centrale Salute, Politiche Sociali e Disabilità, Trieste, Italy

[4]Research Unit of Nursing Science and Health Management, University of Oulu, Oulu, Finland

[5]Regional Healthcare Agency of Abruzzo, Pescara, Italy

[6]Department of Medical Science, University of Ferrara, Ferrara, Italy

[7]Department of Biomedical Science and Human Oncology, University of Bari "Aldo Moro", Bari, Italy

Correspondence
Dania Comparcini, Azienda Ospedaliera Universitaria "Ospedali Riuniti", di Ancona, via Conca 71 – 60100, Ancona, Italy.
Email: da.comparcini@gmail.com

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Abstract

Aims and objectives: To evaluate the effectiveness of a Family Nurse Practitioner (FNP)-led programme on the degree of adherence of current recommendations on home blood pressure self-measurement (HBPM) as compared to routine care and management.

Background: HBPM plays an important role for monitoring hypertensive patients; however, patients' adherence to current guidelines is unsatisfactory. A nurse-led training programme in the community setting could be an effective strategy to achieve high level of patients' adherence to recommendations.

Design: A multicentre randomised controlled trial was carried out from September 2016 to September 2017.

Methods: In total, 170 patients were randomly allocated into the intervention group (n = 83) and the usual care (n = 87). All participants received usual care (written and verbal information on HBPM recommendations); subjects in the intervention group also received 1-hour training session on how to correctly self-measure BP. Clinical trial registration was done (ClinicalTrials.gov.: NCT04681703). The CONSORT checklist for randomised controlled trials was used in this study.

Results: At baseline, the level of adherence to the recommendation was similar in the two groups (p < .05). After 1 month, the adherence significantly increased in the intervention group, where patients were more likely to measure BP at the same hour and from the same arm, in a quiet environment, with the back and uncovered arm supported and the legs uncrossed; recording BP more than once in each measurement session; keeping a diary of blood pressure measurements; use of the appropriate cuff and proper placement of the cuff; and resting for >5 min before performing the measurement (all p < .05).

Conclusions: The FNP-led programme is effective in improving patients' adherence to guidelines on the correct technique to self-measure BP at home.

Valentina Simonetti, Dania Comparcini contributed equally to this work.

Relevance to clinical practice: This programme may be added to the existing interventions in the community setting or considered into specifically nurse-led hypertension management models.

KEYWORDS
home blood pressure measurement, hypertension, nurse-led intervention, randomised controlled trial

What does this paper contribute to the wider global clinical community?

- The targeted nurse-led training programme for home blood pressure (BP) self-measurement could be a suitable strategy to develop patient's empowerment and skills.
- The results of this randomised controlled trial could serve as a feasible nursing practice for the management of hypertensive patients in community settings.
- Our findings highlight that the nurse-led training programme for home BP self-measurement, as an educational intervention, improve patients' adherence to guidelines.

1 | INTRODUCTION

The diagnosis and control of hypertension depend on accurate measurements of blood pressure (BP), which is traditionally done by healthcare workers in different ambulatory care settings, including general practice clinics (Al-Gelban et al., 2011; Baguet, 2012). An important consideration in the diagnosis of hypertension is distinguishing true hypertension from "white coat syndrome," defined as the occurrence and persistence of BP values higher than normal ("hypertensive") when measured in the medical environment and in the presence of a physician (the so-called office blood pressure), but within the normal range during daily life (Verdecchia et al., 2001), as it can lead to over-diagnosis and unnecessary treatment. Accordingly, alternative approaches to measuring BP, such as ambulatory BP monitoring or home blood pressure self-measurement (HBPM), are gaining increasing acceptance in the diagnosis of hypertension and the monitoring of hypertensive patients (Helvaci & Seyhanli, 2006; Stephan et al., 2015; Wagner, 2017). With the new technologies that have recently become widely available, such as automatic and semi-automatic devices, the self-measurement of BP by patients at home has become commonplace (McManus et al., 2014). Furthermore, current guidelines recommend HBPM to improve patient adherence with treatments and care plans (Mancia et al., 2013; Williams et al., 2018) but also to reduce medical costs and the number of visits to ambulatory care centres (Celis et al., 2005; Staessen et al., 2003). HBPM has been shown to contribute to hypertension management and control (Manzoli et al., 2013; Obara et al., 2013) by avoiding an under- or over-estimation of BP levels and therefore potentially inappropriate drug prescriptions by physicians (Al-Gelban et al., 2011; Manzoli et al., 2012). Moreover, out-of-office HBPM empowers patients to play a pivotal role in managing their own health, in turn increasing patient engagement in BP management (Liyanage-Don et al., 2019).

2 | BACKGROUND

To achieve accurate BP measurements at home, existing guidelines must be closely followed, in order to perform accurate BP self-measurement, to choose the correct device and to be aware of the factors that could potentially influence BP (Mancia et al., 2013; Parati et al., 2008; Wagner et al., 2012; Williams et al., 2018). However, previous studies have shown that patients' adherence towards hypertensive guidelines is in most cases unsatisfactory (Celis et al., 2005; Flacco et al., 2015; Wagner et al., 2012, 2013, 2014) that could result in a higher risk of invalid BP readings and therefore inaccurate diagnosis and management (Liyanage-Don et al., 2019). Also, the use of inaccurate devices has resulted in the misdiagnosis and poor management of hypertension, which remains a largely unresolved public health problem (Stergiou et al., 2020). By contrast, the quality of HBPM was found to be higher in patients who received some form of training in BP measurement from healthcare professionals than in patients who did not receive training (Flacco et al., 2015).

Although self-estimation of BP may be prone to error, this risk can be minimised through simple guideline-recommended approaches, through collaborative and proactive partnership among the patient, provider and health system, as suggested by the Chronic Care Model (Carey et al., 2018; Whelton et al., 2018). In this regard, a recent randomised controlled trial on the effectiveness of a nurse-led hypertension management model, demonstrated how home visits, telephone follow-ups and referrals conducted by a trained nurse, were effective in enhancing individuals' healthy lifestyle, satisfaction and maintaining normal BP readings, in a sample of 134 hypertensive patients with uncontrolled BP, in the intervention group than those in the control group (Zhu et al., 2018). Another study proved the efficacy of a nurse-led email reminder programme specifically tailored on the importance of patients to adhere to healthy lifestyles based upon current guidelines, showing a significant improvement

in both lifestyle habits and cardiovascular disease risk factors among hypertensive adults (Cicolini et al., 2014). This evidence confirmed the role of nurses as healthcare providers in primary care, their ability to manage clinical pathways and effectiveness in improving the outcomes for hypertensive patients (Khelehr et al., 2009).

