BMJ Open

Quality of community pharmacy BP monitors screening services: a cross-sectional survey with geospatial analysis.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-032342
Article Type:	Research
Date Submitted by the Author:	16-Jun-2019
Complete List of Authors:	Barrett, Ravina; University of Portsmouth, Pharmacy; University of Portsmouth Portsmouth Business School, University of Portsmouth Hodgkinson, James ; University of Birmingham, Primary Care Clinical Sciences, Institute of Applied Health Research
Keywords:	accuracy, blood pressure monitors, community pharmacy services, Hypertension < CARDIOLOGY, spatial analysis, surveys and questionnaires

Title: Quality of community pharmacy BP monitors screening services: a cross-sectional survey with geospatial analysis.

Author:

Mrs. Ravina Barrett (https://orcid.org/0000-0003-0004-2131), Author affiliations and corresponding author information: Division Of Pharmacy Practice, School Of Pharmacy, University of Portsmouth, St Michael's Building, White Swan Road, Portsmouth, PO1 2DT. +44(0)239284 3683, ravina.barrett@port.ac.uk

Dr. James Hodgkinson Author affiliations: Institute of Applied Health Research, Murray Learning Centre, University of Birmingham, Edgbaston, Birmingham, B15 2TT. 0121 414 8842, j.a.hodgkinson@bham.ac.uk

Role of funding source: This study was funded by the University of Portsmouth.

Conflict of interest: None

Word count: 3939

Keywords:

accuracy, blood pressure monitors, community pharmacy services, hypertension, spatial analysis, surveys and questionnaires.

Abstract

objectives: To assess the accuracy of digital BP monitors used within community pharmacy in England.

design: A cross-sectional survey.

setting: primary-care retail-pharmacies.

participants: 500 pharmacies that contribute to government dispensing-data were invited by post to complete the survey, with 109 responses. Non-NHS contractors were excluded.

interventions: We conducted a survey mail shot with a follow-up (September to December 2018).

results: 109 responses (21.8% response rate) were received. 61% (n=66) of responding pharmacies provided a free BP check to their patients. characteristics of service providers versus non-service providers on demographics, and deprivation including assessment of service quality were examined. 40 (61%) pharmacies used recommended validated clinical meters, 6 (9%) had failed validation, and 20 (30%) provided too little information to enable us to determine their monitor's status.

conclusions: Significant quality enhancements need to be implemented.

Pharmacists can provide BP screening at much reduced cost to the NHS compared to GP services. Pharmacists are generally available without appointment, open for extended hours during unsociable hours and have been shown to provide greater care in areas of highest deprivation. Our mapping provides tentative support for this positive care law. There may be a lower incidence of white coat syndrome in community pharmacy, and we found evidence of GPs using pharmacies to screen for it.

Funders and policy setters should consider the value added to the NHS and other healthcare agencies of such screening. It has the potential to reduce polypharmacy and multi-morbidity with early detection of hypertension. Future work should examine the impact of pharmacist-led BP screening on patients.

Article Summary

Strengths and limitations of this study

- This is the most comprehensive service evaluation on BP monitoring service provision in community pharmacies in England.
- We have for the first time reported on prevalence (61%) and quality of community pharmacy BP monitoring service provision in England.
- Our study for the first time reports on deprivation and geomapping alongside original data.
- Though we have structured this study robustly, there is a risk of confounding.
- For some respondents, there is discrepancy between monthly and annual screening numbers, which could reflect erratic answers and is a potential limitation of this study.

Methods

1. We invited pharmacists from 500 pharmacies that contribute to the Business Services Authority dispensing data across England to complete a survey.
2. We selected the first 500 pharmacies by the lowest number of prescription items dispensed to approximately 1000 items monthly, permitting comparison with like for like businesses, between pharmacies that provide the service and those that do not.
3. We conducted a mail shot with a single follow-up of non-responders (Sept-Dec 2018).
4. Postcodes of pharmacies were linked with freely available data on IMD score, an estimate of the socioeconomic deprivation of the practice population.
5. On our map, we created several layers to visualize the data easily: https://arcg.is/1jrevP.

Introduction.

Hypertension (high blood pressure [BP])is the most important modifiable risk factor for cardiovascular, cerebrovascular and renal disease, and avoidable cause of premature morbidity and mortality (1–6).

According to Health Survey for England, 2016, 28% of adults had hypertension, 10% had controlled hypertension and 12% had untreated hypertension. Thus, approximately 7.9 million people were suffering from undiagnosed hypertension in 2016, who are at risk of heart attack or stroke, leading to hospital admission and reduced quality-of-life.

2014 Public Health England (PHE) figures reveal that diseases caused by high BP are estimated to cost over £2bn annually (3). £850m of NHS and social care spend could be avoided over 10 years by reducing the BP of the nation. If just 15% more people (1.185m people), unaware they have high BP, are diagnosed, £120 million of NHS and social care spend could be avoided over 10 years (7).

Community pharmacists and their teams make an important contribution to the prevention, detection and management of high BP via routine public health promotion, medicines optimisation services and through a wide range of targeted services and interventions specifically designed to detect, diagnose and manage hypertension as recommended by research, in national guidance from Public Health England and NHS England (8–11). Community pharmacy BP monitoring is readily available and recommended by Canadian hypertension guidelines (12).

The digital BP monitors used within the services need to be of good quality (validated for clinical use(13–16)) and need regular maintenance (calibration) for accurate functioning. This phenomenon has been well studied in physicians' offices (17–19), but less so in pharmacy settings (20).

With increasing GP shortages, pharmacy providers are more valued. They often have extended opening hours during evenings and weekends and are frequently located in comfortable and attractive retail spaces accessible within 20 minutes' walk (21). Thus they provide a less clinical space, more convenient for people with less access to healthcare.

Current standards for initial education and training on BP monitoring delivered to pharmacy undergraduate students lack sufficient detail to be incorporated into a service specification. The independent pharmacist prescribers course (22) specifies that students are able to use diagnostic aids relevant to the condition for which the pharmacist intends to prescribe.

Consequently, there is no certification or credentialing for providing a high-quality BP service via pharmacy. As there are no standard specifications integrated into the pharmacy contract, there is likely to be quality variability across postcodes. Finally, there is no consensus on how referrals are made, though patients would be expected to be signposted to their GP.

This study is needed because it seeks to understand the challenges faced by the healthcare team caring for NHS patients (growing patient demand, insufficient funding in primary care, changing patterns of demand, reduced access to GPs and addressing national health inequalities and other under pressure models of care in the Western world). This study aligns with the United Nations (UN)'s agenda for Sustainable Development Goals (SDG) 3: to reduce by one third premature mortality from cardiovascular disease by 2030 (23,24).

Objectives

The primary objective of this study is to assess the accuracy (calibration and validation status) of digital BP monitors used within community pharmacy in England. Secondary objectives include: ascertaining prevalence of service provision, level of service utilization, quality of service (how the monitor make and model was chosen, length of time in service, care and maintenance including calibration history, visual or physical checks before each use, instructions provided to patients before taking measurements, available cuff sizes, relevant staff training), and estimated number of patients newly detected with hypertension. We also aimed to use this data to examine its association with geospatial location, dispensing data and Index of Multiple Deprivation (IMD) score.

Methods.

Participants and recruitment.

We invited 500 pharmacies across England to complete a survey about their BP screening service.

Inclusion Criteria: Community pharmacies that contribute to the NHS Business Services Authority (BSA) dispensing data. (We were interested in the proportion of pharmacies providing the BP check service as well as in the details of the service provided). Exclusion Criteria: Community pharmacies that are not NHS contractors, other settings that offer BP monitoring (e.g. hospitals, GP surgeries, walk-in centres).

Addresses were taken from publicly available NHS BSA website (March 2018) to gain a nationally representative sample. We selected the first 500 pharmacies by the lowest number of prescription items dispensed to approximately 1000 items monthly. This permitted comparison with like for like businesses (approximately equal burden of work, similar team size, similar business complexity) across the country, therefore allowing fair comparison between pharmacies that provide the service and those that do not.

We conducted a mail shot with a single follow-up of non-responders from September to December 2018. Respondents were invited to provide self-reported answers. A prepaid self-addressed envelope was provided. The participants could include registered pharmacists or pharmacy support staff working in community pharmacy.

We sought and received favourable institutional ethical approval. No financial (or similar) benefits were offered to minimise biased responses.

Questionnaire

The questionnaire was composed of items relating to demographics, BP service provision and how it is delivered, blood pressure monitor details, associated training, visual or manual checks performed on monitors and instructions given to patients. The survey is detailed in Appendix A. We had previously iteratively tested the survey in a local pilot study (25).

Sample size

There are 11,619 community pharmacies in England in 2017-18 (26). Assuming confidence level of 95%, confidence interval of 9.5%, relative standard error of 9.69% a sample size of 106 is calculated. To achieve this, we invited 500 pharmacies as previous experience indicates a response range between 15% to 25% in similar studies (25,27,28).

Data analysis

Analyses were undertaken using SPSS (29). The results presented are descriptive, presented as proportions, correlational analysis and independent sample tests. For correlation coefficients, it is generally recognized that a reliability estimate needs to be above .70 and a validity estimate needs to be above .60 to be at an acceptable level (30). All values above 0.6 were examined. Levene's test is an inferential statistic used to assess the equality of variances for a variable calculated for two groups (service providers versus non-providers). Some common statistical procedures assume that variances of the populations from which different samples are drawn are equal. Levene's test assesses this assumption.

Postcodes of pharmacies were linked with freely available data on IMD score, an estimate of the socioeconomic deprivation of the practice population (31) and NHS dispensing data.

We mapped our results using Arc GIS online and ArcGIS Pro (see Figure 1). On our map, we created several layers to visualize the data easily: https://arcg.is/1jrevP.

We mapped our responses alongside the IMD 2015 data (Ranks: every postcode has a rank from 1 which is the most deprived area up to 32,844 which is the least deprived area. Deciles are published alongside ranks to assess relative deprivation).

Results

In total, 109 responses (21.8% response rate) were received, satisfying sample calculation needs. (74 responses on first approach, 35 additional responses on follow-up, six closures and abatements, three spoiled/defaced responses).

Variables	**Respondent Frequencies (Percentage) (n=109)**	**Service providers Frequencies (Percentage) (n=66)**
Role	(2 missing)	(0 missing)
Pharmacist	90 (84%)	55 (83%)
Pharmacy technician	7 (7 %)	2 (3%)
Dispensing assistant	7 (7 %)	7 (11%)
Medicines counter assistant	3 (3 %)	1 (1.5%)
Gender	(3 missing)	(2 missing)
Male	57 (54 %)	32 (50 %)
Female	48 (45 %)	32 (50 %)
Preferred not to say	1 (1 %)	
Years of registration experience	(9 missing)	(7 missing)
0-2	9 (8 %)	5 (8 %)
3-5	16 (15 %)	9 (15 %)
6-8	12 (11 %)	8 (14 %)
9-11	11 (10 %)	8 (14 %)
12-14	5 (5 %)	1 (2 %)
15-17	7 (7 %)	7 (12 %)
18-20	2 (2 %)	1 (2 %)
> 20 years	38 (36 %)	20 (34 %)
Employer type	(2 missing)	(1 missing)

National chain pharmacy	51 (48 %)	35 (54 %)
Independent pharmacy	56 (53 %)	30 (46 %)
Work contract type	(3 missing)	(1 missing)
Full-Time	90 (85 %)	57 (88 %)
Part-Time	12 (11 %)	7 (11 %)
Locum	3 (3 %)	1 (2 %)
Other	1 (1 %)	0
Location of community pharmacy	(2 missing)	(1 missing)
Urban	47 (44 %)	32 (49 %)
Suburban	47 (44 %)	26 (40 %)
Rural	13 (12 %)	7 (11 %)
Co-Located within GP practice	(4 missing)	(2 missing)
Yes	20 (19 %)	10 (16 %)
No	85 (81 %)	54 (84 %)
Provide a BP monitoring service		
Yes	66 (61 %)	
No	43 (39 %)	

Table 1 Response frequency.

61% (n=66) of responding pharmacies provided a free BP check to their patients.

We examined characteristics of service providers versus non-service providers on demographics, and deprivation in Table 1.

Statistically significant Levene's Test findings show service providers employed more full time pharmacists (F=8.904, Sig. 0.004), and were less likely to be co-located in GP practices (F=4.766, Sig. 0.031).

Service Utilization

All but one respondent provided monitoring solely within the pharmacy. One lent their BP monitor to patients for self-monitoring at home.

Employees involved in providing the BP check in the pharmacy included the whole team: 55 were pharmacists, 2 pharmacy technicians, 7 dispensing assistants and 1 medicines counter assistant.

Pharmacies had provided the service for varying lengths of time: nine 0-2 years, twelve 3-6 years, eleven 7-9 years, and 24 over 9 years (8 did not know, with 2 missing).

We enquired about monthly and annual screening figures because there may be distortions in some months when national or local health promotion campaigns are promoted (e.g. 'Know your Numbers!', NHS Health Check, etc.). In the last month, the majority of pharmacies reported providing BP screening for 10 or less customers: 25 1-5 patients, 22 6-10 patients, 8 11-15 patients, 2 16-20 patients, 8 20+ patients (1 missing response). Over the last year, the people screened in each

pharmacy ranged from 10 to 2000 (mean 106.3, SD 295.2, 21 missing), with 10 pharmacies serving 100 or more people. Only one respondent said 2000, which could be an outlier.

When asked: "What is the number of patients newly detected with high BP (BP > 140/90 mmHg) in the last month?" many could not give a clear answer, but estimates ranged from 0 to 25 with a high-frequency of ones and twos (mean 2.3, SD 4.0, 17 missing).

Calibration, validation, cuff sizes, maintenance intervals.

Overwhelmingly pharmacies (97%; n=61) reported using an automatic BP monitor during BP screening (where cuff inflation, deflation and BP determination are fully performed by the device automatically). Two respondents (3%) said they used a semi-automatic device (BP determination is performed automatically but cuff inflation and/or deflation needs manual operation). None used manual sphygmomanometers (3 missing). All measured BP at the upper arm.

We then explored the rationale behind choosing their particular monitor. 58 responses were received: 25 (43%) respondents were given their monitor by head office, 16 (28%) used a monitor that was convenient for them (often present in their own store for sale), seven (12%) had done some brand research, five (9%) participants identified their monitor as being "accredited", and five (9%) were influenced by advertisement.

Further to this, 61 respondents provided a monitor's brand, 50 provided a model number and 53 provided a batch number. We used the dabl (32) and the British and Irish Hypertension Society (BIHS) (33) website to check their validation status.

40 (61%) pharmacies used recommended validated clinical meters, 6 (9%) monitors which had failed validation, and 20 (30%) respondents provided too little information to enable us to determine their monitor's status. One monitor was validated but listed as discontinued by dabl and archived by BIHS, which makes its continued use questionable.

We then inquired about available cuff sizes and 50 responses were received: 7 (14%) stocked small cuffs (18-22 cm), 39 (78%) stocked medium (22-32 cm), 27 (54%) stocked large (32-45 cm), 7 (14%) stocked extra-large (42-50cm) and 1 (2%) stocked other (24 to 40 cm 9.4-15.7"). Though some branches had several cuff sizes in use, 23 (46%) just had one cuff size.

Regarding length of monitor time in use, 43 valid responses were received. Dates ranged from 14/07/2005 to 01/09/2018, thus covering anywhere from over 13 years to two months. From this, we calculated length of time in service: 10 responders had their monitor in use between 0-1 year, 14 had their monitor in use between 1-2 years, 12 had had their monitor in use between 2-5 years, six had had their monitor in use between 5-10 years, and one had their monitor in use over 10 years.

We then inquired whether respondents replaced their BP monitor at a regular interval. One person (2%) said they replaced six monthly, eight (13%) said annually, 26 (41%) said two yearly, 19 (30%) said the meter had not been replaced and nine (14%) said other (3 missing). This demonstrates that community pharmacies to some extent replace the monitor rather than get it calibrated relying on monitors warranty status.

We also asked if respondents sent their monitor for calibration. Three (5%) sent it back to the manufacturer, 13 (20%) sent it back to head office, and 44 (67%) did not send their monitor for calibration (6 missing).

Training

We explored issues around training to gain a better understanding of the level of knowledge, skill and education of respondents regarding the blood pressure monitoring service.

59 (92%) respondents said they received some form of training and five (8%) said they did not (2 missing). Of those who received training, 32 (54%) indicated only one form of training, while the others received multiple forms of training 27 (46%). The type of training included: 33 received an informal chat with the senior pharmacist, six received training provided by the manufacturer, 41 read internal company standard operating procedures (SOPs), 11 read Royal Pharmaceutical Society Guidelines, 13 completed Centre for Pharmacy Postgraduate Education (CPPE) training, and 12 said other. 'Other' comments included training from internal and external providers (online and in-person), local clinical commissioning group (CCG) training, British Heart Foundation training events and reading National Institute for Health and Care Excellence (NICE) guidelines. This represents training with great variability, potential inadequacy (only reading material/ online info/ lack of practical experience) and some reliance on interested parties like manufacturers to deliver the training.

We found there was good correlation between BP training and medicine use reviews (MUR) or new medicine services (NMS) provided as advanced services (r=0.605 to 0.715), suggesting if pharmacists are trained on BP services, they are likely to have engaged in other professional training like MUR and NMS accreditation.

Visual or manual checks of monitor

We explored the kind of in-situ checks that were conducted during each consultation. 40 (61%) respondents performed some visual or manual checks to ensure they were achieving accurate results, 26 (39%) did not. These, variously, included a visual check of the integrity of the monitor, checks for properly affixed tubing, working batteries, appropriate and secure cuff positioning of Velcro, correct inflation and deflation without air leaks, and of the display screen (no error codes). General cleanliness and physical damage (e.g. holes) was assessed, in addition to simply checking that the machine was turned on and actually providing BP and pulse readings. Four respondents would check their own (and colleagues') BP to assess whether the monitor was working well.

Instructions to patients/customers

We also inquired about the instructions provided to patients prior to screening. 64 positive answers were received indicating that most respondents would instruct their patients with only one respondent saying they would give no instructions (1 missing). Instructions, variously, included to remove restrictive clothing, be seated, relax, have both feet on the ground, legs apart and not crossed, rest their elbow on the table with wrist facing up, and not to talk. Respondents also, variously, inquired if patients needed to empty their bladder or had recently consumed caffeine, smoked, felt stressed, made any blood donations, and asked about past medical history, and drug history including any prescribed BP medication. One respondent said they would go through the consenting process (telling the patient what was involved and what to expect). Some patients were given a customer card with a copy of their readings.

We asked if there were any other considerations respondents would make, and they responded in terms either of assessing the reliability of the BP readings generated, considering the most pragmatic way of conducting the tests, or how best to communicate with patients. 41 comments were received. One respondent would consider patient age and weight as part of the assessment. A

few suggested the need for multiple readings, that they "might take an average of three readings". Many would consider prescribed medicines currently taken by the patient. Respondents also would explain the reading and give relevant lifestyle and health promotion advice with respect to exercise, diet, smoking and alcohol (e.g. coffee, energy drink). One considered if the patient had a pacemaker fitted or potential pregnancy. One respondent would consider if patients had breast or underarm surgery. Respondents would also generally take into consideration the patient's character, stress levels, demeanour, life and work and assess if white coat syndrome was present leading to unreliable readings. One respondent took into account ambient temperature, i.e. heat. Some inquired why the patient is requesting a BP measurement.

We invited any other additional comments. Comments included that one respondent had ordered a large cuff and another was considering replacing or getting their monitor calibrated as a result of the survey. Some respondents were proactive at measuring BP by facilitating well-being days.

