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Adding Pharmacist-Led Home Blood Pressure Telemonitoring to Usual Care for Blood Pressure Control: A Systematic Review and Meta-Analysis

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Health systems have been quickly adopting telemedicine throughout the United States, especially since the onset of the COVID-19 pandemic. However, there are limited data on whether adding pharmacist-led home blood pressure (BP) telemonitoring to office-based usual care improves BP. We searched PubMed/MEDLINE and Embase for randomized controlled trials from January 2000 until April 2022, comparing studies on pharmacist-led home BP telemonitoring with usual care. Six randomized controlled trials, including 1,550 participants, satisfied the inclusion criteria. There were 774 participants in the pharmacist-led telemonitoring group and 776 in the usual care group. The addition of pharmacist-led telemonitoring to usual care was associated with a significant decrease in systolic BP (mean difference −8.09, 95% confidence interval −11.15 to −5.04, p <0.001, I^2 = 72%) and diastolic BP (mean difference −4.19, 95% confidence interval −5.58 to −2.81, p <0.001, I^2 = 42%) compared with usual care. In conclusion, this meta-analysis showed that adding pharmacist-led home BP telemonitoring to usual care achieves better BP control than usual care alone. **(Am J Cardiol 2023;203:161−168)**

Hypertension, or high blood pressure (BP), is one of the most common chronic medical conditions managed in an outpatient setting in the United States and worldwide.[1,2] Affecting approximately 30% of the US adult population,[3,4] it is a major risk factor for cardiovascular disease and accounts for about 35% of deaths.[5,6] Unfortunately, medication adherence in hypertension remains relatively poor and complicates treatment.[7] Additionally, the current and projected shortage of primary care providers (PCPs) in the coming years is expected to further limit patient access to care.[8]

These current and expected gaps in care may be minimized through the employment of telehealth and leveraging pharmacists as physician extenders. Telehealth has evolved rapidly to improve access to health care, especially after the onset of the COVID-19 pandemic, and provides a promising platform to help improve BP.[9−11] Indeed, telemedicine-based BP management has been found to reduce systolic BP (SBP) by 4 to 10 mm Hg compared with the usual office-based care.[12,13] Notably, pharmacists play a crucial role in bridging the gap between patients and physicians, ensuring patient compliance, and initiating interventions in treatment in coordination with a physician.[13] Maximizing pharmacists' impact on BP control through telemonitoring has the potential to decrease the burden of hypertension, its complications and healthcare costs, and PCP workload.[1,2,12,13]

We hypothesized that adding pharmacists' telemonitoring to office visits would lead to better management of BP. In this systematic review and meta-analysis of randomized controlled trials (RCTs), we investigated the mean differences in the SBP and diastolic BP (DBP) reduction when pharmacist-led home BP telemonitoring is added to usual care in comparison with usual care alone.

Methods

We searched PubMed, MEDLINE, and Embase for studies from January 2000 until April 2022 with search terms including ("Pharmacist") AND ("Usual care," OR "Standard care") OR ("Telemedicine" OR "Blood pressure management" OR "BP management" OR "Blood Pressure"). We only included RCTs on pharmacist-led telemonitoring home BP management (HBPM) in addition to usual care compared with usual care alone. All adults (>18 years) with clinician-diagnosed hypertension were included.[2] Studies in languages other than English, animal studies, case reports, case series, cohorts, meta-analyses, and observational studies were excluded.

Patients with HBPM led by a pharmacist virtually through telehealth visits using web-based services (e.g.,

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See page 167 for Declaration of Competing Interest.

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Zoom video conference), Viber, telephone, or mobile applications in addition to usual care received at the office, were compared with usual care alone, which included BP management in the office by physicians, nurse practitioners, and/or physician assistants.

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement for reporting systematic reviews as recommended by the Cochrane Collaboration (Oxford, United Kingdom) was followed.[14,15] Search results were saved in EndNote version × 9 (Developer: Clarivate analysis). We extracted data manually through a full-text review. Two reviewers (NB and AS) independently performed the title, abstract and full-text screening. Conflicts were resolved through consensus; if not, a third author (JM) resolved the conflicts. The Cochrane risk of bias tool (Review Manager version 5.4, Cochrane Collaboration) was used to evaluate the quality of included studies. This scale assigns a high risk of bias, low risk of bias, or inability to determine each study's status in 6 domains.