However, although many authors suggested how introducing specialist nurse/consultant led hypertension clinics may lead to a control in BP (Dean et al., 2014), to our current knowledge, empirical evidence-based studies on the pivotal role of nurses in improving patients' adherence to HBPM recommendations, and related accuracy on BP self-measurement, are lacking.

In the current scenario, it would be interesting to explore the role of the Family Nurse Practitioners (FNPs), because of their patient/family-centred, holistic approach to care and competences focussed on providing the full spectrum of healthcare services to include health promotion, disease prevention, health protection, anticipatory guidance, and counselling (Webber & Serowoky, 2017).

Among healthcare workers, the FNP seems to be the most appropriate professional to answer to educational needs of patients, who generally choose the professional on the basis of a relationship of trust that is an intangible asset of nursing and represents a nursing-related quality outcome, that could positively affect health outcomes (Rutherford, 2014).

We hypothesised that a specific educational intervention conducted by the FNP that, like the general practitioner (GP), has a direct relationship with clients (in this case hypertensive patients) could result in higher patients' adherence to HBPM recommendations.

3 | METHODS

3.1 | Objective

The aim of this study was to evaluate the effectiveness of a family nurse (FNP)-led home BP management on the degree of patient's adherence to current recommendations on HBPM based on a comparison with routine care and management.

3.2 | Study design, participants, recruitment and randomisation

A single-blind, multicentre, randomised controlled trial was carried out from September 2016 to September 2017. Only patients were blinded to treatment, while the FNP who was responsible to manage the intervention and undertook all measurements was aware of the study allocation.

We included all adult (18–85 years) patients with a medical diagnosis of hypertension who visited one of two family practice offices located in Chieti or Pescara (two major Italian cities of the Abruzzo region). Other inclusion criteria were patients recommended by their GP or a specialist for HBPM, able to speak and read Italian, having an active phone number, and able to provide written informed consent. Exclusion criteria were mental illness, cognitive impairments, deficit of communication, co-morbidities in contradiction with the programmed intervention, pregnancy or institutionalisation (e.g. in a nursing home). After enrolment, the patients were randomised and assigned into control and intervention groups based on a randomisation list prepared with NCSS PASS 11 software. The randomisation process was managed by the statistical unit of our hospital, and all investigators were blinded to the group assignments.

The randomised trial met the Consolidated Standards of Reporting Trials (CONSORT) guidelines (Schulz et al., 2010) (see File S1).

3.3 | Usual Care

Participants in both groups were guided by two teams made up of a GP and a FNP associated with the respective family practice offices (Chieti and Pescara). Each patient received usual care and was required to attend a routine follow-up visit one month after enrolment (T1). Usual care consisted of verbal and written instructions during which the FNP or GP advised the patient to follow the Italian Guidelines for the Measurement regarding correct HBPM (Parati et al., 2008): (a) to measure BP in a calm environment, after a rest period for at least 5 min, without distractions or noise at the same hour, and to repeat the measurement and to repeat the measurement after few minutes; (b) to remain silent during the measurement, with the same body position; (c) to sit without crossing the legs, with the patient's back supported by a chair or headboard with the same patient's arm supported and positioned at the same height as the heart; (d) to use a BP cuff chosen on the basis of the arm circumference and put it properly; (e) to avoid drinking coffee or smoking 1 h before BP measurement (Box 1). Usual care was not planned in a structured way: all information given by FNP or GP during the routine follow-up could have a variable duration, depending on patients' flow or daily practice organisation. A written summary of the recommendations (Parati et al., 2008) was given to all participants by the GP or FNP at the end of the follow-up visit.

3.4 | Intervention

In addition to receiving the usual care, patients in the intervention group participated in a 1-h training programme (detailed below) conducted by the FNP (one for each centre) in a dedicated room of the ambulatory care centres. Researchers estimated 60 min as a sufficient time to deliver the educational programme and training, established after a simulation conducted by the FNP before the participants' enrolment.

During the programme, the nurse, following the Italian Guidelines for the Measurement of BP (Parati et al., 2008), stressed the importance to patients to follow the recommendations, instructed and showed them on how to self-measure BP using the BP self-measurement device and on the importance of adequate device

BOX 1 Recommendations provided by FNP and general practitioner.

The FN recommends that:

- The BP should be measured in a quiet environment, after a rest period of at least 5 min, without distractions or noise at the same hour, and to repeat the measurement after few minutes.
- The pressure should be measured on the arm with the highest BP, if the difference in the systolic BP is >20 mmHg and that of the diastolic >10 mmHg.
- The patient should refrain from drinking coffee or smoking one hour before the measurement and not talk during the measurement.
- The legs should not be crossed (Adiyaman et al., 2007); a correct position should be assumed in which the arm rests on a rigid support and is at the same height as the heart.
- BP should always be measured in the same body position, as both diastolic and systolic pressure change if the pressure is measured lying down, sitting, or in the Fowler position (Cicolini et al., 2011).
- The back should be adequately supported by a chair or headboard; otherwise BP will increase 5–15 mmHg (Cushman et al., 1990).
- The cuff and the inner tube should be of adequate dimension and the instrument should be validated. For these reasons, all patients are provided with an updated list of validated home self-measurement tools for BP measurement using the oscillometric method (Dabl®Educational Trust, Blood Pressure Monitors, Validations, Papers and Reviews,-; Stergiou et al., 2020). Each patient is given an appropriate size cuff and inner tube.

maintenance (Stergiou et al., 2020). Each patient was given the appropriate size of the cuff and inner tube.

Also, during the training programme the FN emphasised that since morning and evening BP values can widely differ, especially in patients taking medications, BP should be measured twice a day, in the morning and at evening, at specific fixed times (between 6:00 a.m.–9:00 a.m. and between 6:00 p.m.–9:00 p.m.) at least during the first week of monitoring (Parati et al., 2008). Thereafter, measurements can be taken before antihypertensive drugs are taken.