The potential extension to the role of community pharmacy was highlighted by one respondent who commented, *"Clients sometimes use us to record BP on their PMR & then take print out to GP to help record issues. When white coat syndrome, GPs will refer to us."*

Deprivation

Pharmacies in all deciles from most deprived to least deprived responded, with relatively even distribution per decile. Table 2 summarizes our findings stratified by the most deprived deciles versus their more affluent counterparts.

Deciles (1= most deprived, 10= least deprived)	**Number of Respondents**	**BP service providers**	**Service utilization (number of people screened)**	**Validated monitor status**	**Quality of service (Calibration status)**	**Quality of service (purchase date)**
Deprived Deciles 1, 2 and 3.	49 (45%)	33 (67%)	1-5: 12 6-10: 12 11-15: 5 15+: 3	18 (55%)	0-1year: 4 1-2years: 2 2-5years: 2 5-10years: 0 10+years: 1	0-1year: 4 1-2years: 8 2-5years: 7 5-10years: 2 10+years: 0
Affluent Deciles 4, 5, 6, 7, 8, 9 and 10.	60 (55%)	33 (55%)	1-5: 13 6-10: 10 11-15: 3 15+: 7	22 (67%)	0-1year: 3 1-2years: 2 2-5years: 4 5-10years: 1 10+years: 0	0-1year: 6 1-2years: 6 2-5years: 5 5-10years: 4 10+years: 1
Total	109	66		40		

Table 2 Respondent IMD decile distribution.

Table 2 suggests higher frequency of BP screening by community pharmacy providers in the most deprived postcodes, though this is not statistically significant reflecting small sample size. Service utilization was approximately even. Respondents in less deprived areas were slightly more likely to have a validated monitor, though again this is not statistically significant. Calibration rates and length of time in service of monitors show limited relationship to deprivation of surrounding area. Granular decile information is available (see Table 3, Appendix B).
Statistically significant Levene's Test findings show service providers were linked to lower income rank (F=4.029, Sig. 0.047) and lower employment rank (F=4.651, Sig. 0.033).

Discussion

Summary

Between 1 to 10 people were routinely screened monthly by each respondent. Annually, respondents said they screened between 10 to 2000 people (where 2000 could be an outlier). These figures seem credible as they give annualized average figures of at least 10 to 12 people screened by each service provider (the higher annual figures may reflect pharmacies participating in national campaigns such as 'Know Your Numbers' [http://www.bloodpressureuk.org/HealthProfessionals/KnowyourNumbersWeek] at other points in the year). This rate of screening conservatively detected 1 to 2 undiagnosed hypertensive patients monthly per service provider. If these estimates are scaled-up for England and annualized across the 11,619 pharmacies in England, assuming a 60% service provision rate, it would represent detection of an additional 83,657 to 167,314 undiagnosed hypertensives, identifying 2% of the total undiagnosed hypertensive England population. In seven years, in its current state, the service could help diagnose 1.185 million people saving the NHS £120 million (7).

Most monitors were automatic digital monitors, selected by head office or as a convenient model, but price and product guarantees may also play an influential role in monitor selection, rather than validation status. Lack of a range of cuff sizes per provider appears a major issue, as only 59% stocked a medium cuff and 41% a large cuff, with only a minority reporting they stocked multiple cuff sizes.

Many monitors were old which may risk inaccuracy. 56% of service providers replaced the monitors at least every two years, but only 14% (9/63) every year or more frequently, and 30% did not replace at all. This may be because often calibration is guaranteed for up to two years from the date of purchase by manufacturers. However, previous studies recommend at least annual calibration with evidence suggesting declining performance after 18 months (20).

Calibration of devices was reported by 27% of service providers. Overall, this means 23% (15/66) of service providers neither replaced nor calibrated their devices.

Whilst 92% of service providers received some training of variable quality, 8% reported not receiving any. While this is poor, it provides a benchmark for future training quality enhancements.

Strengths and limitations

There are several novelties to our study. We have for the first time reported on prevalence of service provision (61%), level of service utilization, and validation and calibration status within community pharmacy practice in England. This is the most comprehensive service evaluation on BP monitoring service provision in pharmacies in the UK.

Our pharmacies were typical of those nationwide, including in terms of deprivation. There was a good spread in terms of typology of pharmacy and location (geographically; urban, suburban, rural). Therefore, our results are robust, credible and generalizable.

Though we have structured this study robustly, there is a risk of confounding. Potential bias may be introduced by recruiting only pharmacies with the lowest number of prescription items dispensed.

Small sample size and some missing information may make the findings unreliable. This is a potential limitation of our study and in the future we may seek ethical permission to telephone pharmacies to confirm missing information. For some respondents, there is discrepancy between monthly and annual screening numbers, which is a potential limitation of this study and could reflect erratic answers but it highlights the need for more research beyond a survey methodology.

We acknowledge that respondents often represent multiple chain pharmacies that have uniform SOPs in branches across the country. Theoretically, this could bias our results. However, SOPs are interpreted, adapted and implemented differently within each branch and so our research provides a more authentic representation of practice.

Comparison with existing literature

This study provides needed evidence on the quality of BP screening from community pharmacy. Significant quality enhancements need to be implemented.

Pharmacists can provide BP screening service at much reduced cost to the NHS compared to GP services. Pharmacists are generally available without appointment, open for extended hours during unsociable hours and have been shown to provide greater care in areas of highest deprivation (21). Our mapping provides tentative support for this positive care law.

It is important to consider the patient population this study may impact most. The 'hard to reach' groups of patients are typically less affluent and are also less likely to see their GP (or not have a GP), and have poor health literacy. There may be a greater likelihood of identifying new previously undetected cases of hypertension in this group of the population. Community pharmacies are easily accessible and located in all areas, and have been shown to provide greater care in areas of highest deprivation which may be more conducive for the 'hard to reach' patient groups and could assist in reducing health inequalities nationally. Focusing attention on these people at the right time can avoid hospital costs and allow the patient to remain within the community.

Pharmacies deliver a valuable service of providing free BP checks to those who feel they cannot afford to buy monitors. In affluent areas, it may be that more people are self-monitoring with their own-bought home-monitors, and there is simply less demand on pharmacies.

There may be a lower incidence of white coat syndrome in community pharmacy (34), and we found evidence of GPs using pharmacies to screen for white coat hypertension. The potential role of pharmacies in hypertension management through BP testing (checking for white coat syndrome, monitoring the effectiveness of medication) is there, in addition to screening for new hypertension cases.

Implications for clinical practice

Collectively, this provides a social and health economic argument for pharmacists to be involved in routine, NHS-commissioned, hypertension screening for the general population with needed quality enhancements.

Conclusion

Funders and policy setters should consider the value added to the NHS and other healthcare agencies of such screening by pharmacy providers. It has the potential to reduce polypharmacy and multi-morbidity with early detection of hypertension.

As more pharmacists become independent prescribers, the clinical ability to prescribe appropriate pharmacotherapy adds to the quality and quantity of health provision and increases capacity in an already stretched NHS.

The General Pharmaceutical Council (GPhC) and universities should be consistent in training students to standardised curricula.

Future research needs

A larger study is required to validate our findings. Future work should examine the impact of pharmacist-led BP screening on patients. At the very least, we need to study the patient population, their needs in their local context, and which areas or groups represent most undiagnosed people. We encourage the international research community to use our survey to report their findings.

Acknowledgments

Thank you to the 109 retail pharmacy respondent-employees who took the time to provide honest opinions, Carla Orszulik and Sophie Doughty for helping with study administration and data collection, Michelle Sumner for providing excellent technical help to allow data capture and processing, and Martin Schaefer for his help with ArcGIS publisher requests.

A data sharing statement: Dataset available from the Pure repository.

Disclaimer: The views expressed in this publication are those of the authors and not those of the University of Portsmouth, nor the NHS.

Competing interests: none.

Patient consent Not required.

Ethics approval: University of Portsmouth, Science Faculty Ethics Committee provided a favourable ethical review ((Reference Number: SFEC 2018-061, Date Submitted: 31 May 2018).

Data statement: No additional data available.

A competing interests statement: None

A funding statement:

This study was funded by the University of Portsmouth.

No Patient and Public Involvement

Due to the nature of our study, we did not involve patients or the public in our work. This research was done without patient involvement. Patients were not invited to comment on the study design

and were not consulted to develop patient relevant outcomes or interpret the results. Patients were not invited to contribute to the writing or editing of this document for readability or accuracy.

Author contributions:

	RB	JH
Concepts and ideas	X	X
Design	X	X
Definition of intellectual content	X	X
Literature search	X	
Experimental studies	X	
Data acquisition	X	
Data analysis	X	X
Statistical analysis	X	
Manuscript preparation	X	X
Manuscript editing	X	X
Manuscript revision	X	X

References

1. Rothwell PM, Howard SC, Dolan E, O'Brien E, Dobson JE, Dahlöf B, et al. Prognostic significance of visit-to-visit variability, maximum systolic blood pressure, and episodic hypertension. Lancet Lond Engl. 2010 Mar 13;375(9718):895–905.

2. Webb AJS, Fischer U, Mehta Z, Rothwell PM. Effects of antihypertensive-drug class on interindividual variation in blood pressure and risk of stroke: a systematic review and meta-analysis. Lancet Lond Engl. 2010 Mar 13;375(9718):906–15.

3. Clement DL, De Buyzere ML, De Bacquer DA, de Leeuw PW, Duprez DA, Fagard RH, et al. Prognostic value of ambulatory blood-pressure recordings in patients with treated hypertension. N Engl J Med. 2003 Jun 12;348(24):2407–15.

4. Verdecchia P, Porcellati C, Schillaci G, Borgioni C, Ciucci A, Battistelli M, et al. Ambulatory blood pressure. An independent predictor of prognosis in essential hypertension. Hypertension. 1994 Dec;24(6):793–801.

5. Hansen TW, Jeppesen J, Rasmussen S, Ibsen H, Torp-Pedersen C. Ambulatory blood pressure and mortality: a population-based study. Hypertens Dallas Tex 1979. 2005 Apr;45(4):499–504.

6. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA. 2003 May 21;289(19):2560–72.

7. New figures show high blood pressure costs NHS billions each year [Internet]. [cited 2018 Jan 29]. Available from: https://www.gov.uk/government/news/new-figures-show-high-blood-pressure-costs-nhs-billions-each-year

8. High blood pressure: plan and deliver effective services and treatment [Internet]. GOV.UK. [cited 2019 Jan 21]. Available from: https://www.gov.uk/guidance/high-blood-pressure-plan-and-deliver-effective-services-and-treatment

9. Tsuyuki RT, Houle SKD, Charrois TL, Kolber MR, Rosenthal MM, Lewanczuk R, et al. Randomized Trial of the Effect of Pharmacist Prescribing on Improving Blood Pressure in the Community: The Alberta Clinical Trial in Optimizing Hypertension (RxACTION). Circulation. 2015 Jul 14;132(2):93–100.

10. Okada H, Onda M, Shoji M, Sakane N, Nakagawa Y, Sozu T, et al. Effects of lifestyle advice provided by pharmacists on blood pressure: The COMmunity Pharmacists ASSist for Blood Pressure (COMPASS-BP) randomized trial. Biosci Trends. 2018 Jan 9;11(6):632–9.

11. Pharmacy voice. Tackling high blood pressure through community pharmacy. [Internet]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693902/PV_Blood_Pressure_Report.pdf

12. Lamb SA, Al Hamarneh YN, Houle SKD, Leung AA, Tsuyuki RT. Hypertension Canada's 2017 guidelines for diagnosis, risk assessment, prevention and treatment of hypertension in adults for pharmacists: An update. Can Pharm J CPJ Rev Pharm Can RPC. 2018 Feb;151(1):33–42.

13. Eoin O'Brien, James Petrie, William Littler, Michael de Swiet, Paul L. Padfield, Douglas G. Altman, Martin Bland, Andrew Coats, Neil Atkins. The British Hypertension Society protocol for the evaluation of blood pressure measuring devices. J Hypertens. 1993;11(Supplement 2):S43–62.

14. Stergiou GS, Asmar R, Myers M, Palatini P, Parati G, Shennan A, et al. Improving the accuracy of blood pressure measurement: the influence of the European Society of Hypertension International Protocol (ESH-IP) for the validation of blood pressure measuring devices and future perspectives. J Hypertens. 2018;36(3):479–87.

15. O'Brien E, Atkins N, Stergiou G, Karpettas N, Parati G, Asmar R, et al. European Society of Hypertension International Protocol revision 2010 for the validation of blood pressure measuring devices in adults. Blood Press Monit. 2010 Feb;15(1):23–38.

16. Stergiou GS, Alpert BS, Mieke S, Wang J, O'Brien E. Validation protocols for blood pressure measuring devices in the 21st century. J Clin Hypertens Greenwich Conn. 2018 Jul;20(7):1096–9.

17. Clark CE, Horvath IA, Taylor RS, Campbell JL. Doctors record higher blood pressures than nurses: systematic review and meta-analysis. Br J Gen Pract. 2014 Apr;64(621):e223–32.

18. Little P, Barnett J, Barnsley L, Marjoram J, Fitzgerald-Barron A, Mant D. Comparison of agreement between different measures of blood pressure in primary care and daytime ambulatory blood pressure. BMJ. 2002 Aug 3;325(7358):254.

19. A'Court C, Stevens R, Sanders S, Ward A, McManus R, Heneghan C. Type and accuracy of sphygmomanometers in primary care: a cross-sectional observational study. Br J Gen Pract J R Coll Gen Pract. 2011 Sep;61(590):e598-603.

20. Hodgkinson J, Koshiaris C, Martin U, Mant J, Heneghan C, Hobbs FR, et al. Accuracy of monitors used for blood pressure checks in English retail pharmacies: a cross-sectional observational study. Br J Gen Pract. 2016 May 1;66(646):e309–14.

21. Adam Todd, Alison Copeland, Andy Husband, Adetayo Kasim, Clare Bambra. The positive pharmacy care law: an area-level analysis of the relationship between community pharmacy distribution, urbanity and social deprivation in England. BMJ Open 2014 [Internet]. 2014 Aug 12 [cited 2015 Jan 19];4(8). Available from: http://bmjopen.bmj.com/content/4/8/e005764.short

22. General Pharmaceutical Counsel. Pharmacist independent prescribing-learning outcomes and indicative content.

23. United Nations Statistics Division. SDG Indicators - Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development [Internet]. [cited 2018 Dec 5]. Available from: https://unstats.un.org/sdgs/indicators/indicators-list/

24. United Nations Publications. Sustainable Development Goals Report 2018. S.l.: United Nations Pubns; 2018.

25. Barrett R. Blood pressure monitor validation, calibration, and community pharmacy practice: a pilot cross-sectional survey in Hampshire, UK. Blood Press Monit. 2018 Oct;23(5):281–2.

26. UK Statistic. Community pharmacies in England 2006-2018 [Internet]. Statista. [cited 2018 Dec 11]. Available from: https://www.statista.com/statistics/418071/community-pharmacies-in-england/

27. Barrett R, Costa D. An evaluation of community pharmacist perception the misuse and abuse of over-the-counter Co-codamol in Cornwall and Devon, UK: a cross-sectional survey. Heroin Addict Relat Clin Probl. 2018 Feb 21;Published Ahead of Print.

28. Barrett R, Al-Mousawi HA. Development and initial validation of a postal survey evaluation of community pharmacists' opinion regarding falsified (counterfeit) medicines in Hampshire (UK). J Pharm Pharmacogn Res. 2018;6(4):242–249.

29. IBM Corp. IBM SPSS Statistics for Windows. Armonk, NY; 2014.

30. Odom, Leslie R., Morrow, James R., Jr. What's This "r"? A Correlational Approach to Explaining Validity, Reliability and Objectivity Coefficients. Meas Phys Educ Exerc Sci. 2006 Jun;10(2):137–45.

31. Ministry of Housing, Communities & Local Government. English indices of deprivation 2015 [Internet]. National StatisticsGOV.UK. 2015 [cited 2019 Mar 4]. Available from: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015

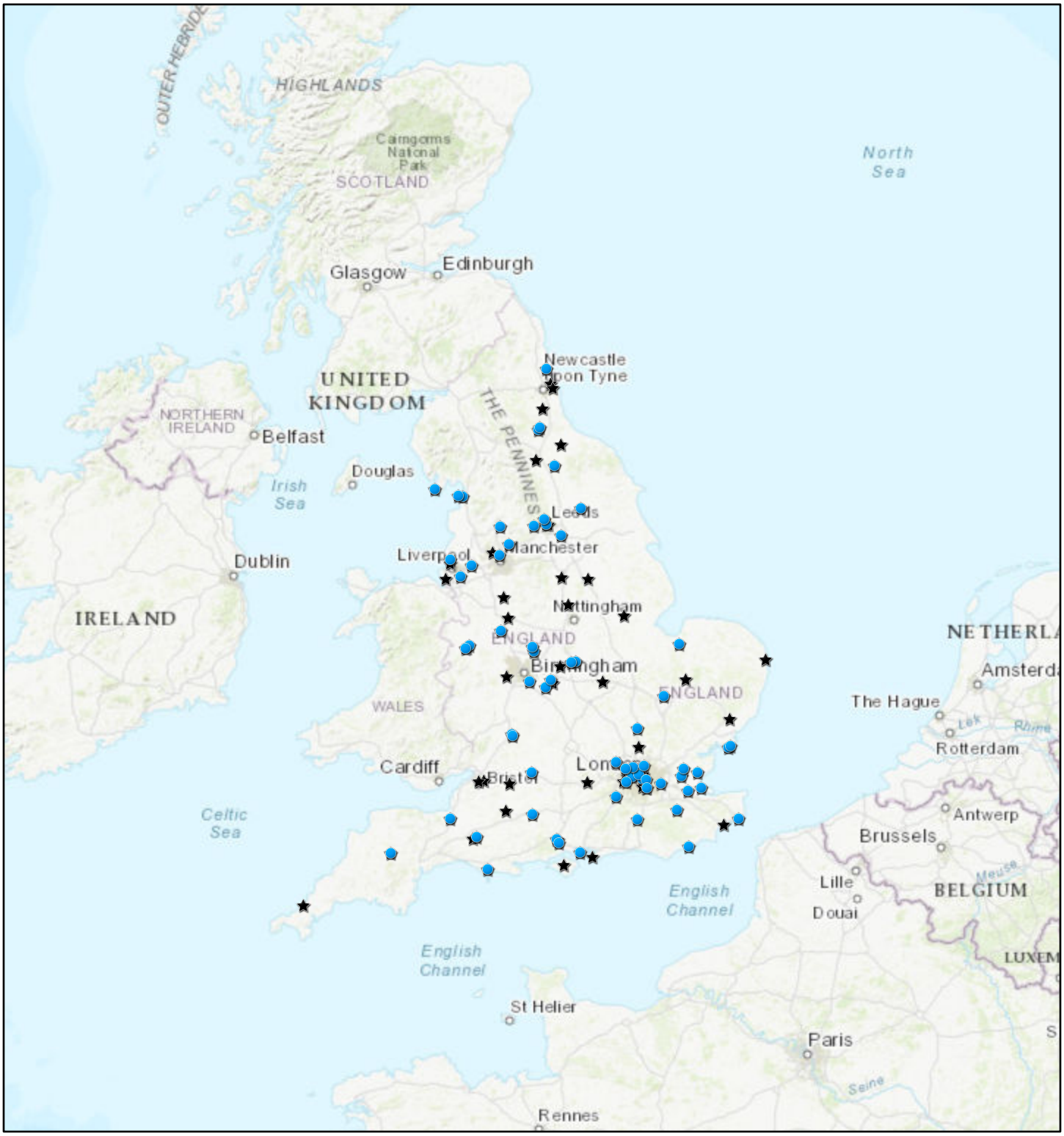
32. dabl®Educational Trust Ltd. Sphygmomanometers for Clinical Use [Internet]. Available from: http://www.dableducational.org/sphygmomanometers/devices_1_clinical.html

33. British and Irish Hypertension Society. Validated BP Monitors for For Specialist Use.

34. Sendra-Lillo J, Sabater-Hernández D, Sendra-Ortolá A, Martínez-Martínez F. Comparison of the white-coat effect in community pharmacy versus the physician's office: the Palmera study. Blood Press Monit. 2011 Apr;16(2):62–6.