The outcome of interest was the mean difference in SBP and DBP after 5 to 12 months of telemedicine-based management/intervention. The frequency of contact varied from weekly to monthly in the included studies.

Statistical analysis: Meta-analyses were performed with Review Manager statistical software (version 5.4, Cochrane Collaboration) using the inverse variance method. We assessed the pooled hazard ratio and 95% confidence interval (CI) using the random effect model. The I^2 statistic was used to assess heterogeneity. We calculated the pooled mean difference in SBP and DBP between the pharmacist-led telemonitoring group and the usual care group.

Results

We identified 240 articles from PubMed/MEDLINE and 1,090 articles from Embase. In total, 71 records were screened after filtering out the remaining articles based on study design, removal of duplicates, and inclusion criteria. Final qualitative and quantitative analyses were done with 6 studies (Figure 1). There were 1550 participants from 6 included studies, of which 774 participants were in the pharmacist-led HBPM group and 776 were in the usual care group.

The included studies were conducted over periods ranging from 5 to 12 months. Four of the studies were conducted in primary care clinics in the United States.[16−19] One was conducted in a community pharmacy in Spain, and the other was conducted in a cardiology clinic in Iran.[20,21] Co-morbidities were prevalent, including diabetes mellitus, chronic kidney disease, and cardiovascular disease.[16,17,19−21] In all studies, the intervention group underwent home BP monitoring and pharmacist intervention through telemonitoring