The intervention was carried out by the FNP every day (from Monday to Friday morning) during outpatient visits of the participants to the GP. The FNP was also responsible for coordinating follow-up visits, performed the educational and training programme, and recorded the baseline (T0) data of all patients, allocated both in the usual care and in the intervention group. All data were collected through face-to-face interviews using both a structured form for socio-demographic variables (age, sex, marital status, education, living status and telephone number for follow-up contact) and a structured questionnaire (Flacco et al., 2015), also administered by the FNP, to assess the habits and HBPM adherence of the patients at T0 and T1.

3.5 | Outcome assessment

The effectiveness of the training programme was evaluated at T0 and T1 using a structured 15-item questionnaire of Flacco et al. (2015), specifically designed to determine patients' adherence to current Italian guidelines on HBPM (Parati et al., 2008). The accuracy of the patient's self-measurement of BP was established both through direct observation of the technique by the FNP (items 6–15 of the instrument), and collecting information on adherence to HBPM guidelines as directly reported by patients (items 1–5 of the instrument). The questionnaire was previously adopted by Flacco et al. (2015) on a population of 725 Italian outpatient hypertensive patients: in this study, the questionnaire was well-accepted by the patients and the response rate was 94%. The questionnaire was developed in Italian and pilot-tested on a 50 patients' sample, and items were developed according to the current recommendations in hypertension management. Redundant items were deleted and the 15-items version agreed by the patient panel (Flacco et al., 2015). Before starting our data collection, we further conducted a pilot test involving 30 patients to preliminary testing the readability and easiness in understanding the questionnaire's items: all patients stated the questionnaire as readable and understandable. Moreover, after the first enrolment process, we had no patients' dropout during the study. Due to the type of the questionnaire, it was not methodologically appropriate to perform a psychometric validation.

3.6 | Sample size estimation

The main outcome was adherence to the recommendations for correct HBPM. Based on Flacco et al. (2015), 52.8% of all participants (undergoing an educational intervention or not) were expected to comply with ≥10 of the HBPM guidelines. Therefore, assuming an alpha error of .05, an adherence rate of 52.8% in the control group and a 25% improvement thereof in the intervention group, the inclusion of 54 patients per group was considered adequate to achieve a statistical power of 80%. To account for a 10% dropout rate, the study population was conservatively composed of 60 patients per group, such that 120 patients were enrolled. The appropriate sample size was calculated using NCSS PASS 11 software.

3.7 | Statistical analysis

The normal distribution of all continuous variables was assessed using the Shapiro–Wilk test. Differences between groups at baseline and at the 1-month follow-up were analysed using a

chi-squared test for categorical variables, and a t test and Kruskal–Wallis test for normally and non-normally distributed continuous variables, respectively. Comparisons between the two groups at baseline and at the one-month follow-up were based on the Kruskal–Wallis test, and the statistical significance within each group (pre–post difference) was evaluated using the Wilcoxon matched-pairs signed-ranks test. Statistical significance was set as a two-tailed *p*-value <.05 in all analyses. All of the statistical analyses were performed using IBM SPSS statistical software for Windows, version 22 (SPSS Inc).

3.8 | Ethical consideration

The study protocol was approved by the local Independent Ethics Committee of the Abruzzo region in Italy (November 19, 2015) and was registered with ClinicalTrials.gov.: NCT04681703. We also obtained approval from the Physicians' directors of the two family practice offices, where the study was conducted. Participants were enrolled after giving their informed consent. Data confidentiality, which was in line with the Personal Data Act (523/1999), was ensured in the data collection and data analysis phases.

4 | RESULTS

4.1 | Characteristics of the sample and procedures at baseline

Of the 215 eligible patients, 170 agreed to participate, with 87 randomly allocated to the usual-care group and 83 to the intervention group (Figure 1). There were no significant differences between the two groups at baseline with respect to mean age, sex, marital status, living status and educational level (all $p > .05$; Table 1). Almost half of patients in the usual-care group and intervention group (57% and 44.6%, respectively) reported to have no previous instruction on the correct performance of HBPM ($p > .05$). For the patients who had received instruction, it most commonly came from a physician or pharmacist ($p > .05$). Occasional home measurement of BP without following a fixed schedule was reported by 60.5% of the patients in the usual-care group and 50.6% of those in the intervention group ($p > .05$) (Table 2).

4.2 | Adherence to HBPM guidelines at baseline

At baseline, the level of adherence to the 15 HBPM practices was similar between the two groups, without significant differences in any of