Figure 1: Black star denotes all respondents that engaged in this study, blue points denote all respondents that provide the BP service.

Black 109 responders, Blue 66 service providers



May 20, 2019

1:9,244,649

0 45 90 180 mi

0 75 150 300 km

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

«AddressBlock»

Title: Accuracy of BP monitors in community pharmacy screening services: a cross-sectional survey, UK

Dear Pharmacist or pharmacy support staff,

Thank you for reading this. The School of Pharmacy at the University of Portsmouth would like to invite you to take part in a study looking to determine community pharmacies' role in blood pressure (BP) monitoring across the UK. You have been identified as a potential participant in this study as you work in a community pharmacy in the United Kingdom.

This survey is intended to be completed by the pharmacist or member of pharmacy staff. We are interested in the opinions of responders who provide free BP monitoring service for the public as well as those who do not. Your participation in this study is greatly appreciated. It is entirely up to you if you want to take part, but there is limited knowledge on this subject and we would be grateful for your contribution. This work is undertaken as part of an MPharm final year student project, and will provide an educational experience in addition to useful data.

The study involves completing the survey questionnaire. You can choose to remain anonymous and not provide any identifiable personal information in this study. As your opinion is valued, at the end of this survey we will ask you if you would like to take part in any future research we conduct. If you say 'yes', we will invite you to give us your name and address so that we can contact you in the future. You do not have to provide this information if you don't want to. Any identifiable information you give us will be stored securely and will not be shared beyond the research team. All reasonable steps will be taken to ensure confidentiality. It should take you approximately 10 minutes to complete the survey.

Responses received will be collated for analysis and the original questionnaires will be archived as per the University data management policy. If you want to know more about this work or the results of this study, you can contact the lead researcher (Mrs Ravina Barrett) using the details at the end of the questionnaire. If you are happy taking part, please read the following instructions.

Instructions: *Please complete this questionnaire by placing a tick ☑ in the most appropriate box unless stated otherwise, and where spaces or boxes are provided please fill in with your comments and justifications. The responses you provide will remain anonymous therefore please answer honestly.*

Demographics

1 What is your role?

Pharmacist	Pharmacy technician	Dispensing assistant or pharmacy assistant	Medicines counter assistant
☐	☐	☐	☐

2 What is your gender?

Male	Female	Prefer not to say
☐	☐	☐

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

3 How many years have you been registered as a pharmacist or technician in the UK?

0-2	3-5	6-8	9-11	12-14	15-17	18-20	> 20
☐	☐	☐	☐	☐	☐	☐	☐

4 Do you work ...?

Full time	Part-time	Locum	Other
☐	☐	☐	☐

5 What is the type of community pharmacy do you work in?

Independent	Multiple
☐	☐

6 What is the location of your community pharmacy?

Urban	Suburban	Rural
☐	☐	☐

7 Are you co-located within a GP practice?

Yes	No
☐	☐

8 Do you provide a blood pressure monitoring service at your pharmacy?

Yes	No
☐	☐

If 'no', please stop filling in the form and return it in the SAE provided.

9 Do you loan out your BP monitor to patients for self-monitoring at home?

Yes	No
☐	☐

10 Who does the BP check in your pharmacy?

Pharmacist	Pharmacy technician	Dispensing assistant or pharmacy assistant	Medicines counter assistant
☐	☐	☐	☐

11 Where on the body do you measure blood pressure?

Upper arm	Wrist	Finger	Other
☐	☐	☐	☐

12 How long has the pharmacy provided the digital blood pressure monitoring service?

0-2 years	3-6 years	7-9 years	> 9 years	don't know
☐	☐	☐	☐	☐

13 How many members of the public have been provided the service in the last month?

1-5	6-10	11-15	16-20	20+
☐	☐	☐	☐	☐

14 How many members of the public have been provided the service in the last year?

15 What is the number of patients newly detected with high blood pressure (BP> 140/90 mmHg) in the last month?

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

Blood pressure monitor details

16 What kind of blood pressure monitor do you use for BP screening?

Automatic (Cuff inflation, deflation and blood pressure determination are fully performed by the device automatically)	Semiautomatic (Blood pressure determination is performed automatically but cuff inflation and/or deflation needs manual operation)	Manual (Blood pressure determination is performed manually irrespective of inflation or deflation control)	Other (please tell us more)
☐	☐	☐	☐

17 How did you decide which blood pressure monitor to use?

18 What is your monitor 's brand?

19 What is your monitor 's model number?

20 What is your monitor 's batch/ serial number?

21 What available cuff sizes do you keep?

18-22 cm 7.1-8.7” Small ☐ 22-32 cm 8.8-12.8” Medium ☐ 32-45 cm 12.8-18” Large ☐ ‘Extra-large’ ☐ Other ☐

22 Date of purchase or date of first use (whichever reflects when you started using this monitor)?

Day | Month | Year

23 Which monitor do you think provides a more accurate blood pressure reading?

Manual ☐ Digital ☐

24 Why do you think that?

25 Do you replace the blood pressure monitor you use for tests at a fixed interval?

Six months ☐ One year ☐ Two years ☐ Other ☐ Not been replaced ☐

26 Do you send your monitor for calibration (to have its accuracy checked)?

Yes, back to manufacturer ☐ Yes, back to head office ☐ No (please go to Q28) ☐

27 At what intervals do you send the monitor for calibration?

Six monthly ☐ Annually ☐ Every two years ☐ Other ☐

28 When was the last time your blood pressure monitor was calibrated (Day, Month, and Year)?

Day | Month | Year

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

Training

29 Is training provided for the professional who delivers the blood pressure monitoring service?

Yes ☐ No ☐

30 What kind of training? (tick all that apply)

Informal chat with senior pharmacist	Training provided by manufacturer	Read standard operating procedures	Read royal pharmaceutical society guidelines	CPPE training	Other
☐	☐	☐	☐	☐	☐

31 Please explain if you said 'other', or have additional comments to make.

Visual or manual checks of monitor

32 Do you perform any visual or manual checks on your digital blood pressure monitor to ensure accurate results?

Yes ☐ No ☐

What checks do you perform? (Please skip this if you answered 'no' above)

33

Before taking a patient's blood pressure, what instructions do you provide to your patients?

34

35 Is there any other considerations you make?

36 Would you like to make any other additional comments?

END OF SURVEY. Thank you for completing this survey.

If you have a concern about this research study, please contact: Mrs Ravina Barrett, Phone: 44 (0) 2392843683, Email: ravina.barrett@port.ac.uk

Appendix B Stratification by decile.

Deciles (1= most deprived, 10= least deprived)	Number of Respondents	BP service providers	Service utilization /66 (number of people screened)	Validated monitor status /66	Quality of service /66 (Calibration status)	Quality of service /66 (purchase date)
Decile 1	15	10	1-5: 4 6-10: 5 11-15: 1 15+: 0	6	0-1year: 0 1-2years: 1 2-5years: 1 5-10years: 0 10+years: 1	0-1 year: 1 1-2 years: 3 2-5 years: 3 5-10 years: 1 10+ years: 0
Decile 2	15	11	1-5: 3 6-10: 3 11-15: 2 15+:2	6	0-1year: 1 1-2years:0 2-5years:1 5-10years:0 10+years:0	0-1 year: 2 1-2 years:3 2-5 years:1 5-10 years:1 10+ years:0
Decile 3	19	12	1-5: 5 6-10: 4 11-15: 2 15+:1	6	0-1year:3 1-2years:1 2-5years:0 5-10years:0 10+year2:0	0-1 year:1 1-2 years:2 2-5 years:3 5-10 years:0 10+ years:0
Decile 4	5	3	1-5: 1 6-10: 1 11-15: 0 15+:1	2	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:0 1-2 years:1 2-5 years:2 5-10 years:0 10+ years:0
Decile 5	16	6	1-5: 3 6-10: 1 11-15: 1 15+:1	4	0-1year:1 1-2years:0 2-5years:1 5-10years:0 10+years:0	0-1 year:2 1-2 years:0 2-5 years:0 5-10 years:1 10+ years:1
Decile 6	9	5	1-5: 2 6-10: 1 11-15: 1 15+:1	3	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:2 2-5 years:0 5-10 years:0 10+ years:0
Decile 7	8	6	1-5: 3 6-10: 3 11-15: 0 15+:0	5	0-1year:1 1-2years:0 2-5years:2 5-10years:0 10+years:0	0-1 year:0 1-2 years:1 2-5 years:3 5-10 years:1 10+ years:0
Decile 8	8	3	1-5: 1 6-10: 1 11-15: 1 15+:1	0	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:0 2-5 years:0 5-10 years:0 10+ years:0
Decile 9	7	4	1-5: 1 6-10: 2 11-15: 0 15+:1	3	0-1year:0 1-2years:1 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:1 2-5 years:0 5-10 years:1 10+ years:0
Decile 10	7	6	1-5: 2 6-10: 1 11-15: 0 15+:3	5	0-1year:1 1-2years:1 2-5years:1 5-10years:1 10+years:0	0-1 year:1 1-2 years:1 2-5 years:0 5-10 years:1 10+ years:0
Total	109	66		40		

Table 1 Data stratified by decile.

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of	4

		recruitment, exposure, follow-up, and data collection	
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	4
Bias	#9	Describe any efforts to address potential sources of bias	4, 9
Study size	#10	Explain how the study size was arrived at	4
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	5
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	5
Statistical methods	#12c	Explain how missing data were addressed	5
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	5
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	5
Participants	#13b	Give reasons for non-participation at each stage	5
Participants	#13c	Consider use of a flow diagram	n/a

Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	5
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	5
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	5
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5
Main results	#16b	Report category boundaries when continuous variables were categorized	5
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	5
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	#18	Summarise key results with reference to study objectives	8
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	9
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	9
Generalisability	#21	Discuss the generalisability (external validity) of the study results	9
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

This checklist was completed on 13. June 2019 using https://www.goodreports.org/, a tool made by the EQUATOR Network in collaboration with Penelope.ai

BMJ Open

Quality of community pharmacy Blood Pressure (BP) monitors screening services: an English cross-sectional survey with geospatial analysis.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-032342.R1
Article Type:	Original research
Date Submitted by the Author:	16-Sep-2019
Complete List of Authors:	Barrett, Ravina; University of Brighton, School of Pharmacy and Biomolecular Sciences; University of Portsmouth, Pharmacy Practice, School of Pharmacy and Biomedical Sciences Hodgkinson, James ; University of Birmingham, Primary Care Clinical Sciences, Institute of Applied Health Research
Primary Subject Heading:	General practice / Family practice
Secondary Subject Heading:	Health services research, Public health, Cardiovascular medicine, Evidence based practice, General practice / Family practice
Keywords:	accuracy, blood pressure monitors, community pharmacy services, Hypertension < CARDIOLOGY, spatial analysis, surveys and questionnaires

Quality of community pharmacy Blood Pressure (BP) monitors screening services: an English cross-sectional survey with geospatial analysis.

Author:

Mrs. Ravina Barrett (https://orcid.org/0000-0003-0004-2131), Author affiliations and corresponding author information:

1. Senior Lecturer in Pharmacy Practice, School Of Pharmacy and Biomolecular Sciences, University of Brighton, Moulsecoomb, Brighton, BN2 4GJ. +44(0)1273643986, R.Barrett2@Brighton.ac.uk
2. Visiting Researcher in Pharmacy Practice, School Of Pharmacy and Biomedical Sciences, University of Portsmouth, St Michael's Building, White Swan Road, Portsmouth, PO1 2DT. +44(0)239284 3683, ravina.barrett@port.ac.uk

Dr. James Hodgkinson Author affiliations: Institute of Applied Health Research, Murray Learning Centre, University of Birmingham, Edgbaston, Birmingham, B15 2TT. 0121 414 8842, j.a.hodgkinson@bham.ac.uk

Keywords:

accuracy, blood pressure monitors, community pharmacy services, hypertension, spatial analysis, surveys and questionnaires.

Abstract

objectives: The primary objective is to assess the accuracy (calibration and validation status) of digital blood pressure (BP) monitors used within community pharmacy in England and the secondary objectives are to assess the overall quality of the BP service by assessing service prevalence, service utilisation and other in-service considerations.

design: A cross-sectional survey.

setting: primary-care retail-pharmacies.

participants: 500 pharmacies that contribute to government dispensing-data were invited by post to complete the survey. Private contractors were excluded.

interventions: We conducted a questionnaire survey with a follow-up (September to December 2018).

results: 109 responses were received. 61% (n=66) of responding pharmacies provided a free BP check to their patients. 40 (61%) pharmacies used recommended validated clinical meters, 6 (9%) had failed validation, and 20 (30%) provided too little information to enable us to determine their monitor's status.

conclusions:

The majority of pharmacies use validated BP monitors. In general, responding pharmacies were able to provide useful BP monitoring services to their patients, though quality enhancements need to be implemented. There was (a) lack of range of cuff sizes, (b) variation in replacement and calibration of monitors, and apparent absence of any replacement or calibration in a minority of pharmacies, (c) variation in training standards. Community pharmacists could play a leading role in BP screening in England. Funders and policy setters should consider the value added to the NHS and other healthcare agencies of such screening by pharmacy providers both nationally and internationally. It has the potential to reduce complications of undiagnosed hypertension and the medicines burden that it creates. Future work should examine the impact of pharmacist-led BP screening on patients.

Article Summary

Strengths and limitations of this study

1. We invited pharmacists from 500 pharmacies across England to complete a survey.
2. We mailed our survey with a single follow-up of non-responders (Sept-Dec 2018).
3. Postcodes of pharmacies were linked with freely available data on index of multiple deprivation (IMD) scores, which provides an estimate of the socioeconomic deprivation of the practice population.
4. The interactive application helps to visualize the data easily: https://portuni.maps.arcgis.com/apps/webappviewer/index.html?id=a4ef6e48721649ada4eec362507245f6 or https://arcg.is/1jrevP.

Introduction.

Hypertension (high blood pressure [BP])is the most important modifiable risk factor for cardiovascular, cerebrovascular and renal disease, and avoidable cause of premature morbidity and mortality (1–6).

The Health Survey for England monitors trends in the nation's health, estimating the proportion of people in England who have specified health conditions, and the prevalence of risk factors and behaviours associated with these conditions. (7) According to the 2016 Survey, 28% of adults had hypertension, 10% had controlled hypertension and 12% had untreated hypertension. Thus, approximately 7.9 million people were suffering from undiagnosed hypertension in 2016, who are at risk of heart attack or stroke, leading to hospital admission and reduced quality-of-life.

Public Health England (PHE) exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. PHE is an operationally autonomous executive agency of the Department of Health.(8) The 2014 PHE figures reveal that diseases caused by high BP are estimated to cost over £2bn annually (3). £850m of the National Health Service (NHS) and social care spend could be avoided over 10 years by reducing the BP of the nation. If just 15% more people (1.185m people), unaware they have high BP, are diagnosed, £120 million of NHS and social care spend could be avoided over 10 years (9).

Community pharmacists and their teams make an important contribution to the prevention, detection and management of high BP via routine public health promotion, medicines optimisation services and through a wide range of targeted services and interventions specifically designed to detect, diagnose and manage hypertension as recommended by research, in national guidance from PHE and NHS England (10–13). Community pharmacy BP monitoring is readily available and recommended by Canadian hypertension guidelines (14).

The digital BP monitors used within the services need to be of good quality (validated for clinical use(15–18)) and need regular maintenance (calibration) for accurate functioning. This phenomenon has been well studied in physicians' offices (19–21), but less so in pharmacy settings (22–24).

With increasing General Practitioner (GP) shortages, pharmacy providers are more valued.(25,26) They often have extended opening hours during evenings and weekends and are frequently located in comfortable and attractive retail spaces accessible within 20 minutes' walk (27). Thus, they provide a less clinical space, more convenient for people with less access to healthcare.

Current standards for initial education and training on BP monitoring delivered to pharmacy undergraduate students lack sufficient detail to be incorporated into a service specification. The independent pharmacist prescribers course (28) specifies that students are able to use diagnostic aids relevant to the condition for which the pharmacist intends to prescribe.

Consequently, there is no certification or credentialing for providing a high-quality BP service via pharmacy in the UK. As there are no standard specifications integrated into the pharmacy contract, there is possibly quality variability across postcodes. Finally, there is no consensus on how or when referrals are made to medical doctors, though patients would be expected to be signposted to their GP.

This study seeks to understand the challenges faced by under pressure models of care in the Western world (growing patient demand, insufficient funding in primary care, changing patterns of demand, reduced access to GPs and addressing national health inequalities). This study aligns with

the United Nations (UN)'s agenda for Sustainable Development Goals (SDG) 3: to reduce by one third premature mortality from cardiovascular disease by 2030 (29,30).

Objectives

The primary objective of this study is to assess t accuracy (calibration and validation status) of digital BP monitors used within community pharmacy in England and the secondary objective is to assess the overall quality of the BP service. Secondary objectives are assessed by ascertaining prevalence of service provision, level of service utilization, quality of service (how the monitor make and model was chosen, length of time in service, care and maintenance including calibration history, visual or physical checks before each use, instructions provided to patients before taking measurements, available cuff sizes, relevant staff training), and estimated number of patients newly detected with hypertension. We also aimed to use this data to examine its association with geospatial location, dispensing data and Index of Multiple Deprivation (IMD) score which provides statistics on relative deprivation in small areas in England.(31)

Methods.

Participants and recruitment.

We invited 500 pharmacies across England to complete a survey about their BP screening service.

Inclusion Criteria: Community pharmacies that contribute to the NHS Business Services Authority (BSA) dispensing data (pharmacy-contractor reimbursement agency). Exclusion Criteria: Community pharmacies that are not NHS contractors, other settings that offer BP monitoring (e.g. hospitals, GP surgeries, walk-in centres).

Addresses were taken from publicly available NHS BSA website (March 2018) to gain a nationally representative sample. We selected the first 500 pharmacies by Contractor Code (FA002 to FAQ67), ensuring they were nationally representative with respect to the number of prescription forms (sample mean 3,633, SD 2,053 versus population mean 4895, SD 2630) and number of prescription items dispensed (sample mean 7,366, SD 4,296 versus population mean 9875, SD 5480). This permitted comparison with like for like businesses (approximately equal burden of work, similar team size and similar business complexity) across the country, therefore allowing fair comparison between pharmacies that provide the service and those that do not.

We mailed the survey with a single follow-up of non-responders from September to December 2018. Respondents were invited to provide self-reported answers. A prepaid self-addressed envelope was provided. The participants could include registered pharmacists or pharmacy support staff working in community pharmacy.

We sought and received favourable institutional ethical approval. No financial (or similar) benefits were offered to minimise biased responses.

Questionnaire

The questionnaire was composed of items relating to demographics, BP service provision and how it is delivered, blood pressure monitor details, associated training, visual or manual checks performed on monitors and instructions given to patients. The survey is detailed in Appendix A. We had previously iteratively tested the survey in a local pilot study (32).

We piloted the questionnaire via six steps. Questionnaire validation (pretesting) was achieved by researchers critically appraising the scale in a research-team focus-group. This comprised two

external practicing community pharmacists, other academics with recent community and hospital practice experience, and student researchers. This allowed for detection and deletion of ambiguous words, misinterpretation of questions, poor questions, and sensitive questions. Amendments and improvements were made to the format, structure, and content. To improve internal validity and reliability, the survey instrument was piloted with another external community pharmacist, and cognitive testing (read-aloud) was conducted. Further refinement was achieved with a research-team focus-group with contribution from experts at the research design service provided by the National Institute for Health Research. It took less than 10 minutes to complete the final survey.