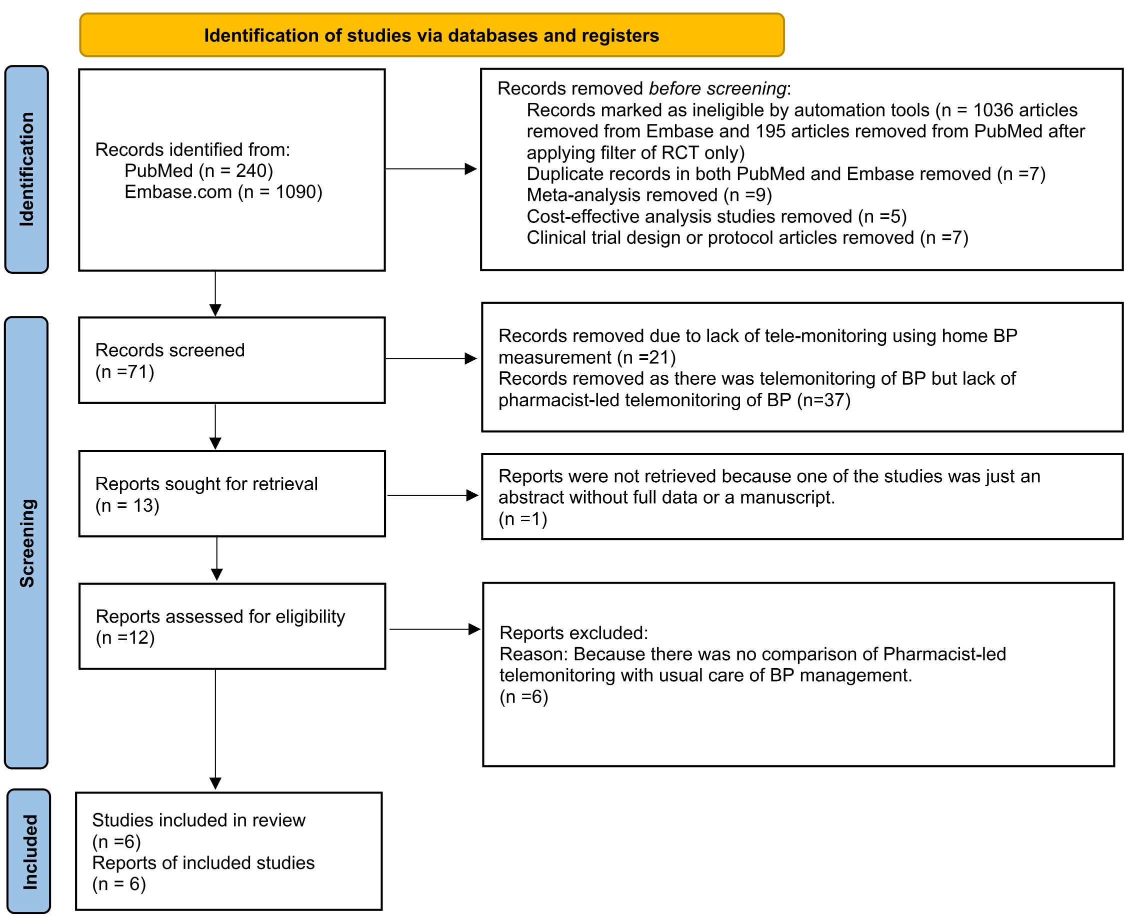

Figure 1. PRISMA flow diagram of included studies.

and/or web applications in addition to usual care.[16–21] The usual care group underwent regular visits with their PCP without home BP monitoring and contact with the pharmacist. Telemonitoring was done through phone calls alone in all except 2 studies. In Green et al,[18] a web application was utilized in addition to phone calls; in Magid et al,[19] the contact was only through a web application.

The baseline characteristics of the intervention and usual care groups were similar (Tables 1 and 2). The mean age across the studies ranged from 51 to 62 years. The percentage of women in the intervention group was 55% versus 49% in the usual care group.

The addition of pharmacist-led home BP telemonitoring to usual care was associated with a statistically significant decrease in SBP (mean difference −8.09, 95% CI −11.15 to −5.04, p <0.001, I^2 = 72%) and DBP (mean difference −4.19, 95% CI −5.58 to −2.81, p <0.001, I^2 = 42%) compared with usual care alone (Figures 2 and 3). These results remain similar even after excluding individual studies in the sensitivity analysis. Pharmacist intervention was associated with an increase in the number of BP medications compared with usual care (after approval by the PCP) in 3 of the 6 studies.[16–21]

Medication adherence was evaluated in 5 of the 6 studies, using pill count, refill data, and/or the Morisky score[22] (Table 2). There was no significant improvement in measured adherence in 4 studies[17,19–21] whereas the fifth study showed improved adherence at 6 months but not at 12 or 18 months.[16]

Bias assessment revealed a high risk of bias in allocation concealment and blinding of participants and personnel (Figures 4 and 5). Given fewer than 10 studies, no comment on publication bias could be made.

To help evaluate the feasibility of the pharmacist-assisted intervention, we assessed the number of patients screened that decreased to participate in each study. In total, 17 of 209 patients (8.1%) decreased to participate in the study by Fikri-benbrahim,[20] 434 of 2,937 (14.8%) refused to participate in Green et al,[18] 942 of 2,818 (33.4%) decreased to participate in Magid et al,[19] 442 of 2,020 (21.9%) refused to participate in Margolis et al,[16] and no patients were reported as declining to participate in Khiali et al[21] or Mehos et al.[17] Over all 6 studies, 1835 of 8,507 (21.6%) decreased to participate. After randomization, there was only 1 patient across all studies who was reported as refusing to participate, and that patient had been randomized to the usual care group in the study by Green et al.[18] There was no significant difference in loss to follow-up after randomization between the 2 arms across the 6 studies (60 of 830 in the intervention group versus 43 of 834 in the usual care group, p = 0.09).