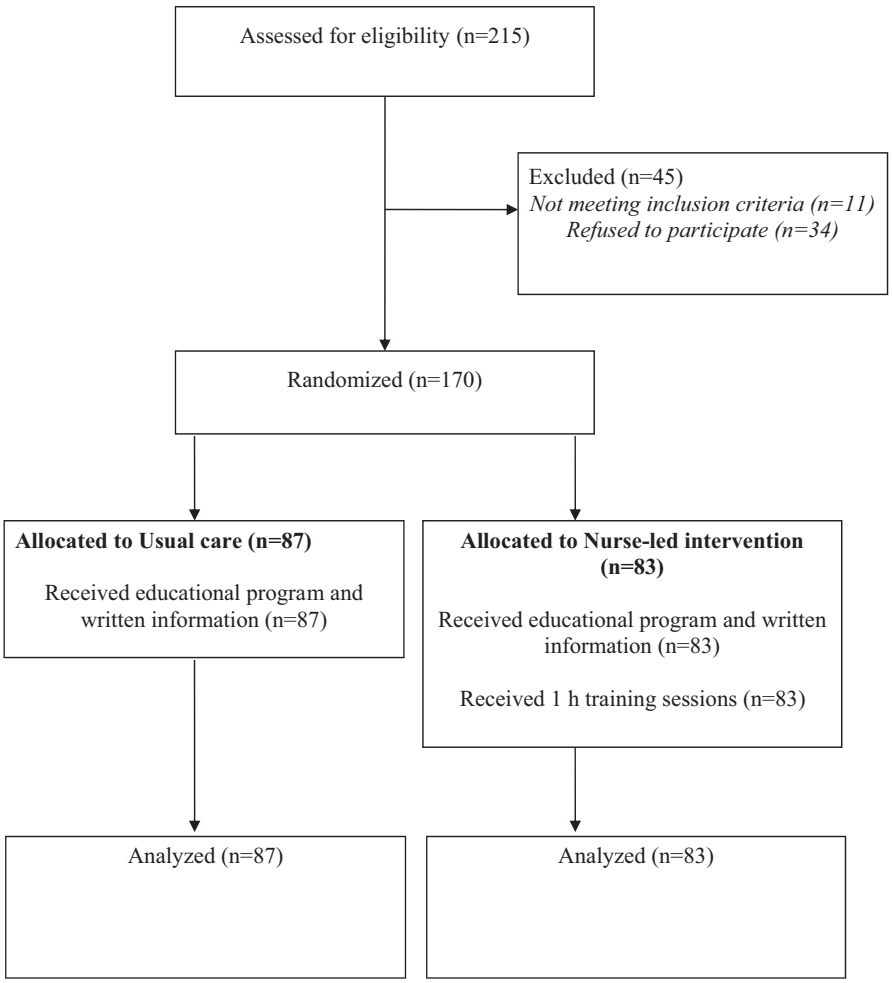

FIGURE 1 Flow of participants through each stage of the trial

TABLE 1 Characteristics of the study population at baseline

Variables	Usual care (*n* = 87)	Intervention (*n* = 83)	*p*
Mean age in years (SD)	63.7 (16.1)	65.1 (15.1)	.559
Male (%)	55.2	49.4	.539
Marital status (%)			
Married	82.8	86.7	.527
Not married	17.2	13.2	
Living status (%)			
Alone	17.2	21.7	.505
With family	79.3	77.1	
With caregiver	3.4	1.2	
Education (%)			
Elementary	41.4	45.8	.824
High school	39.1	34.9	
Graduate	19.5	19.3	

the recommended practices, except for questions number 13: "During BP measurement, was the patient's arm supported?" and 14: "During BP measurement, was the patient's arm positioned at the same height as the heart?" ($p < .05$). Seven recommendations were followed by >60% of patients (measurement of BP at different times of day, use of the same arm and same body position to measure BP, use of a cuff chosen on the basis of the patient's arm circumference, correct positioning and support of the arm during BP measurement), but seven were followed by less than 60% of the patients (repeating the measurement after several minutes, keeping a measurement diary, resting for at least 5 min before BP measurement, remaining quiet during the measurement, keeping the legs uncrossed and sitting supported by a chair or headboard during BP monitoring, with the point where the cuff was located uncovered) (Table 3).

4.3 | Effectiveness of the family nurse intervention

Compared with baseline, after instruction by the FNP, the adherence of patients in the intervention group to the guidelines increased significantly for the following recommendations: BP measurement at the same hour of the day; without talking, with the patient's back supported by a chair or bed saddle; with the patient's legs uncrossed; with the patient's arm positioned at the same height as the heart; more than one BP measurement in each session; keeping a measurement diary; choosing the appropriate cuff and placing it properly on the arm; resting for >5 min before the measurement (all $p < .001$); with the patient's arm supported ($p < .01$) and using the same arm ($p < .05$) with the point where the cuff was located uncovered ($p < .05$). There was no improvement in the use of a cuff chosen on the basis of the patient's arm circumference, always measuring BP in the same body position and in a quiet, undisturbed environment.

Guidelines' adherence also improved in the usual-care group, but only for one specific item: performing the measurement in a calm environment with no distractions (98.9%, $p > .05$). Less than 30% of patients of them adhered to the required 5-min rest before the first measurement, repeating the measurement after several minutes, keeping a measurement diary, using a back support. The results are reported in Tables 4 and 5.

5 | DISCUSSION

This study evaluated the effectiveness of a training programme conducted by a FNP in improving patients' adherence to the current recommendations on HBPM. The results showed a significant improvement of several practices recommended by the HBPM guidelines (Parati et al., 2008). Specifically, in >75% of the patients in the intervention group, all 15 procedures were correctly followed

TABLE 2 Characteristics of blood pressure self-measurement at baseline

Blood pressure self-measurement	Usual care, Yes *n* (%)	Intervention, Yes *n* (%)	*p*
Do you received instructions, written or verbal, on the correct use of BP device and the measurement procedure?	37 (43.0)	46 (55.4)	.125
From who?			
by myself	12 (32.4)	7 (15.2)	.119
from friends	0 (0.0)	2 (4.3)	
from a pharmacist	9 (24.3)	11 (23.9)	
from a nurse	3 (8.1)	11 (23.9)	
from a doctor	13 (35.1)	15 (32.6)	
How many BP measurements do you routinely perform?			
Occasionally, I do not follow a fixed schedule	52 (60.5)	42 (50.6)	.403
About 1 per week	16 (18.6)	15 (30.1)	
About 2 per week	16 (18.6)	25 (18.1)	
About 1 per day	1 (1.2)	1 (1.2)	
About 2 per day or more	1 (1.2)	0 (0.0)	

TABLE 3 Adherence to HBPM guidelines of the two groups at baseline

Items	Usual care Yes *n* (%)	Intervention Yes *n* (%)	*p*
Questions asked to participants by the FNP			
1 a. Do you measure BP at different times of day?	59 (68.6)	53 (64.6)	.626
1 b. When do you measure your BP most frequently?			
Before breakfast	25 (42.4)	18 (34.0)	.511
After breakfast	23 (39.0)	26 (49.1)	
Before lunch	6 (10.2)	7 (13.2)	
After lunch	3 (5.1)	2 (3.8)	
Before dinner	2 (3.4)	0 (0.0)	
2. Do you always measure BP using the same arm?	65 (74.7)	62 (74.7)	1.000
3 a. Do you always measure BP in the same body position?	76 (87.4)	75 (90.4)	.629
3 b. If so, in which body position do you usually measure BP?			
Sitting on a chair	70 (92.1)	66 (89.2)	.146
Sitting on the bed	5 (6.6)	2 (2.7)	
Lying	1 (1.3)	3 (4.1)	
Standing up	0 (0.0)	3 (4.1)	
(value missing)		1	
4. Do you repeat the measurement after few minutes?	14 (16.1)	12 (14.5)	.833
5. Do you keep a diary of your BP measurements?	20 (23.0)	16 (19.3)	.579
Direct observation of the patient' HBP self-measurement by the FNP			
6. Did the patient choose the cuff based on his/her arm circumference?	85 (97.7)	80 (96.4)	.677
7. Did the patient put the cuff on properly?	61 (70.1)	70 (84.3)	.030
8. Before BP measurement, did the patient rest for at least 5 minutes?	18 (20.7)	13 (15.7)	.432
9. During BP measurement, was the room calm, with low noise and no distractions?	50 (57.5)	52 (62.7)	.533
10. During BP measurement, was the patient silent?	17 (19.5)	26 (31.3)	.081
11. During BP measurement, did the patient keep his/her legs uncrossed?	45 (51.7)	34 (41.0)	.170
12. During BP measurement, was the patient's back supported by a chair or headboard?	24 (27.6)	19 (22.9)	.597
13. During BP measurement, was the patient's arm supported?	68 (80.0)	77 (92.8)	**.023**
14. During BP measurement, was the patient's arm positioned at the same height as the heart?	60 (69.0)	73 (88.0)	**.003**
15. During BP measurement, was the point where the cuff was located uncovered?	41 (47.1)	46 (55.4)	.288