Sample size

There are 11,619 community pharmacies in England in 2017-18 (33). Assuming confidence level of 95%, confidence interval of 9.5%, relative standard error of 9.69% a sample size of 106 is calculated. To achieve this, we invited 500 pharmacies as previous experience indicates a response range between 15% to 25% in similar studies (32,34,35).

Data analysis

Analyses were undertaken using SPSS (36). The results presented are descriptive, presented as proportions, correlational analysis and independent sample tests. For correlation coefficients, it is generally recognized that a reliability estimate needs to be above .70 and a validity estimate needs to be above .60 to be at an acceptable level (37). All values above 0.6 were examined. We used Levene's test to assess statistical significance. Levene's test is an inferential statistic used to assess the equality of variances for a variable calculated for two groups (service providers versus non-providers). Some common statistical procedures assume that variances of the populations from which different samples are drawn are equal. Levene's test assesses this assumption.

Postcodes of pharmacies were linked with freely available data on IMD score, an estimate of the socioeconomic deprivation of the practice population (31) and NHS dispensing data.

We mapped our results using Arc GIS online and we created an interactive application to visualize the data easily: https://portuni.maps.arcgis.com/apps/webappviewer/index.html?id=a4ef6e48721649ada4eec362507245f6. It is freely and publicly accessible.

We mapped our responses alongside the IMD 2015 data (Ranks: every postcode has a rank from 1 which is the most deprived area up to 32,844 which is the least deprived area. Deciles are published alongside ranks to assess relative deprivation) to assess any relationship between deprivation and screening quality.

Ethics

Science Faculty Ethics Committee provided a favourable ethical review (Reference Number: SFEC 2018-061, Date Submitted: 31 May 2018).

No Patient and Public Involvement

We did not involve patients or the public in our work. This is likely to be done in the future.

Results

In total, 109 responses (21.8% response rate) were received, satisfying sample calculation needs. (74 responses on first approach, 35 additional responses on follow-up, six closures and abatements, three spoiled/defaced responses).

Table 1 Response frequency.

Variables	Respondent Frequencies (Percentage) (n=109)	Service providers Frequencies (Percentage) (n=66)	Statistical Tests
Role	(2 missing)	(0 missing)	
Pharmacist	90 (84%)	55 (83%)	
Pharmacy technician	7 (7 %)	3 (4.5%)	
Dispensing assistant	7 (7 %)	7 (11%)	
Medicines counter assistant	3 (3 %)	1 (1.5%)	
Gender	(3 missing)	(2 missing)	
Male	57 (54 %)	32 (50 %)	
Female	48 (45 %)	32 (50 %)	
Preferred not to say	1 (1 %)		
Years of registration experience	(9 missing)	(7 missing)	
0-2	9 (8 %)	5 (8 %)	
3-5	16 (15 %)	9 (15 %)	
6-8	12 (11 %)	8 (14 %)	
9-11	11 (10 %)	8 (14 %)	
12-14	5 (5 %)	1 (2 %)	
15-17	7 (7 %)	7 (12 %)	
18-20	2 (2 %)	1 (2 %)	
> 20 years	38 (36 %)	20 (34 %)	
Employer type	(2 missing)	(1 missing)	
National chain pharmacy	51 (48 %)	35 (54 %)	
Independent pharmacy	56 (53 %)	30 (46 %)	
Work contract type	(3 missing)	(1 missing)	
Full-Time	90 (85 %)	57 (88 %)	(F=8.904, p= 0.004)
Part-Time	12 (11 %)	7 (11 %)	
Locum	3 (3 %)	1 (2 %)	
Other	1 (1 %)	0	
Location of community pharmacy	(2 missing)	(1 missing)	
Urban	47 (44 %)	32 (49 %)	
Suburban	47 (44 %)	26 (40 %)	
Rural	13 (12 %)	7 (11 %)	

Co-Located within GP practice	(4 missing)	(2 missing)	
Yes	20 (19 %)	10 (16 %)	
No	85 (81 %)	54 (84 %)	(F=4.766, p= 0.031)
Provide a BP monitoring service			
Yes	66 (61 %)		
No	43 (39 %)		

61% (n=66) of responding pharmacies provided a free BP check to their patients.

Characteristics of service providers versus non-service providers on demographics are shown in Table 1.

Service providers employed more full time pharmacists and were less likely to be co-located in GP practices. We found of the 66 service providers, 57 worked full-time.

Table 2 Pharmacist and non-pharmacist respondents stratified by years of registration experience (small numbers may not add up to 100%).

Years of registration experience of service providers	Pharmacists (n=55)	Non pharmacist (n=11)
0-2	5 (9%)	0
3-5	7 (13%)	2 (18%)
6-8	6 (11%)	2 (18%)
9-11	7 (13%)	1 (9%)
12-14	1 (2%)	0
15-17	7 (13%)	0
18-20	1 (2%)	0
> 20 years	20 (36%)	0
Missing data	0	6 (55%)

Table 2 demonstrates that pharmacists tended to lead the service delivery and tended to be more experienced.

Employees involved in providing the BP check in the pharmacy included the whole team: 55 were pharmacists, 2 pharmacy technicians, 7 dispensing assistants and 1 medicines counter assistant.

Pharmacies had provided the service for varying lengths of time: nine 0-2 years, twelve 3-6 years, eleven 7-9 years, and 24 over 9 years (8 did not know, with 2 missing).

Service Utilization

All but one respondent provided monitoring solely within the pharmacy. One lent their BP monitor to patients for self-monitoring at home.

We enquired about monthly and annual screening figures because there may be distortions in some months when national or local health promotion campaigns are promoted (e.g. 'Know your Numbers!', NHS Health Check, etc.). In the last month, pharmacies reported providing BP screening as per table 3.

Table 3 Number of patients screened in the last month.

Number of patients screened	Response Frequency
1-5	25 (38%)
6-10	22 (34%)
11-15	8 (12%)
16-20	2 (3%)
20+	8 (12%)
Total	65 (1 missing)

Over the last year, the people screened in each pharmacy ranged from 10 to 2000 (mean 106.3, SD 295.2, 21 missing), with 10 pharmacies serving 100 or more people. Only one respondent said 2000, which could be an outlier but is associated with higher business volumes (prescription forms and items dispensed were 5613 and 10144 respectively, IMD decile 10-affluent).

When asked: "What is the number of patients newly detected with high BP (BP > 140/90 mmHg) in the last month?" many could not give a clear answer, but estimates ranged from 0 to 25 with a high-frequency of ones and twos (mean 2.3, SD 4.0, 17 missing).

Calibration, validation, cuff sizes, maintenance intervals.

Overwhelmingly pharmacies (97%; n=61) reported using an automatic BP monitor during BP screening (where cuff inflation, deflation and BP determination are fully performed by the device automatically). Two respondents (3%) said they used a semi-automatic device (BP determination is performed automatically but cuff inflation and/or deflation needs manual operation). None used manual sphygmomanometers (3 missing). All measured BP at the upper arm.

We then explored the rationale behind choosing their particular monitor. 58 responses were received: 25 (43%) respondents were given their monitor by head office (refers to any central office under the control of the superintendent pharmacist, who takes legal responsibility for all business operations), 16 (28%) used a monitor that was convenient for them (often present in their own store for sale), seven (12%) had done some brand research, five (9%) participants identified their monitor as being "accredited", and five (9%) were influenced by advertisement.

Further to this, 61 respondents provided a monitor's brand, 50 provided a model number and 53 provided a batch number. We used the dabl®Educational Trust (38) and the British and Irish Hypertension Society (BIHS) (39) website to check their validation status.

40 (61%) pharmacies used recommended validated clinical meters, 6 (9%) monitors had failed validation, and 20 (30%) respondents provided too little information to enable us to determine their monitor's status. One monitor was validated but listed as discontinued by dabl® and archived by BIHS, which makes its continued use questionable.

Regarding available cuff sizes, 50 responses were received, shown in table 4.

Table 4 Available cuff sizes.

Available cuff sizes	Response frequency (n=50)
Small (18-22 Cm)	7 (14%)
Medium (22-32 Cm)	39 (78%)
Large (32-45 Cm)	27 (54%)
Extra-Large (42-50 Cm)	7 (14%)

Other "24 To 40 Cm 9.4-15.7"	1 (2%)
Missing	16 (24%)

Though some branches had several cuff sizes in use, 23 (46%) just had one cuff size.

Regarding length of monitor time in use, 43 valid responses were received. Dates ranged from 14/07/2005 to 01/09/2018, thus covering anywhere from over 13 years to two months. From this, we calculated length of time in service: 10 responders had their monitor in use between 0-1 year, 14 had their monitor in use between 1-2 years, 12 had had their monitor in use between 2-5 years, six had had their monitor in use between 5-10 years, and one had their monitor in use over 10 years.

Respondents replaced their BP monitor at different intervals; one person (2%) said they replaced six monthly, eight (13%) said annually, 26 (41%) said two yearly, 19 (30%) said the meter had not been replaced and nine (14%) said other (3 missing). We also asked if respondents sent their monitor for calibration. Three (5%) sent it back to the manufacturer, 13 (20%) sent it back to head office, and 44 (67%) did not send their monitor for calibration (6 missing). This demonstrates that community pharmacies to some extent replace the monitor rather than get it calibrated relying on monitors warranty status.

Training

We explored issues around training to gain a better understanding of the level of knowledge, skill and education of respondents regarding the blood pressure monitoring service.

59 (92%) respondents said they received some form of training and five (8%) said they did not (2 missing). Of those who received training, 32 (54%) indicated only one form of training, while the others received multiple forms of training. The types of training are shown in table 5.

Table 5 Type of training received.

Type of training	**Response frequency**
Informal chat with the senior pharmacist	33
Training provided by the monitor manufacturer	6
Read internal company standard operating procedures (SOPs)	41
Read Royal Pharmaceutical Society Guidelines	11
Completed Centre for Pharmacy Postgraduate Education (CPPE) training	13
Other	12

'Other' comments included training from internal and external providers (online and in-person), local clinical commissioning group (CCG) training, British Heart Foundation training events and reading National Institute for Health and Care Excellence (NICE) guidelines. This represents training with great variability, potential inadequacy (only reading material/ online information/ lack of practical experience) and some reliance on interested parties like manufacturers to deliver the training.

We found there was good correlation between BP training and medicine use reviews (MUR) or new medicine services (NMS) (r=0.605 to 0.715), suggesting if pharmacists are trained on BP services, they are likely to have engaged in other professional training like MUR and NMS accreditation which is intended to encourage safe and appropriate use of medicines (40).

Visual or manual checks of monitor

Respondents self-reported in-situ checks that were conducted during each consultation. 40 (61%) respondents performed some visual or manual checks to ensure they were achieving accurate results, 26 (39%) did not. These, variously, included a visual check of the integrity of the monitor, checks for properly affixed tubing, working batteries, appropriate and secure cuff positioning of Velcro, correct inflation and deflation without air leaks, and of the display screen (no error codes). General cleanliness and physical damage (e.g. holes) was assessed, in addition to simply checking that the machine was turned on and actually providing BP and pulse readings. Four respondents would check their own (and colleagues') BP to assess whether the monitor was working well.

Instructions to patients/customers

We also inquired about the instructions provided to patients prior to screening. 64 positive answers were received indicating that most respondents would instruct their patients, with only one respondent saying they would give no instructions (1 missing). Instructions, variously, included to remove restrictive clothing, be seated, relax, have both feet on the ground, legs apart and not crossed, rest their elbow on the table with wrist facing up, and not to talk. Respondents also, variously, inquired if patients needed to empty their bladder or had recently consumed caffeine, smoked, felt stressed, made any blood donations, and asked about past medical history, and drug history including any prescribed BP medication. One respondent said they would go through the consenting process (telling the patient what was involved and what to expect). Some patients were given a customer card with a copy of their readings.

We asked if there were any other considerations respondents would make, and they responded in terms either of assessing the reliability of the BP readings generated, considering the most pragmatic way of conducting the tests, or how best to communicate with patients. 41 comments were received. One respondent would consider patient age and weight as part of the assessment. A few suggested the need for multiple readings, that they "might take an average of three readings". Many would consider prescribed medicines currently taken by the patient. Respondents also would explain the reading and give relevant lifestyle and health promotion advice with respect to exercise, diet, smoking and alcohol or other beverages (e.g. coffee, energy drink). One considered if the patient had a pacemaker fitted or potential pregnancy. One respondent would consider if patients had breast or underarm surgery. Respondents would also generally take into consideration the patient's character, stress levels, demeanour, life and work and assess if white coat syndrome was present leading to unreliable readings. One respondent took into account ambient temperature, i.e. heat. Some inquired why the patient is requesting a BP measurement.

We invited any other additional comments. Comments included that one respondent had ordered a large cuff and another was considering replacing or getting their monitor calibrated because of the survey. Some respondents were proactive at measuring BP by facilitating well-being days.

The potential extension to the role of community pharmacy was highlighted by one respondent who commented, *"Clients sometimes use us to record BP on their PMR [pharmacy patient medical records] & then take print out to GP to help record issues. When white coat syndrome, GPs will refer to us."* This suggests current practice may include referring patients to GP for follow-on care. It also importantly hints at lower rates of white coat syndrome in pharmacy settings than in physician clinics and that GPs actively refer patients for screening in pharmacy settings for this reason.

Deprivation

Pharmacies in all deciles from most deprived to least deprived responded, with relatively even distribution per decile. Table 6 summarizes our findings stratified by the most deprived deciles (a 1 of 10 subdivision) versus their more affluent counterparts.

Table 6 Respondent IMD decile distribution.

Deciles (1= most deprived, 10= least deprived)	**Number of Respondents**	**BP service providers**	**Service utilization (number of people screened)**	**Validated monitor status**	**Quality of service (Calibration status)**	**Quality of service (purchase date)**
Deprived Deciles 1, 2 and 3.	49 (45%)	33 (67%)	1-5 people screened by 12 respondents. 6-10 people screened by 12 respondents. 11-15 people screened by 5 respondents. 15+ people screened by 3 respondents.	18 (55%)	4 calibrated 0-1 year ago. 2 calibrated 1-2 years ago. 2 calibrated 2-5 years ago. None calibrated 5-10 years ago. 1 calibrated 10+years ago.	4 purchased 0-1year ago. 8 purchased 1-2years ago. 7 purchased 2-5years ago. 2 purchased 5-10years ago. None purchased 10+years ago.
Affluent Deciles 4, 5, 6, 7, 8, 9 and 10.	60 (55%)	33 (55%)	1-5 people screened by 13 respondents. 6-10 people screened by 10 respondents. 11-15 people screened by 3 respondents. 15+ people screened by 7 respondents.	22 (67%)	3 calibrated 0-1year ago. 1-2years ago.: 2 4 calibrated 2-5years ago. 1 calibrated 5-10years ago. None calibrated 10+years ago.	6 purchased 0-1year ago. 6 purchased 1-2years ago. 5 purchased 2-5years ago. 4 purchased 5-10years ago. 1 purchased 10+years ago.
Total	109	66		40		

Table 6 suggests higher frequency of BP screening by community pharmacy providers in the most deprived postcodes, though this is not statistically significant reflecting small sample size. Service utilization was approximately even. Respondents in less deprived areas were slightly more likely to have a validated monitor, though again this is not statistically significant. Calibration rates and length of time in service of monitors show limited relationship to deprivation of surrounding area. Granular decile information is available (see Appendix B).
Provision of the service was linked to lower income rank (F=4.029, p= 0.047) and lower employment rank (F=4.651, p= 0.033).

Discussion

Summary

Hypertension-related appointments make up almost one in 10 of all GP consultations each year.(41) With the workload of GPs thought to be nearing saturation point, (42) alternative models of hypertension management such as pharmacist-led care have the potential to alleviate this increasing burden on primary healthcare systems. Evidence from systematic reviews shows that such interventions can significantly reduce blood pressure compared with usual GP care. (25, 43) To explore the potential of implementing extended pharmacist roles in the management of hypertension in community settings, it is essential to describe current practice.

We found between 1 to 10 people were routinely screened monthly by each pharmacy. Annually, respondents said they screened between 10 to 2000 people (where 2000 could be an outlier). These figures seem credible as they give annualized average figures of at least 10 to 12 people screened by each service provider (the higher annual figures may reflect pharmacies participating in national campaigns such as 'Know Your Numbers' [http://www.bloodpressureuk.org/HealthProfessionals/KnowyourNumbersWeek] at other points in the year). This rate of screening conservatively detected 1 to 2 undiagnosed hypertensive patients monthly per service provider. If these estimates are scaled-up for England and annualized across the 11,619 pharmacies in England, assuming a 60% service provision rate, it would represent detection of an additional 83,657 to 167,314 undiagnosed hypertensives, identifying 2% of the total undiagnosed hypertensive English population. In seven years, in its current state, the service could help diagnose 1.185 million people saving the NHS £120 million (9).

Most monitors were automatic digital monitors, selected by head office or as a convenient model, but price and product guarantees may also play an influential role in monitor selection, rather than validation status. Lack of a range of cuff sizes per provider appears a major issue, as only 59% (39/66) stocked a medium cuff and 41% (27/66) a large cuff, with only a minority reporting they stocked multiple cuff sizes.

Many monitors were old which may risk inaccuracy. 56% of service providers replaced the monitors at least every two years, but only 14% (9/63) every year or more frequently, and 30% did not replace at all. This may be because often calibration is guaranteed for up to two years from the date of purchase by manufacturers. However, previous studies recommend at least annual calibration with evidence suggesting declining performance after 18 months (22).

Calibration of devices was reported by 27% of service providers. Overall, this means 23% (15/66) of service providers neither replaced nor calibrated their devices.

Whilst 92% of service providers received some training of variable quality, 8% reported not receiving any. While this is poor, it provides a benchmark for future training-quality enhancements.

Strengths and limitations

This study provides needed evidence on the quality of BP screening from community pharmacy. There are several novelties to our study. We have for the first time reported on prevalence of service provision (61%), level of service utilization, and validation and calibration status within community pharmacy practice in England. This is the most comprehensive service evaluation on BP monitoring service provision in pharmacies in the UK.

Our pharmacies were typical of those nationwide, including in terms of deprivation of surrounding catchment area. There was a good spread in terms of typology of pharmacy and location (geographically; urban, suburban, rural). Therefore, our results are robust, credible and generalizable.

Though we have structured this study robustly, there is a risk of bias. Key limitations of our study are small sample size and low response rate. It is possible that our results may be biased towards more provision than is actually available, if pharmacies providing the service were more likely to respond. However, we did specify we were interested in hearing from non-service providers, and respondents in such pharmacies would have needed much less time to complete the survey. Potential bias may also be introduced by recruiting pharmacies with lower average number of prescription volumes dispensed.

Some missing information may make the findings unreliable. This is a potential limitation of our study and in the future, we may seek ethical permission to telephone pharmacies to confirm missing information. For some respondents, there is discrepancy between monthly and annual screening numbers, which is a potential limitation of this study and could reflect erratic answers, but it highlights the need for more research beyond a survey methodology.

We acknowledge that respondents often represent multiple chain pharmacies that have uniform SOPs in branches across the country. Theoretically, this could bias our results. However, SOPs are interpreted, adapted and implemented differently within each branch and so our research provides a more authentic representation of practice.

Comparison with existing literature

Pharmacists can provide BP screening service at much reduced cost to the NHS compared to GP services.(44) Pharmacists are generally available without appointment, open for extended hours during unsociable hours and have been shown to provide greater care in areas of highest deprivation (27). Our mapping provides tentative support for this positive care law.

There may be a lower incidence of white coat syndrome in community pharmacy (45), and we found evidence of GPs using pharmacies to screen for white coat hypertension. The potential role of pharmacies in hypertension management through BP testing (checking for white coat syndrome, monitoring the effectiveness of medication) is there, in addition to screening for new hypertension cases. Lower rates of white coat syndrome in these settings is supported in the Palmera study (45).