Discussion

In this meta-analysis of 6 RCTs, adding pharmacist-led home BP telemonitoring resulted in a better reduction in the SBP and DBP to usual office-based care. With recent estimates that PCPs need more than 27 hours per day to provide guideline-based care to their patients,[23] this multidisciplinary method of BP management is a feasible approach to improve BP control and ultimately patient outcomes. The addition of pharmacists-led telemonitoring can effectively decentralize the care for hypertension with timely monitoring and intervention, relieving the load off physicians and being more cost-effective than PCP-led telemonitoring or usual care alone.[24,25]

Table 1
Baseline characteristics of included studies

Study Name	Mean age (years)	% women	Number of participants	Duration (Months)	Study design	Study setting	Co-morbidities
Mehos 2000[17]	59	Pharmacist: 77.7% Usual Care: 61%	36 Pharm: 18 Usual: 18	6	Prospective randomized controlled study	Family medicine clinic Denver, Colorado	19.4% DM
Green 2008[18]	59	Pharmacist: 55.9% Usual Care: 54.7%	484 Pharm: 237 Usual: 247	12	Three arm randomized controlled study	10 medical clinics within an integrated group practice in Washington	Not reported
Khiali 2021[21]	51	Pharmacist: 44.2% Usual Care: 39.3%	126 Pharm: 63 Usual: 63	6	Randomized controlled trial	Shahid Madani Heart Center in Iran	Pharm: 31.1% DM Usual: 22.9% DM
Magid 2013[19]	60	Pharmacist: 38.3% Usual Care: 41%	348 Pharm: 175 Usual: 173	6	Pragmatic Randomized controlled trial	10 Kaiser Permanente primary care clinics, Denver-Boulder metro area	48.5% DM or CKD
Margolis 2013[16]	61	Pharmacist: 45.2% Usual Care: 44.1%	450 Pharm:228 Usual: 222	12	Two group clinic randomized controlled trial	16 primary care clinics in integrated health system in Minneapolis St Paul, Minnesota	19.1% DM 18.6% CKD 9.6% CVD
Fikri-benbrahim 2012[20]	62	Pharmacist: 69% Usual Care: 56.2%	176 Pharm: 87 Usual: 89	5	Quasi-experimental study	13 community pharmacies in Spain	41.7% Dyslipidemia 16% DM 15.5% CVD

CKD = chronic kidney disease; CVD = cardiovascular disease; DM = diabetes mellitus.

Table 2
Characteristics of studies in pharmacist-led home blood pressure telemonitoring versus usual care

Study	Intervention	Control	Contact Mode and Frequency	Medication adherence	Medications adjustment	Inclusion and Exclusion Criteria
Mehos 2000[1]	Pharmacist care with home BP monitoring	No home monitoring or pharmacist care	Phone: Monthly intervals for 6-month period	Measurement: % compliance rate which was calculated by obtaining prescription refill data from pharmacies. No significant difference in compliance (89% in usual care vs 82% in pharmacist group, p=0.29).	83% of participants in the intervention group had addition of medication versus 33% in the control group (p <0.01)	**Inclusion**: Age 35 years or older, current therapy with at least one antihypertensive drug, stage 1 or 2 HTN, ability to measure BP with a home monitor and provision of written informed consent **Exclusion**: Stage 3 HTN, an identified secondary cause of hypertension, atrial fibrillation, pregnancy, current HBPM, failure to demonstrate correct use of monitoring device and drug or alcohol abuse
Green 2008[2]	Home BP monitoring and Web training plus pharmacist care	Usual care	Web communication and phone: Every 2 weeks until BP controlled and less frequently thereafter.	Measurement: Medication adherence was not reported.	Increase in the mean number of antihypertensives in intervention group from 1.6 to 2.16 after 12 months (P< 0.01)	**Inclusion**: Patients aged 25 to 75 with a HTN diagnosis and taking antihypertensive medication **Exclusion**: Diagnosis of diabetes, cardiovascular, renal disease or other serious conditions were excluded
Khiali 2021[3]	Pharmacist directed self-monitoring of BP	Office based usual care of HTN by cardiologists	Phone: Weekly over 6-month period	Measurement: Pill counting method with acceptable compliance rate defined as >90%. No statistical comparison reported, but 2 patients (3.2%) in each arm described as having low compliance.	No significant difference in change in medications in both groups	**Inclusion**: Uncontrolled BP (≥ 140 and/or 90 mm Hg) and 18-79 years who signed consent **Exclusion**: History of white coat-HTN, secondary HTN, BP greater than or equal to 180/120 mm Hg, kidney and liver failure, pregnant or nursing mothers, patients who could not measure their BP, mentally impaired patients, vulnerable children and adults, blind and illiterate people, and those who do not have the required qualification were excluded
Magid 2013[4]	Heart 360 supported home BP monitoring and pharmacist care	Usual office-based care	Web application: Weekly over 6-month period	Measurement: Medication adherence calculated from a medication possession ratio using pharmacy fill data. No significant difference in adherence score (0.86 vs. 0.87, p=0.93) in pharmacist group vs. usual care.	70% of participants in the intervention group had addition of medication versus 25% in the control group (p <0.01)	**Inclusion**: 18-80 years, dx of HTN and their 2 most recent BP readings were above goal (SBP> 140 or DBP > 90) or for those with DM or CKD, SBP >130 or DBP> 80, prescribed ≤ 3 antihypertensives, had a PCP who worked at 1 of the 10 participating sites, access to web **Exclusion**: Limited life expectancy, ≥ 80 years of age, recent MI, stroke, percutaneous coronary intervention, or CABG, end stage renal disease or did not speak English. Patients were also excluded if they had no access to the internet