(Continues)

one month after FNP intervention. In general, guideline adherence also improved in the usual-care group, but only for one specific item: performing the measurement in a calm environment with no distractions (98.9% at T1 vs 57.5 at T0). However, only a great percentage of patients (≤70%) in the usual-care group did not: (a) rest 5-min before the first measurement, (b) repeat the measurement after several minutes, (c) keep a measurement diary and (d) use a back support. These results are consistent with those of other studies (Flacco et al., 2015; Wagner et al., 2012, 2013, 2014) of the accuracy of HBPM, which similarly found a low level of adherence with current recommendations. Flacco et al. (2015) suggested patient training in HBPM especially for the less-frequently followed recommendations, such as the importance of performing the measurement more than once. This suggestion is supported by studies showing a difference in systolic BP of ≥10 mm Hg between temporally close measurements in 30% of patients (Cicolini et al., 2011) and a 40% probability of misdiagnosis when only single measurements are made (Powers et al., 2011). Other studies have similarly recommended that healthcare workers educate patients regarding the importance of measuring BP after a period of rest (Badeli & Assadi, 2014) and always at the same time of day, in order to avoid the risk of an overestimated BP and a misdiagnosis caused by circadian variations (Verdecchia et al., 1990). Other important instructions are the need for back support and uncrossed legs during BP measurement as both can falsely increase pressure levels (Cushman et al., 1990; Peters et al., 1999). Furthermore, coherently with previous studies, our findings highlighted that even the low-adherence patients before intervention had an improvement after the intervention as well (Flacco et al., 2015; Wagner et al., 2012, 2013, 2014). Our finding of a benefit of FNP intervention in improving adherence to HBPM guidelines is in line with the conclusions of other studies that evaluated similar strategies to manage hypertension (Hebert et al., 2012; Irewall et al., 2015, 2019; Sharrief et al., 2019; Zhu et al., 2014, 2018) or in cardiovascular disease prevention (Cicolini et al., 2014). However, a novel aspect of our study was the use of a training programme as an effective approach to hypertension management. The hypertension training programme consisted of a specific curriculum developed for implementation by nurses to expand their role in hypertension management while allowing greater responsibility and closer interaction with patients (Miao et al., 2020).

TABLE 4 Characteristics of blood pressure self-measurement at the follow-up visit.

Blood pressure self-measurement	Usual care Yes, *n* (%)	Intervention Yes, *n* (%)	*p*	Odds ratio (95% CI)
Do you received instructions, written or verbal, on the correct use of BP device and the measurement procedure?	37 (43.0)	79 (95.2)	<.001	26.1 (8.8–77.9)
From who?				
by myself	12 (32.4)	1 (1.3)	<.001	
from a pharmacist	9 (24.3)	4 (5.1)		
from a nurse	3 (8.1)	71 (89.9)		
from a doctor	13 (35.1)	3 (3.8)		
How many BP measurements do you routinely perform?				
Occasionally, I do not follow a fixed schedule	52 (59.8)	14 (16.9)	<.001	
About 1 per week	17 (19.5)	19 (22.9)		
About 2 per week	16 (18.4)	8 (9.6)		
About 1 per day	1 (1.1)	32 (38.6)		
About 2 per day or more	1 (1.1)	10 (12.0)		

5.1 | Limits

This study also had several limitations that should be noted. First, the evaluation period lasted only 1 month; whether the benefits derived from the educational programme persist, decrease or even disappear over a longer period remains to be determined. Second, the FNP-led intervention was tested only in two centres of an Italian community setting, which could limit the generalisability of our results to a larger population. Third, whether additional training is needed to maintain an adequate level of adherence with HBPM recommendations was not investigated. Fourth, the instrument used for data collection included a section in which patients self-report their habits, such that recall bias or social desirability bias cannot be excluded (Brener et al., 2003).

Another possible limitation of our study is that it was conducted as a single blind: only the patient was blinded, while the FNP was aware of the study allocation with a potential observer bias: Rosenthal effect (Rosehthal, 1996; Rosenthal & Rabin, 1978) that we tried to avoid using the structured instrument for data collection: all the items of the questionnaire or observation allowed the FNP to achieve objective data.

However, a strength of this study was that it employed a procedure conducted by a FNP who was able to directly assess the habits and performance of the patients using a measurement instrument to evaluate effectiveness.

6 | CONCLUSIONS

A FNP-led training programme for HBPM can yield positive results. In our series of hypertensive patients who participated in a training programme, a large and statistically significant improvement in adherence with 12 out of 15 HBPM recommendations was determined. Our results demonstrate the importance of designing targeted and educational interventions conducted by a FNP or a specialised hypertension nurse who are able to support hypertensive patients at various stages of treatment, including by helping them to develop skills needed to self-measure BP in order to better manage their disease. In particular, patients with long-term pathologies, who usually have to carry out their own self-management to control their pathology and/or BP, could also benefit from similar interventions, useful for maintaining long-term adherence to guidelines. This will ultimately translate into an improved health outcome related to BP control for hypertensive patients, through involvement in their own care pathway.

7 | RELEVANCE TO CLINICAL PRACTICE

The challenges faced by hypertensive patients, including the difficulty in controlling and monitoring BP and reducing the risk of developing diseases such as acute myocardial infarction, stroke, kidney and disease, could be competently addressed. This aim could be addressed through individualised training and re-training interventions, thus leading, on the whole to a better control of BP and its related health outcomes in hypertensive patients. By correct self-measurement of BP, patients can reduce their clinic visits, a particular advantage for those with limited access to healthcare facilities. The educational programme is relatively simple, requiring only a 1-hr training session, and does not involve additional costs and, beyond the usual care, as the FNP conducted the intervention during his/her working hours. Thus, given the programme's efficacy in improving patient adherence to HBPM, it should be added to existing interventions aimed at supporting patients with hypertension. Moreover, based on the programme's results, nurses should be encouraged to develop new training strategies that increase the technical skills of patients with chronic illnesses to enable greater self-management.