Implications for clinical practice

Significant quality enhancements need to be implemented. It is important to consider the patient population this study may impact most. The 'hard to reach' groups of patients are typically less affluent and are also less likely to see their GP (or not have a GP), and have poor health literacy. There may be a greater likelihood of identifying new previously undetected cases of hypertension in

this group of the population. Community pharmacies are easily accessible and located in all areas, and have been shown to provide greater care in areas of highest deprivation which may be more conducive for the 'hard to reach' patient groups and could assist in reducing health inequalities nationally. Focusing attention on these people at the right time can avoid hospital costs and allow the patient to remain within the community.

Pharmacies deliver a valuable service of providing free BP checks to those who feel they cannot afford to buy monitors. In affluent areas, it may be that more people are self-monitoring with their own-bought home-monitors, and there is simply less demand on pharmacies.

Collectively, this provides a social and health economic argument for pharmacists to be involved in routine, NHS-commissioned, hypertension screening for the general population with needed quality enhancements.

Conclusion

The majority of pharmacies use validated BP monitors. In general, responding pharmacies were able to provide useful BP monitoring services to their patients, though quality enhancements need to be implemented. There was (a) lack of range of cuff sizes, (b) variation in recruitment and calibration of monitors, and apparent absence of any replacement or calibration in a minority of pharmacies, (c) variation in training standards. Community pharmacists could play a leading role in BP screening in England.

Funders and policy setters should consider the value added to the NHS and other healthcare agencies of such screening by pharmacy providers both nationally and internationally. It has the potential to reduce complications of undiagnosed hypertension and the medicines burden that it creates.

Future research needs

A larger study is required to validate our findings. Future work should examine the impact of pharmacist-led BP screening on patients. At the very least, we need to study the patient population, their needs in their local context, and which areas or groups represent most undiagnosed people. We encourage the international research community to use our survey to report their findings.

Acknowledgments

Thank you to the 109 retail pharmacy respondent-employees who took the time to provide honest opinions, Carla Orszulik and Sophie Doughty for helping with study administration and data collection, Michelle Sumner for providing excellent technical help to allow data capture and processing, and Martin Schaefer for his help with ArcGIS publisher requests.

Disclaimer: The views expressed in this publication are those of the authors and not those of the University of Portsmouth, University of Brighton, University of Birmingham nor the NHS.

Competing interests: None.

Patient consent: Not required.

Ethics approval: University of Portsmouth, Science Faculty Ethics Committee provided a favourable ethical review (Reference Number: SFEC 2018-061, Date Submitted: 31 May 2018).

Data statement: No additional data available.

A funding statement: This study was funded by the University of Portsmouth.

Author contributions:

RB led on the literature search, conduct, data acquisition and statistical analysis. RB and JH were involved in study conception and design, data analysis and interpretation of data, manuscript preparation, editing and revision and agreed upon the final version of the paper.

References

1. Rothwell PM, Howard SC, Dolan E, O'Brien E, Dobson JE, Dahlöf B, et al. Prognostic significance of visit-to-visit variability, maximum systolic blood pressure, and episodic hypertension. Lancet Lond Engl. 2010 Mar 13;375(9718):895–905.

2. Webb AJS, Fischer U, Mehta Z, Rothwell PM. Effects of antihypertensive-drug class on interindividual variation in blood pressure and risk of stroke: a systematic review and meta-analysis. Lancet Lond Engl. 2010 Mar 13;375(9718):906–15.

3. Clement DL, De Buyzere ML, De Bacquer DA, de Leeuw PW, Duprez DA, Fagard RH, et al. Prognostic value of ambulatory blood-pressure recordings in patients with treated hypertension. N Engl J Med. 2003 Jun 12;348(24):2407–15.

4. Verdecchia P, Porcellati C, Schillaci G, Borgioni C, Ciucci A, Battistelli M, et al. Ambulatory blood pressure. An independent predictor of prognosis in essential hypertension. Hypertension. 1994 Dec;24(6):793–801.

5. Hansen TW, Jeppesen J, Rasmussen S, Ibsen H, Torp-Pedersen C. Ambulatory blood pressure and mortality: a population-based study. Hypertens Dallas Tex 1979. 2005 Apr;45(4):499–504.

6. Chobanian AV, Bakris GL, Black HR, Cushman WC, Green LA, Izzo JL, et al. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA. 2003 May 21;289(19):2560–72.

7. NHS Digital. Health Survey for England, 2016 [Internet]. NHS Digital. [cited 2019 Aug 20]. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/health-survey-for-england-2016

8. Public Health England. About us [Internet]. GOV.UK. [cited 2019 Aug 20]. Available from: https://www.gov.uk/government/organisations/public-health-england/about

9. New figures show high blood pressure costs NHS billions each year [Internet]. [cited 2018 Jan 29]. Available from: https://www.gov.uk/government/news/new-figures-show-high-blood-pressure-costs-nhs-billions-each-year

10. High blood pressure: plan and deliver effective services and treatment [Internet]. GOV.UK. [cited 2019 Jan 21]. Available from: https://www.gov.uk/guidance/high-blood-pressure-plan-and-deliver-effective-services-and-treatment

11. Tsuyuki RT, Houle SKD, Charrois TL, Kolber MR, Rosenthal MM, Lewanczuk R, et al. Randomized Trial of the Effect of Pharmacist Prescribing on Improving Blood Pressure in the Community: The Alberta Clinical Trial in Optimizing Hypertension (RxACTION). Circulation. 2015 Jul 14;132(2):93–100.

12. Okada H, Onda M, Shoji M, Sakane N, Nakagawa Y, Sozu T, et al. Effects of lifestyle advice provided by pharmacists on blood pressure: The COMmunity Pharmacists ASSist for Blood Pressure (COMPASS-BP) randomized trial. Biosci Trends. 2018 Jan 9;11(6):632–9.

13. Pharmacy voice. Tackling high blood pressure through community pharmacy. [Internet]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693902/PV_Blood_Pressure_Report.pdf

14. Lamb SA, Al Hamarneh YN, Houle SKD, Leung AA, Tsuyuki RT. Hypertension Canada's 2017 guidelines for diagnosis, risk assessment, prevention and treatment of hypertension in adults for pharmacists: An update. Can Pharm J CPJ Rev Pharm Can RPC. 2018 Feb;151(1):33–42.

15. Eoin O'Brien, James Petrie, William Littler, Michael de Swiet, Paul L. Padfield, Douglas G. Altman, Martin Bland, Andrew Coats, Neil Atkins. The British Hypertension Society protocol for the evaluation of blood pressure measuring devices. J Hypertens. 1993;11(Supplement 2):S43–62.

16. Stergiou GS, Asmar R, Myers M, Palatini P, Parati G, Shennan A, et al. Improving the accuracy of blood pressure measurement: the influence of the European Society of Hypertension International Protocol (ESH-IP) for the validation of blood pressure measuring devices and future perspectives. J Hypertens. 2018;36(3):479–87.

17. O'Brien E, Atkins N, Stergiou G, Karpettas N, Parati G, Asmar R, et al. European Society of Hypertension International Protocol revision 2010 for the validation of blood pressure measuring devices in adults. Blood Press Monit. 2010 Feb;15(1):23–38.

18. Stergiou GS, Alpert BS, Mieke S, Wang J, O'Brien E. Validation protocols for blood pressure measuring devices in the 21st century. J Clin Hypertens Greenwich Conn. 2018 Jul;20(7):1096–9.

19. Clark CE, Horvath IA, Taylor RS, Campbell JL. Doctors record higher blood pressures than nurses: systematic review and meta-analysis. Br J Gen Pract. 2014 Apr;64(621):e223–32.

20. Little P, Barnett J, Barnsley L, Marjoram J, Fitzgerald-Barron A, Mant D. Comparison of agreement between different measures of blood pressure in primary care and daytime ambulatory blood pressure. BMJ. 2002 Aug 3;325(7358):254.

21. A'Court C, Stevens R, Sanders S, Ward A, McManus R, Heneghan C. Type and accuracy of sphygmomanometers in primary care: a cross-sectional observational study. Br J Gen Pract J R Coll Gen Pract. 2011 Sep;61(590):e598-603.

22. Hodgkinson J, Koshiaris C, Martin U, Mant J, Heneghan C, Hobbs FR, et al. Accuracy of monitors used for blood pressure checks in English retail pharmacies: a cross-sectional observational study. Br J Gen Pract. 2016 May 1;66(646):e309–14.

23. Pappaccogli M, Enri LR, Perlo E, Di Monaco S, Pignata I, Baratta F, et al. Assessment of a non-physician screening program for hypertension and cardiovascular risk in community pharmacies. Nutr Metab Cardiovasc Dis NMCD. 2019 Jul 19;

24. Fleming S, Atherton H, McCartney D, Hodgkinson J, Greenfield S, Hobbs FDR, et al. Self-Screening and Non-Physician Screening for Hypertension in Communities: A Systematic Review. Am J Hypertens. 2015 Nov;28(11):1316–24.

25. Cheema E, Sutcliffe P, Singer DRJ. The impact of interventions by pharmacists in community pharmacies on control of hypertension: a systematic review and meta-analysis of randomized controlled trials: The impact of interventions by pharmacists in community pharmacies on control of hypertension. Br J Clin Pharmacol. 2014 Dec;78(6):1238–47.

26. Ryan K, Patel N, Lau WM, Abu-Elmagd H, Stretch G, Pinney H. Pharmacists in general practice: a qualitative interview case study of stakeholders' experiences in a West London GP federation. BMC Health Serv Res. 2018 02;18(1):234.

27. Adam Todd, Alison Copeland, Andy Husband, Adetayo Kasim, Clare Bambra. The positive pharmacy care law: an area-level analysis of the relationship between community pharmacy distribution, urbanity and social deprivation in England. BMJ Open 2014 [Internet]. 2014 Aug 12 [cited 2015 Jan 19];4(8). Available from: http://bmjopen.bmj.com/content/4/8/e005764.short

28. General Pharmaceutical Counsel. Pharmacist independent prescribing-learning outcomes and indicative content.

29. United Nations Statistics Division. SDG Indicators - Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development [Internet]. [cited 2018 Dec 5]. Available from: https://unstats.un.org/sdgs/indicators/indicators-list/

30. United Nations Publications. Sustainable Development Goals Report 2018. S.l.: United Nations Pubns; 2018.

31. Ministry of Housing, Communities & Local Government. English indices of deprivation 2015 [Internet]. National StatisticsGOV.UK. 2015 [cited 2019 Mar 4]. Available from: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015

32. Barrett R. Blood pressure monitor validation, calibration, and community pharmacy practice: a pilot cross-sectional survey in Hampshire, UK. Blood Press Monit. 2018 Oct;23(5):281–2.

33. UK Statistic. Community pharmacies in England 2006-2018 [Internet]. Statista. [cited 2018 Dec 11]. Available from: https://www.statista.com/statistics/418071/community-pharmacies-in-england/

34. Barrett R, Costa D. An evaluation of community pharmacist perception the misuse and abuse of over-the-counter Co-codamol in Cornwall and Devon, UK: a cross-sectional survey. Heroin Addict Relat Clin Probl. 2018 Feb 21;Published Ahead of Print.

35. Barrett R, Al-Mousawi HA. Development and initial validation of a postal survey evaluation of community pharmacists' opinion regarding falsified (counterfeit) medicines in Hampshire (UK). J Pharm Pharmacogn Res. 2018;6(4):242–249.

36. IBM Corp. IBM SPSS Statistics for Windows. Armonk, NY; 2014.

37. Odom, Leslie R., Morrow, James R., Jr. What's This "r"? A Correlational Approach to Explaining Validity, Reliability and Objectivity Coefficients. Meas Phys Educ Exerc Sci. 2006 Jun;10(2):137–45.

38. dabl®Educational Trust Ltd. Sphygmomanometers for Clinical Use [Internet]. Available from: http://www.dableducational.org/sphygmomanometers/devices_1_clinical.html

39. British and Irish Hypertension Society. Validated BP Monitors for For Specialist Use.

40. NHSBSA. Medicines use review (MUR) / new medicine services (NMS) quarterly submission. [Internet]. [cited 2019 Sep 11]. Available from: https://www.nhsbsa.nhs.uk/pharmacies-gp-practices-and-appliance-contractors/dispensing-contractors-information/medicines-use

41. Public Health England. Tackling high blood pressure From evidence into action [Internet]. Available from:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/527916/Tackling_high_blood_pressure.pdf

42. Hobbs FDR, Bankhead C, Mukhtar T, Stevens S, Perera-Salazar R, Holt T, et al. Clinical workload in UK primary care: a retrospective analysis of 100 million consultations in England, 2007–14. The Lancet. 2016 Jun;387(10035):2323–30.

43. Albasri A, Prinjha S, McManus RJ, Sheppard JP. Hypertension referrals from community pharmacy to general practice: multivariate logistic regression analysis of 131 419 patients. Br J Gen Pract. 2018 Aug;68(673):e541–50.

44. Dalton K, Byrne S. Role of the pharmacist in reducing healthcare costs: current insights. Integr Pharm Res Pract. 2017;6:37–46.

45. Sendra-Lillo J, Sabater-Hernández D, Sendra-Ortolá A, Martínez-Martínez F. Comparison of the white-coat effect in community pharmacy versus the physician's office: the Palmera study. Blood Press Monit. 2011 Apr;16(2):62–6.

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

«AddressBlock»

Title: Accuracy of BP monitors in community pharmacy screening services: a cross-sectional survey, UK

Dear Pharmacist or pharmacy support staff,

Thank you for reading this. The School of Pharmacy at the University of Portsmouth would like to invite you to take part in a study looking to determine community pharmacies' role in blood pressure (BP) monitoring across the UK. You have been identified as a potential participant in this study as you work in a community pharmacy in the United Kingdom.

This survey is intended to be completed by the pharmacist or member of pharmacy staff. We are interested in the opinions of responders who provide free BP monitoring service for the public as well as those who do not. Your participation in this study is greatly appreciated. It is entirely up to you if you want to take part, but there is limited knowledge on this subject and we would be grateful for your contribution. This work is undertaken as part of an MPharm final year student project, and will provide an educational experience in addition to useful data.

The study involves completing the survey questionnaire. You can choose to remain anonymous and not provide any identifiable personal information in this study. As your opinion is valued, at the end of this survey we will ask you if you would like to take part in any future research we conduct. If you say 'yes', we will invite you to give us your name and address so that we can contact you in the future. You do not have to provide this information if you don't want to. Any identifiable information you give us will be stored securely and will not be shared beyond the research team. All reasonable steps will be taken to ensure confidentiality. It should take you approximately 10 minutes to complete the survey.

Responses received will be collated for analysis and the original questionnaires will be archived as per the University data management policy. If you want to know more about this work or the results of this study, you can contact the lead researcher (Mrs Ravina Barrett) using the details at the end of the questionnaire. If you are happy taking part, please read the following instructions.

Instructions: *Please complete this questionnaire by placing a tick ☑ in the most appropriate box unless stated otherwise, and where spaces or boxes are provided please fill in with your comments and justifications. The responses you provide will remain anonymous therefore please answer honestly.*

Demographics

1 What is your role?

Pharmacist	Pharmacy technician	Dispensing assistant or pharmacy assistant	Medicines counter assistant
☐	☐	☐	☐

2 What is your gender?

Male	Female	Prefer not to say
☐	☐	☐

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

3 How many years have you been registered as a pharmacist or technician in the UK?

0-2	3-5	6-8	9-11	12-14	15-17	18-20	> 20
☐	☐	☐	☐	☐	☐	☐	☐

4 Do you work ...?

Full time	Part-time	Locum	Other
☐	☐	☐	☐

5 What is the type of community pharmacy do you work in?

Independent	Multiple
☐	☐

6 What is the location of your community pharmacy?

Urban	Suburban	Rural
☐	☐	☐

7 Are you co-located within a GP practice?

Yes	No
☐	☐

8 Do you provide a blood pressure monitoring service at your pharmacy?

Yes	No
☐	☐

If 'no', please stop filling in the form and return it in the SAE provided.

9 Do you loan out your BP monitor to patients for self-monitoring at home?

Yes	No
☐	☐

10 Who does the BP check in your pharmacy?

Pharmacist	Pharmacy technician	Dispensing assistant or pharmacy assistant	Medicines counter assistant
☐	☐	☐	☐

11 Where on the body do you measure blood pressure?

Upper arm	Wrist	Finger	Other
☐	☐	☐	☐

12 How long has the pharmacy provided the digital blood pressure monitoring service?

0-2 years	3-6 years	7-9 years	> 9 years	don't know
☐	☐	☐	☐	☐

13 How many members of the public have been provided the service in the last month?

1-5	6-10	11-15	16-20	20+
☐	☐	☐	☐	☐

14 How many members of the public have been provided the service in the last year?

15 What is the number of patients newly detected with high blood pressure (BP> 140/90 mmHg) in the last month?

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

Blood pressure monitor details

16 What kind of blood pressure monitor do you use for BP screening?

Automatic (Cuff inflation, deflation and blood pressure determination are fully performed by the device automatically)	Semiautomatic (Blood pressure determination is performed automatically but cuff inflation and/or deflation needs manual operation)	Manual (Blood pressure determination is performed manually irrespective of inflation or deflation control)	Other (please tell us more)
☐	☐	☐	☐

17 How did you decide which blood pressure monitor to use?

18 What is your monitor 's brand?

19 What is your monitor 's model number?

20 What is your monitor 's batch/ serial number?

21 What available cuff sizes do you keep?

18-22 cm 7.1-8.7" Small ☐ 22-32 cm 8.8-12.8" Medium ☐ 32-45 cm 12.8-18" Large ☐ 'Extra-large' ☐ Other ☐

22 Date of purchase or date of first use (whichever reflects when you started using this monitor)?

Day	Month	Year

23 Which monitor do you think provides a more accurate blood pressure reading?

Manual ☐ Digital ☐

24 Why do you think that?

25 Do you replace the blood pressure monitor you use for tests at a fixed interval?

Six months ☐ One year ☐ Two years ☐ Other ☐ Not been replaced ☐

26 Do you send your monitor for calibration (to have its accuracy checked)?

Yes, back to manufacturer ☐ Yes, back to head office ☐ No (please go to Q28) ☐

27 At what intervals do you send the monitor for calibration?

Six monthly ☐ Annually ☐ Every two years ☐ Other ☐

28 When was the last time your blood pressure monitor was calibrated (Day, Month, and Year)?

Day	Month	Year

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

Training

29 Is training provided for the professional who delivers the blood pressure monitoring service?

Yes ☐ No ☐

30 What kind of training? (tick all that apply)

Informal chat with senior pharmacist	Training provided by manufacturer	Read standard operating procedures	Read royal pharmaceutical society guidelines	CPPE training	Other
☐	☐	☐	☐	☐	☐

31 Please explain if you said 'other', or have additional comments to make.

Visual or manual checks of monitor

32 Do you perform any visual or manual checks on your digital blood pressure monitor to ensure accurate results?

Yes ☐ No ☐

What checks do you perform? (Please skip this if you answered 'no' above)

33

Before taking a patient's blood pressure, what instructions do you provide to your patients?

34

35 Is there any other considerations you make?

36 Would you like to make any other additional comments?

END OF SURVEY. Thank you for completing this survey.

If you have a concern about this research study, please contact: Mrs Ravina Barrett, Phone: 44 (0) 2392843683, Email: ravina.barrett@port.ac.uk

Appendix B Stratification by decile.