(*continued on next page*)

Table 2 (***Continued***)

Study	Intervention	Control	Contact Mode and Frequency	Medication adherence	Medications adjustment	Inclusion and Exclusion Criteria
Margolis 2013[5]	BP telemonitoring plus pharmacist case management	Usual care	Phone: Once every 2 weeks for 6 weeks and then monthly until month 6. 7-12 months: once every 2 months via phone.	Measurement: Self-reported 4-item scale by Morisky et al.[6] Increased adherence at 6 months (+10.7%, vs. -5.9%, p<0.05) but not significantly different at 12 and 18 months in pharmacist group vs. usual care.	Increase in mean number of anti-hypertensives: I- 1.6 to 2.2 and C- 1.4 to 1.6 (P> 0.001)	**Inclusion**: Elevated BP (systolic BP ≥ 140 or DBP ≥ 90 mm Hg at their 2 most recent primary care encounters and informed consent **Exclusion**: Stage 4 or 5 kidney disease or albumin-creatinine ratio ≥ 700, ACS, coronary revascularization or stroke within past 3 months, secondary causes of HTN, pregnancy, class 3 or 4 NYHA heart failure or known LVEF less than 30%. Also required patients with a cell phone.
Fikri-Benbrahim 2012[7]	Pharmacist directed home BP monitoring with physician referral	Usual care	Direct visit: 4 pharmacy visits during follow-up period.	Measurement: Patient was considered adherent when adherence using manual pill-count method was between 80% and 110%. No significant differences in percentage of patients adherent in pharmacist group vs. usual care (86% vs 86.5%, p=0.78)	No significant change in the medication number in both groups	**Inclusion**: Treated hypertensive patients of both sexes over age 18 years **Exclusion**: Living with a person taking same anti- hypertensive medication, pregnant, avg systolic/diastolic BP ≥ 200/110 at the time of first visit to the pharmacy, were advised against HBPM, had a psychological disorder, had experienced a cardiovascular event within the previous 6 months, had changes in their antihypertensive treatment schedule during the previous four weeks, were following a specific program for hypertensive patients or already performed HBPM at least two days per month

ACS = acute coronary syndrome; BP= blood pressure; CABG = coronary artery bypass graft; CKD = chronic kidney disease; CVD = cardiovascular disease; DBP = diastolic blood pressure; DM = diabetes mellitus; HBPM = home blood pressure monitoring; HTN = hypertension; MI = myocardial infarction; NYHA = New York Heart Association; PCP = primary care physician.