TABLE 5 Adherence to HBPM guidelines by the two groups at the follow-up visit

Items	Usual Care Yes *n* (%)	Intervention Yes *n* (%)	*p*	Odds ratio (95% CI)
Questions asked to participants by the FNP				
1 a. Do you measure BP at different times of day?	58 (67.4)	20 (24.4)	<.001	6.4 (3.3–12.6)
1 b. When do you measure your BP most frequently?				
Before breakfast	25 (43.1)	7 (35.0)	.218	
After breakfast	23 (39.7)	13 (65.0)		
Before lunch	6 (10.3)	0 (0.0)		
After lunch	3 (5.2)	0 (0.0)		
Before dinner	1 (1.7)	0 (0.0)		
2. Do you always measure BP using the same arm?	65 (74.7)	72 (86.7)	.047	2.2 (1–4.9)
3 a. Do you always measure BP in the same body position?	74 (86.0)	75 (91.5)	.333	1.7 (0.6–4.7)
3 b. If so, in which body position do you usually measure BP?				
Sitting on a chair	69 (93.2)	74 (98.7)	.116	
Sitting on the bed	5 (6.8)	1 (1.3)		
4. Do you repeat the measurement after few minutes?	15 (17.2)	67 (80.7)	<.001	20.1 (9.2–43.8)
5. Do you keep a diary of your BP measurements?	19 (21.8)	71 (85.5)	<.001	21.2 (9.6–46.9)
Direct observation of the patient' HBP self-measurement by the FNP				
6. Did the patient choose the cuff on the basis of his/her arm circumference?	85 (97.7)	81 (97.6)	1.000	0.9 (0.1–6.9)
7. Did the patient put the cuff on properly?	61 (70.1)	83 (100.0)	<.001	2.4 (1.9–2.9)[a]
8. Before BP measurement, did the patient rest for at least 5 minutes?	19 (21.8)	77 (92.8)	<.001	45.9 (17.3–121.6)
9. During BP measurement, was the room calm, with low noise and no distractions?	86 (98.9)	83 (100.0)	1.000	2 (1.7–2.3)[a]
10. During BP measurement, was the patient silent?	29 (33.3)	72 (86.7)	<.001	0.1 (0–0.2)
11. During BP measurement, did the patient keep his/her legs uncrossed?	48 (55.2)	76 (91.6)	<.001	0.1 (0.1–0.3)
12. During BP measurement, was the patient's back supported by a chair or bed saddle?	20 (23.3)	75 (90.4)	<.001	30.9 (12.8–74.9)
13. During BP measurement, was the patient's arm supported?	72 (82.8)	81 (97.6)	.0015	8.4 (1.9–38.2)
14. During BP measurement, was the patient's arm positioned at the same height as the heart?	60 (69.0)	80 (97.6)	<.001	18 (4.1–78.7)
15. During BP measurement, was the point where the cuff was located uncovered?	44 (50.6)	78 (94.0)	<.001	0.1 (0–0.2)

[a]For cohort Usual Care.

In particular, in this period of COVID-19 pandemic we observed an exacerbation of barriers to adherence and self-management of vulnerable population suffering from chronic conditions, potentially resulting in greater health disparity. In this situation, ongoing monitoring and promotion of adherence and self-management are critical. Technology offers several opportunities for this via telemedicine, electronic monitoring and mobile apps, but these solutions are not sufficient di per se. In fact, FNPs, GPs and paediatrics are the key-professionals to manage each Clinical Pathways, and to develop and implement adherence-promotion efforts to support those affected by long-term conditions and their families in achieving and sustaining optimal disease management as required by today public health situation. Further research should focus on the efficacy of educational and training programmes and the results then shared within the clinical community.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

All authors participated in all phases of the study (design, data collection and interpretation of the results); Valentina Simonetti (VS),

Dania Comparcini (DC), Marco Tomietto (MT) and Giancarlo Cicolini (GC) designed the study; Daniele Pavone (DP) made the statistical analysis; Valentina Simonetti (VS), Dania Comparcini (DC) and Giancarlo Cicolini (GC) wrote the article; Giancarlo Cicolini (GC), Marco Tomietto (MT) and Maria Elena Flacco (MEF) critically revised the paper.

ORCID

Valentina Simonetti https://orcid.org/0000-0002-7185-4850
Dania Comparcini https://orcid.org/0000-0003-3622-6370
Marco Tomietto https://orcid.org/0000-0002-3813-1490
Maria Elena Flacco https://orcid.org/0000-0003-1404-4314
Giancarlo Cicolini https://orcid.org/0000-0002-2736-1792

REFERENCES

Adiyaman, A., Tosun, N., Elving, L. D., Deinum, J., Lenders, J. W. M., & Thien, T. (2007). The effect of crossing legs on blood pressure. *Blood Pressure Monitoring*, *12*(3), 189–193.

Al-Gelban, K. S., Khan, M. Y., Al-Khaldi, Y. M., Mahfouz, A. A., Abdelmoneim, I., Daffalla, A., Mostafa, O. A., & Al-Amri, H. S. (2011). Adherence of primary health care physicians to hypertension management guidelines in the Aseer region of Saudi Arabia. *Saudi Journal of Kidney Diseases and Transplantation*, *22*(5), 941–948.

Badeli, H. & Assadi, F. (2014). Strategies to reduce pitfalls in measuring blood pressure. *International Journal of Preventive Medicina*, *5*(suppl 1), S17–S20.