Deciles (1= most deprived, 10= least deprived)	Number of Respondents	BP service providers	Service utilization /66 (number of people screened)	Validated monitor status /66	Quality of service /66 (Calibration status)	Quality of service /66 (purchase date)
Decile 1	15	10	1-5: 4 6-10: 5 11-15: 1 15+: 0	6	0-1year: 0 1-2years: 1 2-5years: 1 5-10years: 0 10+years: 1	0-1 year: 1 1-2 years: 3 2-5 years: 3 5-10 years: 1 10+ years: 0
Decile 2	15	11	1-5: 3 6-10: 3 11-15: 2 15+:2	6	0-1year: 1 1-2years:0 2-5years:1 5-10years:0 10+years:0	0-1 year: 2 1-2 years:3 2-5 years:1 5-10 years:1 10+ years:0
Decile 3	19	12	1-5: 5 6-10: 4 11-15: 2 15+:1	6	0-1year:3 1-2years:1 2-5years:0 5-10years:0 10+year2:0	0-1 year:1 1-2 years:2 2-5 years:3 5-10 years:0 10+ years:0
Decile 4	5	3	1-5: 1 6-10: 1 11-15: 0 15+:1	2	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:0 1-2 years:1 2-5 years:2 5-10 years:0 10+ years:0
Decile 5	16	6	1-5: 3 6-10: 1 11-15: 1 15+:1	4	0-1year:1 1-2years:0 2-5years:1 5-10years:0 10+years:0	0-1 year:2 1-2 years:0 2-5 years:0 5-10 years:1 10+ years:1
Decile 6	9	5	1-5: 2 6-10: 1 11-15: 1 15+:1	3	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:2 2-5 years:0 5-10 years:0 10+ years:0
Decile 7	8	6	1-5: 3 6-10: 3 11-15: 0 15+:0	5	0-1year:1 1-2years:0 2-5years:2 5-10years:0 10+years:0	0-1 year:0 1-2 years:1 2-5 years:3 5-10 years:1 10+ years:0
Decile 8	8	3	1-5: 1 6-10: 1 11-15: 1 15+:1	0	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:0 2-5 years:0 5-10 years:0 10+ years:0
Decile 9	7	4	1-5: 1 6-10: 2 11-15: 0 15+:1	3	0-1year:0 1-2years:1 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:1 2-5 years:0 5-10 years:1 10+ years:0
Decile 10	7	6	1-5: 2 6-10: 1 11-15: 0 15+:3	5	0-1year:1 1-2years:1 2-5years:1 5-10years:1 10+years:0	0-1 year:1 1-2 years:1 2-5 years:0 5-10 years:1 10+ years:0
Total	109	66		40		

Table 1 Data stratified by decile.

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	#3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	#4	Present key elements of study design early in the paper	4
Setting	#5	Describe the setting, locations, and relevant dates, including periods of	4

		recruitment, exposure, follow-up, and data collection	
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	4
Bias	#9	Describe any efforts to address potential sources of bias	4, 9
Study size	#10	Explain how the study size was arrived at	4
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	5
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	5
Statistical methods	#12c	Explain how missing data were addressed	5
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	5
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	5
Participants	#13b	Give reasons for non-participation at each stage	5
Participants	#13c	Consider use of a flow diagram	n/a

Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	5
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	5
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	5
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5
Main results	#16b	Report category boundaries when continuous variables were categorized	5
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	5
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	8
Discussion			
Key results	#18	Summarise key results with reference to study objectives	8
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	9
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	9
Generalisability	#21	Discuss the generalisability (external validity) of the study results	9
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	1

This checklist was completed on 13. June 2019 using https://www.goodreports.org/, a tool made by the EQUATOR Network in collaboration with Penelope.ai

BMJ Open

Quality evaluation of community pharmacy Blood Pressure (BP) screening services: an English cross-sectional survey with geospatial analysis.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-032342.R2
Article Type:	Original research
Date Submitted by the Author:	01-Nov-2019
Complete List of Authors:	Barrett, Ravina; University of Brighton, School of Pharmacy and Biomolecular Sciences; University of Portsmouth, Pharmacy Practice, School of Pharmacy and Biomedical Sciences Hodgkinson, James ; University of Birmingham, Primary Care Clinical Sciences, Institute of Applied Health Research
Primary Subject Heading:	General practice / Family practice
Secondary Subject Heading:	Health services research, Public health, Cardiovascular medicine, Evidence based practice, General practice / Family practice
Keywords:	accuracy, blood pressure monitors, community pharmacy services, Hypertension < CARDIOLOGY, spatial analysis, surveys and questionnaires

Quality evaluation of community pharmacy Blood Pressure (BP) screening services: an English cross-sectional survey with geospatial analysis.

Author:

Mrs. Ravina Barrett (https://orcid.org/0000-0003-0004-2131), Author affiliations and corresponding author information:

1. Senior Lecturer in Pharmacy Practice, School Of Pharmacy and Biomolecular Sciences, University of Brighton, Moulsecoomb, Brighton, BN2 4GJ. +44(0) 1273641655, R.Barrett2@Brighton.ac.uk
2. Visiting Researcher in Pharmacy Practice, School Of Pharmacy and Biomedical Sciences, University of Portsmouth, St Michael's Building, White Swan Road, Portsmouth, PO1 2DT. +44(0)239284 3683, ravina.barrett@port.ac.uk

Dr. James Hodgkinson Author affiliations: Institute of Applied Health Research, Murray Learning Centre, University of Birmingham, Edgbaston, Birmingham, B15 2TT. 0121 414 8842, j.a.hodgkinson@bham.ac.uk

Keywords:

accuracy, blood pressure monitors, community pharmacy services, hypertension, spatial analysis, surveys and questionnaires.

Abstract

objectives: The primary objective was to assess the accuracy (calibration and validation status) of digital blood pressure (BP) monitors used within community pharmacy in England and the secondary objectives were to assess the overall quality of the BP service by assessing service prevalence, service utilisation and other in-service considerations.

design: A cross-sectional survey.

setting: primary-care retail-pharmacies.

participants: 500 pharmacies that contribute to government dispensing-data were invited by post to complete the survey. Private contractors were excluded.

interventions: We conducted a questionnaire survey with a follow-up (September to December 2018).

results: 109 responses were received. 61% (n=66) of responding pharmacies provided a free BP check to their patients. 40 (61%) pharmacies used recommended validated clinical meters, 6 (9%) had failed validation, and 20 (30%) provided too little information to enable us to determine their monitor's status.

conclusions:

Responding pharmacies were able to provide useful BP monitoring services to their patients, though quality enhancements need to be implemented. Majority of pharmacies use validated BP monitors, however, there was a lack of range of cuff sizes, variation in replacement and calibration of monitors, and apparent absence of such practice in a minority of pharmacies alongside variation in training standards. We noted higher frequency of BP screening in the most deprived postcodes.

We recommend in-service redesign and delivery improvements, and suggest professional bodies and researchers work together to create clearer frameworks for front-line practitioners, creating appropriate incentives to facilitate this service redesign.

Funders and policy setters should consider the value added to the National Health Service and other healthcare agencies of such screening by pharmacy providers both nationally and internationally. It has the potential to reduce complications of undiagnosed hypertension and the medicines burden that it creates. Future work should examine the impact of pharmacist-led BP screening on patients.

Article Summary

Strengths and limitations of this study

1. We invited pharmacists from 500 pharmacies across England to complete a survey.
2. We mailed our survey with a single follow-up of non-responders (Sept-Dec 2018).
3. Postcodes of pharmacies were linked with freely available data on index of multiple deprivation (IMD) scores, which provides an estimate of the socioeconomic deprivation of the practice population.
4. The interactive application helps to visualize the data easily: https://portuni.maps.arcgis.com/apps/webappviewer/index.html?id=a4ef6e48721649ada4eec362507245f6 or https://arcg.is/1jrevP.

Introduction.

Hypertension (high blood pressure [BP])is the most important modifiable risk factor for cardiovascular, cerebrovascular and renal disease, and avoidable cause of premature morbidity and mortality.[1–6]

The Health Survey for England monitors trends in the nation's health, estimating the proportion of people in England who have specified health conditions, and the prevalence of risk factors and behaviours associated with these conditions.[7] According to the 2016 Survey, 28% of adults had hypertension, 10% had controlled hypertension and 12% had untreated hypertension. Thus, approximately 7.9 million people were suffering from undiagnosed hypertension in 2016, who are at risk of heart attack or stroke, leading to hospital admission and reduced quality-of-life.

Public Health England (PHE) exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. PHE is an operationally autonomous executive agency of the Department of Health.[8] The 2014 PHE figures reveal that diseases caused by high BP are estimated to cost over £2bn annually.[9] £850m of the National Health Service (NHS) and social care spend could be avoided over 10 years by reducing the BP of the nation. If just 15% more people (1.185m people), unaware they have high BP, are diagnosed, £120 million of NHS and social care spend could be avoided over 10 years.[9]

Community pharmacists and their teams make an important contribution to the prevention, detection and management of high BP via routine public health promotion, medicines optimisation services and through a wide range of targeted services and interventions specifically designed to detect, diagnose and manage hypertension as recommended by research, in national guidance from PHE and NHS England.[10–13] Community pharmacy BP monitoring is readily available and recommended by Canadian hypertension guidelines.[14]

The digital BP monitors used within the services need to be of good quality (validated for clinical use[15–18]) and need regular maintenance (calibration) for accurate functioning. This phenomenon has been well studied in physicians' offices,[19–21] but less so in pharmacy settings.[22–24]

With increasing General Practitioner (GP) shortages, pharmacy providers are more valued.[25,26] They often have extended opening hours during evenings and weekends and are frequently located in comfortable and attractive retail spaces accessible within 20 minutes' walk.[27] Thus, they provide a less clinical space, more convenient for people with less access to healthcare.

Current standards for initial education and training on BP monitoring delivered to pharmacy undergraduate students lack sufficient detail to be incorporated into a service specification. The independent pharmacist prescribers course[28] specifies that students are able to use diagnostic aids relevant to the condition for which the pharmacist intends to prescribe.

Consequently, there is no certification or credentialing for providing a high-quality BP service via pharmacy in the UK. As there are no standard specifications integrated into the pharmacy contract, there is possibly quality variability across postcodes. Finally, there is no consensus on how or when referrals are made to medical doctors, though patients would be expected to be signposted to their GP.

This study seeks to understand the challenges faced by under pressure models of care in the Western world (growing patient demand, insufficient funding in primary care, changing patterns of demand, reduced access to GPs and addressing national health inequalities). This study aligns with

the United Nations (UN)'s agenda for Sustainable Development Goals (SDG) 3: to reduce by one third premature mortality from cardiovascular disease by 2030.[29,30]

Objectives.

The primary objective of this study was to assess the accuracy (calibration and validation status) of digital BP monitors used within community pharmacy in England and the secondary objectives were to assess the overall quality of the BP service. Secondary objectives were assessed by ascertaining prevalence of service provision, level of service utilization, quality of service (how the monitor make and model was chosen, length of time in service, care and maintenance including calibration history, visual or physical checks before each use, instructions provided to patients before taking measurements, available cuff sizes, relevant staff training), and estimated number of patients newly detected with hypertension. We also aimed to use this data to examine its association with geospatial location, dispensing data and Index of Multiple Deprivation (IMD) score which provides statistics on relative deprivation in small areas in England.[31]

Methods.

Participants and recruitment.

We invited 500 pharmacies across England to complete a survey about their BP screening service.

Inclusion Criteria: Community pharmacies that contribute to the NHS Business Services Authority (BSA) dispensing data (pharmacy-contractor reimbursement agency). Exclusion Criteria: Community pharmacies that are not NHS contractors, other settings that offer BP monitoring (e.g. hospitals, GP surgeries, walk-in centres).

Addresses were taken from publicly available NHS BSA website (March 2018) to gain a nationally representative sample. We selected the first 500 pharmacies by Contractor Code (FA002 to FAQ67), ensuring they were nationally representative with respect to the number of prescription forms (invited sample mean 3,633, SD 2,053 versus England population mean 3564, SD 2692) and number of prescription items dispensed (invited sample mean 7,366, SD 4,296 versus England population mean 7132, SD 5167). This permitted comparison with like for like businesses (approximately equal burden of work, similar team size and similar business complexity) across the country, therefore allowing fair comparison between pharmacies that provide the service and those that do not.

We mailed the survey with a single follow-up of non-responders from September to December 2018. Respondents were invited to provide self-reported answers. A prepaid self-addressed envelope was provided. The participants could include registered pharmacists or pharmacy support staff working in community pharmacy.

We sought and received favourable institutional ethical approval. No financial (or similar) benefits were offered to minimise biased responses.[32]

Sample size

There are 11,619 community pharmacies in England in 2017-18.[33] Assuming confidence level of 95%, confidence interval of 9.5%, relative standard error of 9.69% a sample size of 106 is calculated. To achieve this, we invited 500 pharmacies as research and previous experience indicates a response range between 15% to 25% in similar studies.[34–39]

Questionnaire.

The questionnaire was composed of items relating to demographics, BP service provision and how it is delivered, blood pressure monitor details, associated training, visual or manual checks performed on monitors and instructions given to patients. The survey is detailed in Appendix A. We had previously iteratively tested the survey in a local pilot study.[34]

We piloted the questionnaire via six steps. Questionnaire validation (pretesting) was achieved by researchers critically appraising the scale in a research-team focus-group. This comprised two external practicing community pharmacists, other academics with recent community and hospital practice experience, and student researchers. This allowed for detection and deletion of ambiguous words, misinterpretation of questions, poor questions, and sensitive questions. Amendments and improvements were made to the format, structure, and content. To improve internal validity and reliability, the survey instrument was piloted with another external community pharmacist, and cognitive testing (read-aloud) was conducted. Further refinement was achieved with a research-team focus-group with contribution from experts at the research design service provided by the National Institute for Health Research. It took less than 10 minutes to complete the final survey.

Data analysis.

Analyses were undertaken using SPSS.[40] The results presented are descriptive, presented as proportions, correlational analysis and independent sample tests. Missing data are presented. For correlation coefficients, it is generally recognized that a reliability estimate needs to be above .70 and a validity estimate needs to be above .60 to be at an acceptable level.[41] All values above 0.6 were examined. We used Levene's test to assess statistical significance. Levene's test is an inferential statistic used to assess the equality of variances for a variable calculated for two groups (service providers versus non-providers). Some common statistical procedures assume that variances of the populations from which different samples are drawn are equal. Levene's test assesses this assumption.

Postcodes of pharmacies were linked with freely available data on IMD score, an estimate of the socioeconomic deprivation of the practice population[31] and NHS dispensing data.

We mapped our results using Arc GIS online and we created an interactive application to visualize the data easily: https://portuni.maps.arcgis.com/apps/webappviewer/index.html?id=a4ef6e48721649ada4eec362507245f6. It is freely and publicly accessible.

We mapped our responses alongside the IMD 2015 data (Ranks: every postcode has a rank from 1 which is the most deprived area up to 32,844 which is the least deprived area. Deciles are published alongside ranks to assess relative deprivation) to assess any relationship between deprivation and screening quality.

Ethics.

Science Faculty Ethics Committee provided a favourable ethical review (Reference Number: SFEC 2018-061, Date Submitted: 31 May 2018).

We used the STROBE cross sectional reporting guidelines.[42]

No Patient and Public Involvement

We did not involve patients or the public in our work. This is likely to be done in the future.

Results.

In total, 109 responses (21.8% response rate) were received, satisfying sample calculation needs. (74 responses on first approach, 35 additional responses on follow-up, six closures and abatements, three spoiled/defaced responses).

Table 1 Response frequency.

Variables	Respondent Frequencies (Percentage) (n=109)	Service providers Frequencies (Percentage) (n=66)	Levene's Test for Equality of Variances at 95%, where Equal variances assumed
Role	(2 missing)	(0 missing)	F=0.706, p=0.403
Pharmacist	90 (84%)	55 (83%)	
Pharmacy technician	7 (7 %)	3 (4.5%)	
Dispensing assistant	7 (7 %)	7 (11%)	
Medicines counter assistant	3 (3 %)	1 (1.5%)	
Gender	(3 missing)	(2 missing)	F=0.203, p=0.653
Male	57 (54 %)	32 (50 %)	
Female	48 (45 %)	32 (50 %)	
Preferred not to say	1 (1 %)		
Years of registration experience	(9 missing)	(7 missing)	F=0.730, p=0.395
0-2	9 (8 %)	5 (8 %)	
3-5	16 (15 %)	9 (15 %)	
6-8	12 (11 %)	8 (14 %)	
9-11	11 (10 %)	8 (14 %)	
12-14	5 (5 %)	1 (2 %)	
15-17	7 (7 %)	7 (12 %)	
18-20	2 (2 %)	1 (2 %)	
> 20 years	38 (36 %)	20 (34 %)	
Employer type	(2 missing)	(1 missing)	F=0.245, p=0.621
National chain pharmacy	51 (48 %)	35 (54 %)	
Independent pharmacy	56 (53 %)	30 (46 %)	
Work contract type	(3 missing)	(1 missing)	F=8.904, p=0.004
Full-Time	90 (85 %)	57 (88 %)	
Part-Time	12 (11 %)	7 (11 %)	
Locum	3 (3 %)	1 (2 %)	
Other	1 (1 %)	0	
Location of community pharmacy	(2 missing)	(1 missing)	F=0.471, p=0.494

Urban	47 (44 %)	32 (49 %)	
Suburban	47 (44 %)	26 (40 %)	
Rural	13 (12 %)	7 (11 %)	
Co-Located within GP practice	(4 missing)	(2 missing)	F=4.766, p=0.031
Yes	20 (19 %)	10 (16 %)	
No	85 (81 %)	54 (84 %)	
Provide a BP monitoring service			
Yes	66 (61 %)		
No	43 (39 %)		

61% (n=66) of responding pharmacies provided a free BP check to their patients.

Characteristics of service providers versus non-service providers on demographics are shown in Table 1.

Service providers employed more full time pharmacists and were less likely to be co-located in GP practices. We found of the 66 service providers, 57 worked full-time.

Table 2 Pharmacist and non-pharmacist respondents stratified by years of registration experience (small numbers may not add up to 100%).

Years of registration experience of service providers	**Pharmacists (n=55)**	**Non pharmacist (n=11)**
0-2	5 (9%)	0
3-5	7 (13%)	2 (18%)
6-8	6 (11%)	2 (18%)
9-11	7 (13%)	1 (9%)
12-14	1 (2%)	0
15-17	7 (13%)	0
18-20	1 (2%)	0
> 20 years	20 (36%)	0
Missing data	0	6 (55%)

Table 2 demonstrates that pharmacists tended to lead the service delivery and tended to be more experienced.

Employees involved in providing the BP check in the pharmacy included the whole team: 55 were pharmacists, 2 pharmacy technicians, 7 dispensing assistants and 1 medicines counter assistant.

Pharmacies had provided the service for varying lengths of time: nine 0-2 years, twelve 3-6 years, eleven 7-9 years, and 24 over 9 years (8 did not know, with 2 missing).

Service Utilization.

All but one respondent provided monitoring solely within the pharmacy. One lent their BP monitor to patients for self-monitoring at home.

We enquired about monthly and annual screening figures because there may be distortions in some months when national or local health promotion campaigns are promoted (e.g. 'Know your Numbers!', NHS Health Check, etc.). In the last month, pharmacies reported providing BP screening as per table 3.

Table 3 Number of patients screened in the last month.

Number of patients screened	Response Frequency
1-5	25 (38%)
6-10	22 (34%)
11-15	8 (12%)
16-20	2 (3%)
20+	8 (12%)
Total	65 (1 missing)

Over the last year, the people screened in each pharmacy ranged from 10 to 2000 (mean 106.3, SD 295.2, 21 missing), with 10 pharmacies serving 100 or more people. Only one respondent said 2000 patients screened, which could be an outlier but this pharmacy is associated with higher business volumes (prescription forms and items dispensed were 5613 and 10144 respectively, IMD decile 10-affluent).

When asked: "What is the number of patients newly detected with high BP (BP > 140/90 mmHg) in the last month?" many could not give a clear answer, but estimates ranged from 0 to 25 with a high-frequency of ones and twos (mean 2.3, SD 4.0, 17 missing).

Calibration, validation, cuff sizes, maintenance intervals.