Study or Subgroup	Pharmacist Mean	SD	Total	Usual care Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Magid 2013	−20.7	18.5596	175	−8.2	18.5596	173	17.9%	−12.50 [−16.40, −8.60]
Margolis 2013	−21.5	13.667	194	−10.8	16.1463	186	20.3%	−10.70 [−13.71, −7.69]
Mehos 2000	−17.1	16.4	18	−7	14.6	18	6.7%	−10.10 [−20.24, 0.04]
Green 2008	−14.2	14.0658	237	−5.3	14.3625	247	21.6%	−8.90 [−11.43, −6.37]
Fikri−Benbrahim 2012	−6.8	13.7	87	−2.1	9.3	89	19.1%	−4.70 [−8.17, −1.23]
Khiali 2021	−34.9	15.8	63	−33.6	14.4	63	14.4%	−1.30 [−6.58, 3.98]
Total (95% CI)			**774**			**776**	**100.0%**	**−8.09 [−11.15, −5.04]**

Heterogeneity: $Tau^2 = 9.59$; $Chi^2 = 18.04$, df = 5 (P = 0.003); $I^2 = 72\%$
Test for overall effect: Z = 5.19 (P < 0.00001)

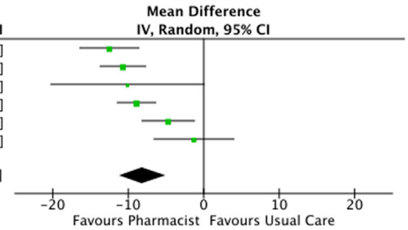

Figure 2. The risk of bias graph in included studies.

Study or Subgroup	Pharmacist Mean	SD	Total	Usual Care Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Fikri−Benbrahim 2012	−2.1	8.9	87	0.1	6.2	89	19.9%	−2.20 [−4.47, 0.07]
Green 2008	−7	7.8144	237	−3.5	7.9792	247	29.7%	−3.50 [−4.91, −2.09]
Khiali 2021	−18.9	9.9	63	−16.3	15	63	7.9%	−2.60 [−7.04, 1.84]
Magid 2013	−10.5	9.9936	175	−4.8	9.9936	173	21.6%	−5.70 [−7.80, −3.60]
Margolis 2013	−9.4	12.9268	194	−3.4	12.9268	186	17.1%	−6.00 [−8.60, −3.40]
Mehos 2000	−10.5	10.8	18	−3.8	9.8	18	3.8%	−6.70 [−13.44, 0.04]
Total (95% CI)			**774**			**776**	**100.0%**	**−4.19 [−5.58, −2.81]**

Heterogeneity: $Tau^2 = 1.16$; $Chi^2 = 8.67$, df = 5 (P = 0.12); $I^2 = 42\%$
Test for overall effect: Z = 5.94 (P < 0.00001)

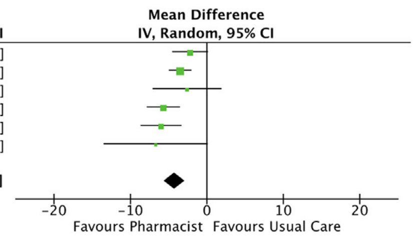

Figure 3. The risk of bias summary in included studies.

Figure 4. Pooled means the difference in systolic blood pressure comparing pharmacist-led home blood pressure telemonitoring plus usual care versus usual care.

Previous systemic reviews and meta-analyses have shown an improvement in BP control with telemonitoring. However, to the best of our knowledge, this is the first meta-analysis to focus on pharmacist-led home BP telemonitoring.[24,26] These results reinforce the international expert consensus recommendations advocating for the use of a multidisciplinary team, including physicians and pharmacists, as an optimal approach to improve BP outcomes.[27] Effective transmission of the BP logbook, counseling on medication adherence, lifestyle modifications, modifiable risk factor control, and shared decision-making have occurred more frequently with pharmacist intervention, potentially playing a role in better BP control.[17,18,20,24,27,28] Other factors influencing effective hypertension treatment in the pharmacist-led telemonitoring group may be increased patient interaction with pharmacists, increased reconciliations of antihypertensive regimens, and strict protocol-based practice of evidence-based medicine.[17,18,20,28]

Notably, the study of Khiali et al[21] was the only one included in this meta-analysis to show no significant difference in mean BP between the pharmacist-led home BP monitoring group and the usual care group. The study was inherently different from other studies included in this meta-analysis as it was conducted in a single center in a medium-income country, and the usual care group was managed by cardiologists rather than by PCP or advanced practice providers, including a twice-weekly visit by cardiologists. Such an aggressive "usual care" strategy of twice-weekly visits would have been expected to bias the results toward the null, is not consistent with typical practice, and is not sustainable on a population level.