Baguet, J. P. (2012). Out-of-office blood pressure: From measurement to control. *Integrated Blood Pressure Control*, *5*, 27–34. https://doi.org/10.2147/IBPC.S30409

Brener, N. D., Billy, J. O., & Grady, W. R. (2003). Assessment of factors affecting the validity of self-reported health-risk behaviour among adolescents: Evidence from the scientific literature. *The Journal of Adolescent Health*, *33*(6), 436–457. https://doi.org/10.1016/s1054-139x(03)00052-1

Carey, R. M., Muntner, P., Bosworth, H. B., & Whelton, P. K. (2018). Prevention and control of hypertension: JACC health promotion series. *Journal of American College of Cardiology*, *72*(11), 1278–1293. https://doi.org/10.1016/j.jacc.2018.07.008

Celis, H., Hond, E. D., & Staessen, J. A. (2005). Self-measurement of blood pressure at home in the management of hypertension. *Clinical Medicine & Research*, *3*(1), 19–26. https://doi.org/10.3121/cmr.3.1.19

Cicolini, G., Pizzi, C., Palma, E., Bucci, M., Schioppa, F., Mezzetti, A., & Manzoli, L. (2011). Difference in blood pressure by body position (supine, fowler's, and sitting) in hypertensive subjects. *American Journal of Hypertension*, *24*(10), 1073–1079. https://doi.org/10.1038/ajh.2011.106

Cicolini, G., Simonetti, V., Comparcini, D., Celiberti, I., Di Nicola, M., Capasso, L. M., Flacco, M., Bucci, M., Mezzetti, A., & Manzoli, L. (2014). Efficacy of a nurse-led email reminder program for cardiovascular prevention risk reduction in hypertensive patients: a randomized controlled trial. *International Journal of Nursing Studies*, *51*(6), 833–843. https://doi.org/10.1016/j.ijnurstu.2013.10.010

Cushman, W. C., Cooper, K. M., Horne, R. A., & Meydrech, E. F. (1990). Effect of back support and stethoscope head on seated blood pressure determinations. *American Journal of Hypertension*, *3*(3), 240–241. https://doi.org/10.1093/ajh/3.3.240

Dabl®Educational Trust, Blood Pressure Monitors, Validations, Papers and Reviews. Retrieved from http://www.dableducational.org

Dean, S. C., Kerry, S. M., Khong, T. K., Kerry, S. R., & Oakeshott, P. (2014). Evaluation of a specialist nurse-led hypertension clinic with consultant backup in two inner citygeneral practices: Randomized controlled trial. *Family Practice*, *31*(2), 172–179. https://doi.org/10.1093/fampra/cmt074

Flacco, M. E., Manzoli, L., Bucci, M., Capasso, L., Comparcini, D., Simonetti, V., Gualano, M. R., Nocciolini, M., D'Amario, C., & Cicolini, G. (2015). Uneven accuracy of home blood pressure measurement: A multicentric survey. *Journal of Clinical Hypertension (Greenwich, Conn.)*, *17*(8), 638–643. https://doi.org/10.1111/jch.12552

Hebert, P. L., Sisk, J. E., Tuzzio, L., Casabianca, J. M., Pogue, V. A., Wang, J. J., Chen, Y., Cowles, C., McLaughlin, M. A. & McLaughlin, M. A. (2012). Nurse-led disease management for hypertension control in a diverse urban community: A randomized trial. *Journal of General Internal Medicine*, *27*(6), 630–639. https://doi.org/10.1007/s11606-011-1924-1

Helvaci, M. R. & Seyhanli, M. (2006). What a high prevalence of white coat hypertension in society! *Internal Medicine*, *45*(10), 671–674. https://doi.org/10.2169/internalmedicine.45.1650

Irewall, A.-L., Ögren, J., Bergström, L., Laurell, K., Söderström, L., & Mooe, T. (2015). Nurse-led, telephone-based, secondary preventive follow-up after stroke or transient ischemic attack improves blood pressure and LDL cholesterol: Results from the first 12 months of the randomized, controlled NAILED stroke risk factor trial. *PLoS One*, *10*(10), e0139997. https://doi.org/10.1371/journal.pone.0139997

Irewall, A. L., Ögren, J., Bergström, L., Laurell, K., Söderström, L., & Mooe, T. (2019). Nurse-led, telephone-based secondary preventive follow-up benefits stroke/TIA patients with low education: A randomized controlled trial sub-study. *Trials*, *20*(1), 52. https://doi.org/10.1186/s13063-018-3131-4

Keleher, H., Parker, R., Abdulwadud, O., & Francis, K. (2009). Systematic review of the effectiveness of primary care nursing. *International Journal of Nursing Practice*, *15*(1), 16–24.

Liyanage-Don, N., Fung, D., Phillips, E., & Kronish, I. M. (2019). Implementing home blood pressure monitoring into clinical practice. *Current Hypertension Report*, *21*(2), 14. https://doi.org/10.1007/s11906-019-0916-0

Mancia, G., Fagard, R., Narkiewicz, K., Redón, J., Zanchetti, A., Böhm, M., & Zannad, F. (2013). 2013 ESH/ESC Guidelines for the management of arterial hypertension: The task force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Journal of Hypertension*, *31*(7), 1281–1357. https://doi.org/10.1097/01.hjh.0000431740.32696.cc

Manzoli, L., Pizzi, C., Flacco, M. E., & Cicolini, G. (2013). Compliance to the recommendations on blood pressure measurements in the clinical settings. *Journal of Hypertension*, *31*(1), 213–214. https://doi.org/10.1097/HJH.0b013e32835ab012

Manzoli, L., Simonetti, V., D'Errico, M. M., De Vito, C., Flacco, M. E., Forni, C., La Torre, G., Liguori, G., Messina, G., Mezzetti, A., Panella, M., Pizzi, C., Siliquini, R., Villari, P., & Cicolini, G. (2012). (In)accuracy of blood pressure measurement in 14 Italian hospitals. *Journal of Hypertension*, *30*(10), 1955–1960. https://doi.org/10.1097/HJH.0b013e3283577b20

McManus, R. J., Wood, S., Bray, E. P., Glasziou, P., Hayen, A., Heneghan, C., Mant, J., Padfield, P., Potter, J. F., & Hobbs, F. D. R. (2014). Self-monitoring in hypertension: A web-based survey of primary care physicians. *Journal of Human Hypertension*, *28*(2), 123–127. https://doi.org/10.1038/jhh.2013.54

Miao, J. H., Wang, H. S., & Liu, N. (2020). The evaluation of a nurse-led hypertension management model in an urban community healthcare: A randomized controlled trial. *Medicine (Baltimore)*, *99*(27), e20967.