Overwhelmingly pharmacies (97%; n=61) reported using an automatic BP monitor during BP screening (where cuff inflation, deflation and BP determination are fully performed by the device automatically). Two respondents (3%) said they used a semi-automatic device (BP determination is performed automatically but cuff inflation and/or deflation needs manual operation). None used manual sphygmomanometers (3 missing). All measured BP at the upper arm.

We then explored the rationale behind choosing their particular monitor. Fifty-eight responses were received: 25 (43%) respondents were given their monitor by head office (refers to any central office under the control of the superintendent pharmacist, who takes legal responsibility for all business operations), 16 (28%) used a monitor that was convenient for them (often present in their own store for sale), seven (12%) had done some brand research, five (9%) participants identified their monitor as being "accredited", and five (9%) were influenced by advertisement.

Further to this, 61 respondents provided a monitor's brand, 50 provided a model number and 53 provided a batch number. We used the dabl®Educational Trust [43] and the British and Irish Hypertension Society (BIHS) [44] website to check their validation status.

Forty (61%) pharmacies used recommended validated clinical meters, 6 (9%) monitors had failed validation, and 20 (30%) respondents provided too little information to enable us to determine their monitor's status. One monitor was validated but listed as discontinued by dabl® and archived by BIHS, which makes its continued use questionable.

Regarding available cuff sizes, 50 responses were received, shown in table 4.

Table 4 Available cuff sizes.

Available cuff sizes	Response frequency (n=50)
Small (18-22 Cm)	7 (14%)
Medium (22-32 Cm)	39 (78%)
Large (32-45 Cm)	27 (54%)
Extra-Large (42-50 Cm)	7 (14%)
Other "24 To 40 Cm 9.4-15.7"	1 (2%)
Missing	16 (24%)

Though some branches had several cuff sizes in use, 23 (46%) just had one cuff size.

Regarding length of monitor time in use, 43 valid responses were received. Dates ranged from 14/07/2005 to 01/09/2018, thus covering anywhere from over 13 years to two months. From this, we calculated length of time in service: 10 responders had their monitor in use between 0-1 year, 14 had their monitor in use between 1-2 years, 12 had had their monitor in use between 2-5 years, six had had their monitor in use between 5-10 years, and one had their monitor in use over 10 years.

Respondents replaced their BP monitor at different intervals; one person (2%) said they replaced six monthly, eight (13%) said annually, 26 (41%) said two yearly, 19 (30%) said the meter had not been replaced and nine (14%) said other (3 missing). We also asked if respondents sent their monitor for calibration. Three (5%) sent it back to the manufacturer, 13 (20%) sent it back to head office, and 44 (67%) did not send their monitor for calibration (6 missing). This demonstrates that community pharmacies to some extent replace the monitor rather than get it calibrated relying on monitors warranty status.

Training.

We explored issues around training to gain a better understanding of the level of knowledge, skill and education of respondents regarding the blood pressure monitoring service.

Fifty-nine (92%) respondents said they received some form of training and five (8%) said they did not (2 missing). Of those who received training, 32 (54%) indicated only one form of training, while the others received multiple forms of training. The types of training are shown in table 5.

Table 5 Type of training received.

Type of training	Response frequency
Informal chat with the senior pharmacist	33
Training provided by the monitor manufacturer	6
Read internal company standard operating procedures (SOPs)	41
Read Royal Pharmaceutical Society Guidelines	11
Completed Centre for Pharmacy Postgraduate Education (CPPE) training	13
Other	12

'Other' comments included training from internal and external providers (online and in-person), local clinical commissioning group (CCG) training, British Heart Foundation training events and reading National Institute for Health and Care Excellence (NICE) guidelines. This represents training with great variability, potential inadequacy (only reading material/ online information/ lack of practical experience) and some reliance on interested parties like manufacturers to deliver the training.

We found there was good correlation between BP training and medicine use reviews (MUR) or new medicine services (NMS) (r=0.605 to 0.715), suggesting if pharmacists are trained on BP services, they are likely to have engaged in other professional training like MUR and NMS accreditation which is intended to encourage safe and appropriate use of medicines.[45]

Visual or manual checks of monitor.

Respondents self-reported in-situ checks that were conducted during each consultation. Forty (61%) respondents performed some visual or manual checks to ensure they were achieving accurate results, 26 (39%) did not. These, variously, included a visual check of the integrity of the monitor, checks for properly affixed tubing, working batteries, appropriate and secure cuff positioning of Velcro, correct inflation and deflation without air leaks, and of the display screen (no error codes). General cleanliness and physical damage (e.g. holes) was assessed, in addition to simply checking that the machine was turned on and actually providing BP and pulse readings. Four respondents would check their own (and colleagues') BP to assess whether the monitor was working well.

Instructions to patients/customers.

We also inquired about the instructions provided to patients prior to screening. Sixty-four positive answers were received indicating that most respondents would instruct their patients, with only one respondent saying they would give no instructions (1 missing). Instructions, variously, included to remove restrictive clothing, be seated, relax, have both feet on the ground, legs apart and not crossed, rest their elbow on the table with wrist facing up, and not to talk. Respondents also, variously, inquired if patients needed to empty their bladder or had recently consumed caffeine, smoked, felt stressed, made any blood donations, and asked about past medical history, and drug history including any prescribed BP medication. One respondent said they would go through the consenting process (telling the patient what was involved and what to expect). Some patients were given a customer card with a copy of their readings.

We asked if there were any other considerations respondents would make, and they responded in terms either of assessing the reliability of the BP readings generated, considering the most pragmatic way of conducting the tests, or how best to communicate with patients. Forty-one comments were received. One respondent would consider patient age and weight as part of the assessment. A few suggested the need for multiple readings, that they "might take an average of three readings". Many would consider prescribed medicines currently taken by the patient. Respondents also would explain the reading and give relevant lifestyle and health promotion advice with respect to exercise, diet, smoking and alcohol or other beverages (e.g. coffee, energy drink). One considered if the patient had a pacemaker fitted or potential pregnancy. One respondent would consider if patients had breast or underarm surgery. Respondents would also generally take into consideration the patient's character, stress levels, demeanour, life and work and assess if white coat syndrome was present leading to unreliable readings. One respondent took into account ambient temperature, i.e. heat. Some inquired why the patient is requesting a BP measurement.

We invited any other additional comments. Comments included that one respondent had ordered a large cuff and another was considering replacing or getting their monitor calibrated because of the survey. Some respondents were proactive at measuring BP by facilitating well-being days.

The potential extension to the role of community pharmacy was highlighted by one respondent who commented, *"Clients sometimes use us to record BP on their PMR [pharmacy patient medical records] & then take print out to GP to help record issues. When white coat syndrome, GPs will refer*

to us." This suggests current practice may include referring patients to GP for follow-on care. It also importantly hints at lower rates of white coat syndrome in pharmacy settings than in physician clinics and that GPs actively refer patients for screening in pharmacy settings for this reason.

Deprivation.

Pharmacies in all deciles from most deprived to least deprived responded, with relatively even distribution per decile. Table 6 summarizes our findings stratified by the most deprived deciles (a 1 of 10 subdivision) versus their more affluent counterparts.

Table 6 Respondent IMD decile distribution.

Deciles (1= most deprived, 10= least deprived)	**Number of Respondents**	**BP service providers**	**Service utilization (number of people screened)**	**Validated monitor status**	**Quality of service (Calibration status)**	**Quality of service (purchase date)**
Deprived Deciles 1, 2 and 3.	49 (45%)	33 (67%)	1-5 people screened by 12 respondents. 6-10 people screened by 12 respondents. 11-15 people screened by 5 respondents. 15+ people screened by 3 respondents.	18 (55%)	4 calibrated 0-1 year ago. 2 calibrated 1-2 years ago. 2 calibrated 2-5 years ago. None calibrated 5-10 years ago. 1 calibrated 10+years ago.	4 purchased 0-1year ago. 8 purchased 1-2years ago. 7 purchased 2-5years ago. 2 purchased 5-10years ago. None purchased 10+years ago.
Affluent Deciles 4, 5, 6, 7, 8, 9 and 10.	60 (55%)	33 (55%)	1-5 people screened by 13 respondents. 6-10 people screened by 10 respondents. 11-15 people screened by 3 respondents. 15+ people screened by 7 respondents.	22 (67%)	3 calibrated 0-1year ago. 1-2years ago.: 2 4 calibrated 2-5years ago. 1 calibrated 5-10years ago. None calibrated 10+years ago.	6 purchased 0-1year ago. 6 purchased 1-2years ago. 5 purchased 2-5years ago. 4 purchased 5-10years ago. 1 purchased 10+years ago.
Total	109	66		40		

Table 6 suggests higher frequency of BP screening by community pharmacy providers in the most deprived postcodes, though this is not statistically significant reflecting small sample size. Service utilization was approximately even. Respondents in less deprived areas were slightly more likely to have a validated monitor, though again this is not statistically significant. Calibration rates and length of time in service of monitors show limited relationship to deprivation of surrounding area. Granular decile information is available (see Appendix B).

Provision of the service was linked to lower income rank ($F=4.029$, $p= 0.047$) and lower employment rank ($F=4.651$, $p= 0.033$).

Discussion.

Summary.

Hypertension-related appointments make up almost one in 10 of all GP consultations each year.[46] With the workload of GPs thought to be nearing saturation point,[47] alternative models of hypertension management such as pharmacist-led care have the potential to alleviate this increasing burden on primary healthcare systems. Evidence from systematic reviews shows that such

interventions can significantly reduce blood pressure compared with usual GP care.[25,48] To explore the potential of implementing extended pharmacist roles in the management of hypertension in community settings, it is essential to describe current practice.

We found between 1 to 10 people were routinely screened monthly by each pharmacy. Annually, respondents said they screened between 10 to 2000 people (where 2000 could be an outlier). These figures seem credible as they give annualized average figures of at least 10 to 12 people screened by each service provider (the higher annual figures may reflect pharmacies participating in national campaigns such as 'Know Your Numbers' [http://www.bloodpressureuk.org/HealthProfessionals/KnowyourNumbersWeek] at other points in the year). This rate of screening conservatively detected 1 to 2 undiagnosed hypertensive patients monthly per service provider. If these estimates are scaled-up for England and annualized across the 11,619 pharmacies in England, assuming a 60% service provision rate, it would represent detection of an additional 83,657 to 167,314 undiagnosed hypertensives, identifying 2% of the total undiagnosed hypertensive English population. In seven years, in its current state, the service could help diagnose 1.185 million people saving the NHS £120 million.[9]

Most monitors were automatic digital monitors, selected by head office or as a convenient model, but price and product guarantees may also play an influential role in monitor selection, rather than validation status. Lack of a range of cuff sizes per provider appears a major issue, as only 59% (39/66) stocked a medium cuff and 41% (27/66) a large cuff, with only a minority reporting they stocked multiple cuff sizes.

Many monitors were old which may risk inaccuracy. Fifty-six percent of service providers replaced the monitors at least every two years, but only 14% (9/63) every year or more frequently, and 30% did not replace at all. This may be because often calibration is guaranteed for up to two years from the date of purchase by manufacturers. However, previous studies recommend at least annual calibration with evidence suggesting declining performance after 18 months.[22].

Calibration of devices was reported by 27% of service providers. Overall, this means 23% (15/66) of service providers neither replaced nor calibrated their devices.

Whilst 92% of service providers received some training of variable quality, 8% reported not receiving any. While this is poor, it provides a benchmark for future training-quality enhancements.

Strengths and limitations.

This study provides needed evidence on the quality of BP screening from community pharmacy. There are several novelties to our study. We have for the first time reported on prevalence of service provision (61%), level of service utilization, and validation and calibration status within community pharmacy practice in England. This is the most comprehensive service evaluation on BP monitoring service provision in pharmacies in the UK.

Though we have structured this study robustly, there is a risk of bias. Key limitations of our study are small sample size and low response rate. It is possible that our results may be biased towards more provision than is actually available, if pharmacies providing the service were more likely to respond. However, we did specify we were interested in hearing from non-service providers, and respondents in such pharmacies would have needed much less time to complete the survey.

Some missing information may make the findings unreliable. This is a potential limitation of our study and in the future, we may seek ethical permission to telephone pharmacies to confirm missing information. For some respondents, there is discrepancy between monthly and annual screening

numbers, which is a potential limitation of this study and could reflect erratic answers, but it highlights the need for more research beyond a survey methodology.

We acknowledge that respondents often represent multiple chain pharmacies that have uniform SOPs in branches across the country. Theoretically, this could bias our results. However, SOPs are interpreted, adapted and implemented differently within each branch and so our research provides a more authentic representation of practice.

Potential bias was assessed by examining the total number of prescription forms and items dispensed across England (table 7). Respondents tended to be from slightly busier pharmacies than nonrespondents, though by a small margin, making our findings relevant.

Table 7 Respondent bias assessment based on dispensing volumes.

NHS Dispensing Monthly (Mar 2018) Statistics		**Number of Prescription Forms (nominal)**	**Number of Prescription Items (nominal)**
Mean	(England) Population	3564 (3564±0)	7132 (7132±0)
	Invited	3,633 (3564+69)	7,366 (7132+234)
	Respondent	3693 (3564+129)	7444 (7132+312)
	Non-Respondent (excluding closures and abatements)	3,666 (3564+102)	7,444 (7132+312)
Standard deviation	(England) Population	2692 (2692±0)	5167 (5167±0)
	Invited	2053 (2692-639)	4296 (5167-871)
	Respondent	2154 (2692-538)	4569 (5167-598)
	Non-Respondent (excluding closures and abatements)	1999 (2692-693)	4171 (5167-996)

Our pharmacies were typical of those nationwide, including in terms of deprivation of surrounding catchment area. There was a good spread in terms of typology of pharmacy and location (geographically; urban, suburban, rural). Therefore, our results are robust, credible and generalizable.

Comparison with existing literature.Pharmacists can provide BP screening service at much reduced cost to the NHS compared to GP services.[49] Pharmacists are generally available without appointment, open for extended hours during unsociable hours and have been shown to provide greater care in areas of highest deprivation.[27] Our mapping provides tentative support for this positive care law.

There may be a lower incidence of white coat syndrome in community pharmacy,[50] and we found evidence of GPs using pharmacies to screen for white coat hypertension. The potential role of pharmacies in hypertension management through BP testing (checking for white coat syndrome,

monitoring the effectiveness of medication) is there, in addition to screening for new hypertension cases. Lower rates of white coat syndrome in these settings is supported in the Palmera study.[50]

Implications for clinical practice.

Significant quality enhancements need to be implemented. It is important to consider the patient population this study may impact most. The 'hard to reach' groups of patients are typically less affluent and are also less likely to see their GP (or not have a GP), and have poor health literacy. There may be a greater likelihood of identifying new previously undetected cases of hypertension in this group of the population. Community pharmacies are easily accessible and located in all areas, and have been shown to provide greater care in areas of highest deprivation which may be more conducive for the 'hard to reach' patient groups and could assist in reducing health inequalities nationally. Focusing attention on these people at the right time can avoid hospital costs and allow the patient to remain within the community.

Pharmacies deliver a valuable service of providing free BP checks to those who feel they cannot afford to buy monitors. In affluent areas, it may be that more people are self-monitoring with their own-bought home-monitors, and there is simply less demand on pharmacies.

Collectively, this provides a social and health economic argument for pharmacists to be involved in routine, NHS-commissioned, hypertension screening for the general population with needed quality enhancements.

Our recommendations.

Based on these results, we recommend in-service redesign and delivery improvements, and suggest professional bodies and researchers work together to create clearer frameworks for front-line practitioners, creating appropriate incentives to facilitate this service redesign.

Specifically we recommend that pharmacies providing this service: 1. Utilise validated BP monitors, calibrated at one-yearly intervals; 2. Maintain audited records incorporating monitor details, service history and use frequency; 3. Stock at least 3 cuff sizes; 4. Train service staff to quality standards both in a theoretical and competency-based framework, which is accredited.

Further research needs to be conducted to demonstrate the sufficiency of these measures, which once achieved, could be a nationally commissioned service. Ongoing analysis of this work needs to consider local area deprivation status with priority given to these service providers.

Conclusion.

The majority of pharmacies use validated BP monitors. In general, responding pharmacies were able to provide useful BP monitoring services to their patients, though quality enhancements need to be implemented. There was a lack of range of cuff sizes, variation in recruitment and calibration of monitors, and apparent absence of any replacement or calibration in a minority of pharmacies, variation in training standards. Community pharmacists could play a leading role in BP screening in England.

Funders and policy setters should consider the value added to the NHS and other healthcare agencies of such screening by pharmacy providers both nationally and internationally. It has the potential to reduce complications of undiagnosed hypertension and the medicines burden that it creates.

Future research needs.

A larger study is required to validate our findings. Future work should examine the impact of pharmacist-led BP screening on patients. At the very least, we need to study the patient population, their needs in their local context, and which areas or groups represent most undiagnosed people. We encourage the international research community to use our survey to report their findings.

Acknowledgments.

Thank you to the 109 retail pharmacy respondent-employees who took the time to provide honest opinions, Carla Orszulik and Sophie Doughty for helping with study administration and data collection, Michelle Sumner for providing excellent technical help to allow data capture and processing, and Martin Schaefer for his help with ArcGIS publisher requests.

Disclaimer: The views expressed in this publication are those of the authors and not those of the University of Portsmouth, University of Brighton, University of Birmingham nor the NHS.

Competing interests: None.

Patient consent: Not required.

Ethics approval: University of Portsmouth, Science Faculty Ethics Committee provided a favourable ethical review (Reference Number: SFEC 2018-061, Date Submitted: 31 May 2018).

Data statement: No additional data available.

A funding statement: This study was funded by the University of Portsmouth.

Author contributions:

RB led on the literature search, conduct, data acquisition and statistical analysis. RB and JH were involved in study conception and design, data analysis and interpretation of data, manuscript preparation, editing and revision and agreed upon the final version of the paper.

References.

1 Rothwell PM, Howard SC, Dolan E, *et al.* Prognostic significance of visit-to-visit variability, maximum systolic blood pressure, and episodic hypertension. *Lancet Lond Engl* 2010;**375**:895–905. doi:10.1016/S0140-6736(10)60308-X

2 Webb AJS, Fischer U, Mehta Z, *et al.* Effects of antihypertensive-drug class on interindividual variation in blood pressure and risk of stroke: a systematic review and meta-analysis. *Lancet Lond Engl* 2010;**375**:906–15. doi:10.1016/S0140-6736(10)60235-8

3 Clement DL, De Buyzere ML, De Bacquer DA, *et al.* Prognostic value of ambulatory blood-pressure recordings in patients with treated hypertension. *N Engl J Med* 2003;**348**:2407–15. doi:10.1056/NEJMoa022273

4 Verdecchia P, Porcellati C, Schillaci G, *et al.* Ambulatory blood pressure. An independent predictor of prognosis in essential hypertension. *Hypertension* 1994;**24**:793–801. doi:10.1161/01.HYP.24.6.793

5 Hansen TW, Jeppesen J, Rasmussen S, *et al.* Ambulatory blood pressure and mortality: a population-based study. *Hypertens Dallas Tex 1979* 2005;**45**:499–504. doi:10.1161/01.HYP.0000160402.39597.3b

6 Chobanian AV, Bakris GL, Black HR, *et al.* The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. *JAMA* 2003;**289**:2560–72. doi:10.1001/jama.289.19.2560

7 NHS Digital. Health Survey for England, 2016. NHS Digit. https://digital.nhs.uk/data-and-information/publications/statistical/health-survey-for-england/health-survey-for-england-2016 (accessed 20 Aug 2019).

8 Public Health England. About us. GOV.UK. https://www.gov.uk/government/organisations/public-health-england/about (accessed 20 Aug 2019).

9 New figures show high blood pressure costs NHS billions each year. https://www.gov.uk/government/news/new-figures-show-high-blood-pressure-costs-nhs-billions-each-year (accessed 29 Jan 2018).