Alternatively, telemedicine provides a ready opportunity to help augment the PCP. A team-based approach could potentially reduce the workload of a PCP from 27 to 9 hours per day.[23] With improving technology, telemedicine is increasingly more widely available, even from remote locations, with data conveyance through the internet.[29,30]

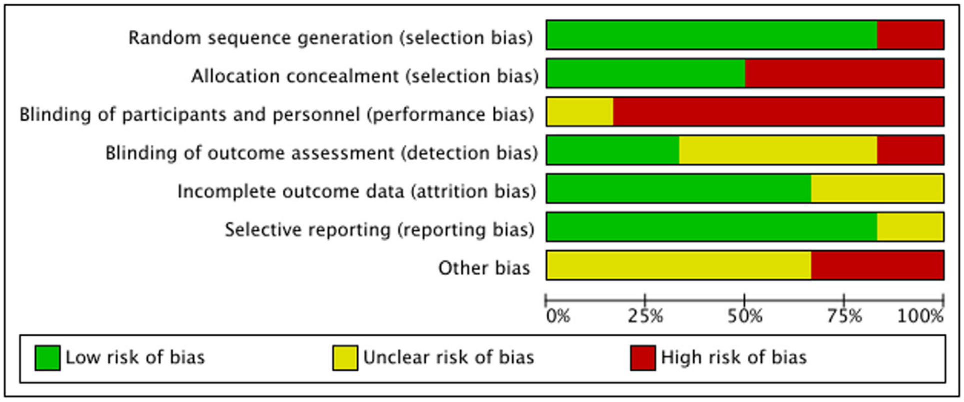

Figure 5. Pooled means the difference in diastolic blood pressure comparing pharmacist-led home blood pressure telemonitoring plus usual care versus usual care.

Pharmacist-led telemonitoring intertwines home-based management, digital technology, and behavioral intervention providing a system that can substantially reduce the burden of hypertension in health care.[24,26,29] The intervention appears fairly feasible, with only 1 in 5 potential participants during screening declining to participate.

Our study has several limitations. In the included studies, BP control was generally assessed over 5 to 12 months. Hence, this study does not ascertain the long-term application of this strategy. Adherence was high in both the intervention and control groups during the study period, and it is unknown whether adherence would change with time with or without pharmacist assistance. Future studies are needed to assess long-term BP reduction and its effect on primary adverse cardiovascular outcomes with the addition of pharmacist-led telemonitoring on BP control.

Further research will also be needed to assess if the intervention is generalizable across all age groups. The mean age of patients across the included studies was 51 to 62 years of age. Although an upper age cutoff of 75 to 80 years was only reported by 3 studies, it is not known how many of the patients were older and whether the intervention effectiveness differed across age groups. Because different forms of home BP monitoring with tele-based assistance for BP control were used across studies, there is no methodology standardization, and we cannot determine the most effective method. We were unable to evaluate the cost-effectiveness of adding pharmacists to usual care because of a lack of sufficient data in the included studies.

In conclusions, pharmacist-led home BP telemonitoring improves SBP and DBP control in patients with hypertension compared with usual care alone. Future studies should focus on more novel and cost-effective ways of leveraging pharmacists to address an aging population's vast healthcare needs.

Declaration of Competing Interest

Dr. Volgman reports as Sanofi (consulting), Pfizer (consulting), Merck (Consulting), Janssen (consulting), Bristol Myers Squibb Foundation Diverse Clinical Investigator Career Development Program (DCICDP), National Advisory Committee (NAC), Novartis and NIH Clinical Trials, Apple Inc. stock. Dr. Mitchell reports grants from Pfizer, Abbott Laboratories, Myocardial Solutions, and Children's Discovery Institute. Modest consulting from Pfizer and BridgeBio, unrelated to the contents of the manuscript. The remaining authors have no conflicts of interest to declare.

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