Obara, T., Ohkubo, T., Mano, N., Kuriyama, S., & Imai, Y. (2013). Compliance to the recommendations on blood pressure measurements in the clinical settings. *Journal of Hypertension*, *31*(1), 213. https://doi.org/10.1097/HJH.0b013e32835aaffd

Parati, G., Omboni, S., Palatini, P., Rizzoni, D., Bilo, G., Valentini, M., Agabiti Rosei, E., & Mancia, G. (2008). Italian society of hypertension guidelines for conventional and automated blood pressure measurement in the office, at home and over 24 hours. *High Blood Pressure and Cardiovascular Prevention*, *15*(4), 283–310. https://doi.org/10.2165/0151642-200815040-00008

Peters, G. L., Binder, S. K., & Campbell, N. R. (1999). The effect of crossing legs on blood pressure: A randomized single-blind cross-over study. *Blood Pressure Monitoring*, *4*(2), 97–101.

Powers, B. J., Olsen, M. K., Smith, V. A., Woolson, R. F., Bosworth, H. B., & Oddone, E. Z. (2011). Measuring blood pressure for decision making and quality reporting: where and how many measures? *Annals of Internal Medicine*, *154*(12), 781–788, W-289-90. https://doi.org/10.7326/0003-4819-154-12-201106210-00005

Rosenthal, R. (1966). *Experimenter effects in behavioral research*. Appleton.

Rosenthal, R. & Rubin, D. (1978). Interpersonal expectancy effects: The first 345 studies. *Behavioral and Brain Sciences*, *1*(3), 377–386. https://doi.org/10.1017/S0140525X00075506

Rutherford, M. M. (2014). The value of trust to nursing. *Nursing Economics*, *32*(6), 283–327.

Schulz, K. F., Altman, D. G., Moher, D., & CONSORT Group. (2010). CONSORT 2010 statement: Updated guidelines for reporting parallel group randomised trials. *British Medical Journal*, *23*(340), c332. https://doi.org/10.1136/bmj.c332.

Sharrief, A. Z., Hinojosa, E., Cooksey, G., Okpala, M. N., Avritscher, E. B., Pedroza, C., Denny, M. C., Samuels, J., Tyson, J. E., & Savitz, S. I. (2019). Does care in a specialised stroke prevention clinic improve poststroke blood pressure control: A protocol for a randomised comparative effectiveness study. *British Medical Journal Open*, *9*(2), e024695. https://doi.org/10.1136/bmjopen-2018-024695

Staessen, J. A., Wang, J., Bianchi, G., & Birkenhager, W. H. (2003). Essential hypertension. *Lancet*, *361*(9369), 1629–1641. https://doi.org/10.1016/S0140-6736(03)13302-8

Stephan, D., Gaertner, S., & Cordeanu, E. M. (2015). A critical appraisal of the guidelines from France, the UK, Europe and the USA for the management of hypertension in adults. *Archives of Cardiovascular Diseases*, *108*(8–9), 453–459. https://doi.org/10.1016/j.acvd.2015.05.006

Stergiou, G. S., O'Brien, E., Myers, M., Palatini, P., & Parati, G. (2020). STRIDE BP scientific advisory board. STRIDE BP: An international initiative for accurate blood pressure measurement. *Journal of Hypertension*, *38*(3), 395–399. https://doi.org/10.1097/HJH.0000000000002289.

Verdecchia, P., Schillaci, G., Guerrieri, M., Gatteschi, C., Benemio, G., Boldrini, F., & Porcellati, C. (1990). Circadian blood pressure changes and left ventricular hypertrophy in essential hypertension. *Circulation*, *81*(2), 528–536. https://doi.org/10.1161/01.cir.81.2.528

Verdecchia, P., Staessen, J. A., White, W. B., Imai, Y., & O'Brien, E. T. (2001). Properly defining white coat hypertension. *European Heart Journal*, *23*(2), 106–109. https://doi.org/10.1053/euhj.2001.2657

Wagner, S. (2017). Blood pressure self-measurement. *Advances in Experimental Medicine and Biology*, *956*, 97–107. https://doi.org/10.1007/5584_2016_151

Wagner, S., Buus, N. H., Jespersen, B., Ahrendt, P., Bertelsen, O. W., & Toftegaard, T. S. (2013). Measurement adherence in the blood pressure self measurement room. *Telemedicine Journal and E-Health*, *19*(11), 826–833. https://doi.org/10.1089/tmj.2013.0032

Wagner, S., Kamper, C. H., Rasmussen, N. H., Ahrendt, P., Toftegaard, T. S., & Bertelsen, O. W. (2014). Reliable blood pressure self-measurement in the obstetric waiting room. *Methods of Information in Medicine*, *53*(3), 225–234. https://doi.org/10.3414/ME13-01-0032

Wagner, S., Toftegaard, T. S., & Bertelsen, O. W. (2012). Challenges in blood pressure self-measurement. *International Journal of Telemedicine & Applications*, *2012*, 437350. https://doi.org/10.1155/2012/437350

Webber, E. & Serowoky, M. (2017). Breastfeeding curricular content of family nurse practitioner programs. *Journal of Pediatric Health Care*, *31*(2), 189–195. https://doi.org/10.1016/j.pedhc.2016.07.006.

Whelton, P. K., Carey, R. M., Aronow, W. S., Casey, D. E. Jr, Collins, K. J., Dennison Himmelfarb, C., De Palma, S. M., Gidding, S., Jamerson, K. A., Jones, D. W., MacLaughlin, E. J., Muntner, P., Ovbiagele, B., Smith JR, S. C., Spencer, C. C., Stafford, R. S., Taler, S. J., Thomas, R. J., & Williams Sr, K. A. (2018). 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/ APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: A report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *Journal of the American College of Cardiology*, *71*(19), e127–e248. https://doi.org/10.1016/j.jacc.2017.11.005

Williams, B., Mancia, G., Spiering, W., Agabiti Rosei, E., Azizi, M., Burnier, M. et al (2018). Practice guidelines for the management of arterial hypertension of the European Society of Hypertension and the European Society of Cardiology: ESH/ESC task force for the management of arterial hypertension. *Journal of Hypertension*, *36*(12), 2284–2309. https://doi.org/10.1097/HJH.0000000000001961

Zhu, X., Wong, F. K. Y., & Wu, C. L. H. (2018). Development and evaluation of a nurse-led hypertension management model: A randomized controlled trial. *International Journal of Nursing Studies*, *77*, 171–178. https://doi.org/10.1016/j.ijnurstu.2017.10.006

Zhu, X., Wong, F. K., & Wu, L. H. (2014). Development and evaluation of a nurse-led hypertension management model in a community: A pilot randomized controlled trial. *International Journal of Clinical and Experimental Medicine*, *7*(11), 4369–4377.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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