10 High blood pressure: plan and deliver effective services and treatment. GOV.UK. https://www.gov.uk/guidance/high-blood-pressure-plan-and-deliver-effective-services-and-treatment (accessed 21 Jan 2019).

11 Tsuyuki RT, Houle SKD, Charrois TL, *et al.* Randomized Trial of the Effect of Pharmacist Prescribing on Improving Blood Pressure in the Community: The Alberta Clinical Trial in Optimizing Hypertension (RxACTION). *Circulation* 2015;**132**:93–100. doi:10.1161/CIRCULATIONAHA.115.015464

12 Okada H, Onda M, Shoji M, *et al.* Effects of lifestyle advice provided by pharmacists on blood pressure: The COMmunity Pharmacists ASSist for Blood Pressure (COMPASS-BP) randomized trial. *Biosci Trends* 2018;**11**:632–9. doi:10.5582/bst.2017.01256

13 Pharmacy voice. Tackling high blood pressure through community pharmacy. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/693902/PV_Blood_Pressure_Report.pdf

14 Lamb SA, Al Hamarneh YN, Houle SKD, *et al.* Hypertension Canada's 2017 guidelines for diagnosis, risk assessment, prevention and treatment of hypertension in adults for pharmacists: An update. *Can Pharm J CPJ Rev Pharm Can RPC* 2018;**151**:33–42. doi:10.1177/1715163517743525

15 Eoin O'Brien, James Petrie, William Littler, Michael de Swiet, Paul L. Padfield, Douglas G. Altman, Martin Bland, Andrew Coats, Neil Atkins. The British Hypertension Society protocol for the evaluation of blood pressure measuring devices. *J Hypertens* 1993;**11**:S43–62.

16 Stergiou GS, Asmar R, Myers M, *et al.* Improving the accuracy of blood pressure measurement: the influence of the European Society of Hypertension International Protocol (ESH-IP) for the validation of blood pressure measuring devices and future perspectives. *J Hypertens* 2018;**36**:479–87. doi:10.1097/HJH.0000000000001635

17 O'Brien E, Atkins N, Stergiou G, *et al.* European Society of Hypertension International Protocol revision 2010 for the validation of blood pressure measuring devices in adults. *Blood Press Monit* 2010;**15**:23–38. doi:10.1097/MBP.0b013e3283360e98

18 Stergiou GS, Alpert BS, Mieke S, *et al.* Validation protocols for blood pressure measuring devices in the 21st century. *J Clin Hypertens Greenwich Conn* 2018;**20**:1096–9. doi:10.1111/jch.13294

19 Clark CE, Horvath IA, Taylor RS, *et al.* Doctors record higher blood pressures than nurses: systematic review and meta-analysis. *Br J Gen Pract* 2014;**64**:e223–32. doi:10.3399/bjgp14X677851

20 Little P, Barnett J, Barnsley L, *et al.* Comparison of agreement between different measures of blood pressure in primary care and daytime ambulatory blood pressure. *BMJ* 2002;**325**:254.

21 A'Court C, Stevens R, Sanders S, *et al.* Type and accuracy of sphygmomanometers in primary care: a cross-sectional observational study. *Br J Gen Pract J R Coll Gen Pract* 2011;**61**:e598-603. doi:10.3399/bjgp11X593884

22 Hodgkinson J, Koshiaris C, Martin U, *et al.* Accuracy of monitors used for blood pressure checks in English retail pharmacies: a cross-sectional observational study. *Br J Gen Pract* 2016;**66**:e309–14. doi:10.3399/bjgp16X684769

23 Pappaccogli M, Enri LR, Perlo E, *et al.* Assessment of a non-physician screening program for hypertension and cardiovascular risk in community pharmacies. *Nutr Metab Cardiovasc Dis NMCD* Published Online First: 19 July 2019. doi:10.1016/j.numecd.2019.07.009

24 Fleming S, Atherton H, McCartney D, *et al.* Self-Screening and Non-Physician Screening for Hypertension in Communities: A Systematic Review. *Am J Hypertens* 2015;**28**:1316–24. doi:10.1093/ajh/hpv029

25 Cheema E, Sutcliffe P, Singer DRJ. The impact of interventions by pharmacists in community pharmacies on control of hypertension: a systematic review and meta-analysis of randomized controlled trials: The impact of interventions by pharmacists in community pharmacies on control of hypertension. *Br J Clin Pharmacol* 2014;**78**:1238–47. doi:10.1111/bcp.12452

26 Ryan K, Patel N, Lau WM, *et al.* Pharmacists in general practice: a qualitative interview case study of stakeholders' experiences in a West London GP federation. *BMC Health Serv Res* 2018;**18**:234. doi:10.1186/s12913-018-3056-3

27 Adam Todd, Alison Copeland, Andy Husband, Adetayo Kasim, Clare Bambra. The positive pharmacy care law: an area-level analysis of the relationship between community pharmacy distribution, urbanity and social deprivation in England. *BMJ Open 2014* 2014;**4**.http://bmjopen.bmj.com/content/4/8/e005764.short (accessed 19 Jan 2015).

28 General Pharmaceutical Counsel. Pharmacist independent prescribing-learning outcomes and indicative content.

29 United Nations Statistics Division. SDG Indicators - Global indicator framework for the Sustainable Development Goals and targets of the 2030 Agenda for Sustainable Development. https://unstats.un.org/sdgs/indicators/indicators-list/ (accessed 5 Dec 2018).

30 United Nations Publications. *Sustainable Development Goals Report 2018.* S.l.: : United Nations Pubns 2018.

31 Ministry of Housing, Communities & Local Government. English indices of deprivation 2015. Natl. Stat. 2015.https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015 (accessed 4 Mar 2019).

32 Cook JV, Dickinson HO, Eccles MP. Response rates in postal surveys of healthcare professionals between 1996 and 2005: an observational study. *BMC Health Serv Res* 2009;**9**:160. doi:10.1186/1472-6963-9-160

33 UK Statistic. Community pharmacies in England 2006-2018. Statista. https://www.statista.com/statistics/418071/community-pharmacies-in-england/ (accessed 11 Dec 2018).

34 Barrett R. Blood pressure monitor validation, calibration, and community pharmacy practice: a pilot cross-sectional survey in Hampshire, UK. *Blood Press Monit* 2018;**23**:281–2. doi:10.1097/MBP.0000000000000335

35 Barrett R, Costa D. An evaluation of community pharmacist perception the misuse and abuse of over-the-counter Co-codamol in Cornwall and Devon, UK: a cross-sectional survey. *Heroin Addict Relat Clin Probl* 2018;**Published Ahead of Print**.

36 Barrett R, Al-Mousawi HA. Development and initial validation of a postal survey evaluation of community pharmacists' opinion regarding falsified (counterfeit) medicines in Hampshire (UK). *J Pharm Pharmacogn Res* 2018;**6**:242–249.

37 Mavis BE, Brocato JJ. Postal surveys versus electronic mail surveys. The tortoise and the hare revisited. *Eval Health Prof* 1998;**21**:395–408. doi:10.1177/016327879802100306

38 Nota SPFT, Strooker JA, Ring D. Differences in response rates between mail, e-mail, and telephone follow-up in hand surgery research. *Hand N Y N* 2014;**9**:504–10. doi:10.1007/s11552-014-9618-x

39 Raziano DB, Jayadevappa R, Valenzula D, *et al.* E-mail Versus Conventional Postal Mail Survey of Geriatric Chiefs. *The Gerontologist* 2001;**41**:799–804. doi:10.1093/geront/41.6.799

40 IBM Corp. *IBM SPSS Statistics for Windows*. Armonk, NY: 2014.

41 Odom, Leslie R., Morrow, James R., Jr. What's This "r"? A Correlational Approach to Explaining Validity, Reliability and Objectivity Coefficients. *Meas Phys Educ Exerc Sci* 2006;**10**:137–45.

42 von Elm E, Altman DG, Egger M, *et al.* The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: Guidelines for reporting observational studies. *Int J Surg* 2014;**12**:1495–9. doi:10.1016/j.ijsu.2014.07.013

43 dabl®Educational Trust Ltd. Sphygmomanometers for Clinical Use. http://www.dableducational.org/sphygmomanometers/devices_1_clinical.html

44 British and Irish Hypertension Society. Validated BP Monitors for For Specialist Use.

45 NHSBSA. Medicines use review (MUR) / new medicine services (NMS) quarterly submission. https://www.nhsbsa.nhs.uk/pharmacies-gp-practices-and-appliance-contractors/dispensing-contractors-information/medicines-use (accessed 11 Sep 2019).

46 Public Health England. Tackling high blood pressure From evidence into action. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/527916/Tackling_high_blood_pressure.pdf

47 Hobbs FDR, Bankhead C, Mukhtar T, *et al.* Clinical workload in UK primary care: a retrospective analysis of 100 million consultations in England, 2007–14. *The Lancet* 2016;**387**:2323–30. doi:10.1016/S0140-6736(16)00620-6

48 Albasri A, Prinjha S, McManus RJ, *et al.* Hypertension referrals from community pharmacy to general practice: multivariate logistic regression analysis of 131 419 patients. *Br J Gen Pract* 2018;**68**:e541–50. doi:10.3399/bjgp18X697925

49 Dalton K, Byrne S. Role of the pharmacist in reducing healthcare costs: current insights. *Integr Pharm Res Pract* 2017;**6**:37–46. doi:10.2147/IPRP.S108047

50 Sendra-Lillo J, Sabater-Hernández D, Sendra-Ortolá A, *et al.* Comparison of the white-coat effect in community pharmacy versus the physician's office: the Palmera study. *Blood Press Monit* 2011;**16**:62–6. doi:10.1097/MBP.0b013e328344c755

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

«AddressBlock»

Title: Accuracy of BP monitors in community pharmacy screening services: a cross-sectional survey, UK

Dear Pharmacist or pharmacy support staff,

Thank you for reading this. The School of Pharmacy at the University of Portsmouth would like to invite you to take part in a study looking to determine community pharmacies' role in blood pressure (BP) monitoring across the UK. You have been identified as a potential participant in this study as you work in a community pharmacy in the United Kingdom.

This survey is intended to be completed by the pharmacist or member of pharmacy staff. We are interested in the opinions of responders who provide free BP monitoring service for the public as well as those who do not. Your participation in this study is greatly appreciated. It is entirely up to you if you want to take part, but there is limited knowledge on this subject and we would be grateful for your contribution. This work is undertaken as part of an MPharm final year student project, and will provide an educational experience in addition to useful data.

The study involves completing the survey questionnaire. You can choose to remain anonymous and not provide any identifiable personal information in this study. As your opinion is valued, at the end of this survey we will ask you if you would like to take part in any future research we conduct. If you say 'yes', we will invite you to give us your name and address so that we can contact you in the future. You do not have to provide this information if you don't want to. Any identifiable information you give us will be stored securely and will not be shared beyond the research team. All reasonable steps will be taken to ensure confidentiality. It should take you approximately 10 minutes to complete the survey.

Responses received will be collated for analysis and the original questionnaires will be archived as per the University data management policy. If you want to know more about this work or the results of this study, you can contact the lead researcher (Mrs Ravina Barrett) using the details at the end of the questionnaire. If you are happy taking part, please read the following instructions.

Instructions: *Please complete this questionnaire by placing a tick ☑ in the most appropriate box unless stated otherwise, and where spaces or boxes are provided please fill in with your comments and justifications. The responses you provide will remain anonymous therefore please answer honestly.*

Demographics

1 What is your role?

Pharmacist	Pharmacy technician	Dispensing assistant or pharmacy assistant	Medicines counter assistant
☐	☐	☐	☐

2 What is your gender?

Male	Female	Prefer not to say
☐	☐	☐

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

3 How many years have you been registered as a pharmacist or technician in the UK?

0-2	3-5	6-8	9-11	12-14	15-17	18-20	> 20
☐	☐	☐	☐	☐	☐	☐	☐

4 Do you work ...?

Full time	Part-time	Locum	Other
☐	☐	☐	☐

5 What is the type of community pharmacy do you work in?

Independent	Multiple
☐	☐

6 What is the location of your community pharmacy?

Urban	Suburban	Rural
☐	☐	☐

7 Are you co-located within a GP practice?

Yes	No
☐	☐

8 Do you provide a blood pressure monitoring service at your pharmacy?

Yes	No
☐	☐

If 'no', please stop filling in the form and return it in the SAE provided.

9 Do you loan out your BP monitor to patients for self-monitoring at home?

Yes	No
☐	☐

10 Who does the BP check in your pharmacy?

Pharmacist	Pharmacy technician	Dispensing assistant or pharmacy assistant	Medicines counter assistant
☐	☐	☐	☐

11 Where on the body do you measure blood pressure?

Upper arm	Wrist	Finger	Other
☐	☐	☐	☐

12 How long has the pharmacy provided the digital blood pressure monitoring service?

0-2 years	3-6 years	7-9 years	> 9 years	don't know
☐	☐	☐	☐	☐

13 How many members of the public have been provided the service in the last month?

1-5	6-10	11-15	16-20	20+
☐	☐	☐	☐	☐

14 How many members of the public have been provided the service in the last year?

15 What is the number of patients newly detected with high blood pressure (BP> 140/90 mmHg) in the last month?

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

Blood pressure monitor details

16 What kind of blood pressure monitor do you use for BP screening?

Automatic (Cuff inflation, deflation and blood pressure determination are fully performed by the device automatically)	Semiautomatic (Blood pressure determination is performed automatically but cuff inflation and/or deflation needs manual operation)	Manual (Blood pressure determination is performed manually irrespective of inflation or deflation control)	Other (please tell us more)
☐	☐	☐	☐

17 How did you decide which blood pressure monitor to use?

18 What is your monitor 's brand?

19 What is your monitor 's model number?

20 What is your monitor 's batch/ serial number?

21 What available cuff sizes do you keep?

18-22 cm 7.1-8.7" Small ☐ 22-32 cm 8.8-12.8" Medium ☐ 32-45 cm 12.8-18" Large ☐ 'Extra-large' ☐ Other ☐

22 Date of purchase or date of first use (whichever reflects when you started using this monitor)?

Day	Month	Year

23 Which monitor do you think provides a more accurate blood pressure reading?

Manual ☐ Digital ☐

24 Why do you think that?

25 Do you replace the blood pressure monitor you use for tests at a fixed interval?

Six months ☐ One year ☐ Two years ☐ Other ☐ Not been replaced ☐

26 Do you send your monitor for calibration (to have its accuracy checked)?

Yes, back to manufacturer ☐ Yes, back to head office ☐ No (please go to Q28) ☐

27 At what intervals do you send the monitor for calibration?

Six monthly ☐ Annually ☐ Every two years ☐ Other ☐

28 When was the last time your blood pressure monitor was calibrated (Day, Month, and Year)?

Day	Month	Year

University of Portsmouth, School of Pharmacy and Biomedical Sciences.

Training

29 Is training provided for the professional who delivers the blood pressure monitoring service?

Yes ☐ No ☐

30 What kind of training? (tick all that apply)

Informal chat with senior pharmacist	Training provided by manufacturer	Read standard operating procedures	Read royal pharmaceutical society guidelines	CPPE training	Other
☐	☐	☐	☐	☐	☐

31 Please explain if you said 'other', or have additional comments to make.

Visual or manual checks of monitor

32 Do you perform any visual or manual checks on your digital blood pressure monitor to ensure accurate results?

Yes ☐ No ☐

What checks do you perform? (Please skip this if you answered 'no' above)

33

Before taking a patient's blood pressure, what instructions do you provide to your patients?

34

35 Is there any other considerations you make?

36 Would you like to make any other additional comments?

END OF SURVEY. Thank you for completing this survey.

If you have a concern about this research study, please contact: Mrs Ravina Barrett, Phone: 44 (0) 2392843683, Email: ravina.barrett@port.ac.uk

Appendix B Stratification by decile.

Deciles (1= most deprived, 10= least deprived)	Number of Respondents	BP service providers	Service utilization /66 (number of people screened)	Validated monitor status /66	Quality of service /66 (Calibration status)	Quality of service /66 (purchase date)
Decile 1	15	10	1-5people screened by 4 respondents. 6-10 people screened by 5 respondents. 11-15 people screened by 1 respondent. 15+ people screened by 0 respondents.	6	0-1year: 0 1-2years: 1 2-5years: 1 5-10years: 0 10+years: 1	0-1 year: 1 1-2 years: 3 2-5 years: 3 5-10 years: 1 10+ years: 0
Decile 2	15	11	1-5 people screened by 3 respondents. 6-10 people screened by 3 respondents. 11-15 people screened by 2 respondents. 15+ people screened by 2 respondents.	6	0-1year: 1 1-2years:0 2-5years:1 5-10years:0 10+years:0	0-1 year: 2 1-2 years:3 2-5 years:1 5-10 years:1 10+ years:0
Decile 3	19	12	1-5 people screened by 5 respondents. 6-10 people screened by 4 respondents. 11-15 people screened by 2 respondents. 15+ people screened by 1 respondent.	6	0-1year:3 1-2years:1 2-5years:0 5-10years:0 10+year2:0	0-1 year:1 1-2 years:2 2-5 years:3 5-10 years:0 10+ years:0
Decile 4	5	3	1-5 people screened by 1 respondent. 6-10 people screened by 1 respondent. 11-15 people screened by 0 respondents. 15+ people screened by 1 respondent.	2	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:0 1-2 years:1 2-5 years:2 5-10 years:0 10+ years:0
Decile 5	16	6	1-5 people screened by 3 respondents. 6-10 people screened by 1 respondent.	4	0-1year:1 1-2years:0 2-5years:1 5-10years:0 10+years:0	0-1 year:2 1-2 years:0 2-5 years:0 5-10 years:1 10+ years:1

			11-15 people screened by 1 respondent. 15+ people screened by 1 respondent.			
Decile 6	9	5	1-5 people screened by 2 respondents. 6-10 people screened by 1 respondent. 11-15 people screened by 1 respondent. 15+ people screened by 1 respondent.	3	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:2 2-5 years:0 5-10 years:0 10+ years:0
Decile 7	8	6	1-5 people screened by 3 respondents. 6-10 people screened by 3 respondents. 11-15 people screened by 0 respondents. 15+ people screened by 0 respondents.	5	0-1year:1 1-2years:0 2-5years:2 5-10years:0 10+years:0	0-1 year:0 1-2 years:1 2-5 years:3 5-10 years:1 10+ years:0
Decile 8	8	3	1-5 people screened by 1 respondent. 6-10 people screened by 1 respondent. 11-15 people screened by 1 respondent. 15+ people screened by 1 respondent.	0	0-1year:0 1-2years:0 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:0 2-5 years:0 5-10 years:0 10+ years:0
Decile 9	7	4	1-5 people screened by 1 respondent. 6-10 people screened by 2 respondents. 11-15 people screened by 0 respondents. 15+ people screened by 1 respondent.	3	0-1year:0 1-2years:1 2-5years:0 5-10years:0 10+years:0	0-1 year:1 1-2 years:1 2-5 years:0 5-10 years:1 10+ years:0
Decile 10	7	6	1-5 people screened by 2 respondents. 6-10 people screened by 1 respondent. 11-15 people screened by 0 respondents.	5	0-1year:1 1-2years:1 2-5years:1 5-10years:1 10+years:0	0-1 year:1 1-2 years:1 2-5 years:0 5-10 years:1 10+ years:0

			15+ people screened by 3 respondents.			
Total	109	66		40		

Table 1 Data stratified by decile.

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary	2

		of what was done and what was found	
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	4-5
Objectives	#3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	#4	Present key elements of study design early in the paper	5
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	5
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5
Bias	#9	Describe any efforts to address potential sources of bias	5
Study size	#10	Explain how the study size was arrived at	5

Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	6
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	6
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	6
Statistical methods	#12c	Explain how missing data were addressed	6
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	6
Statistical methods	#12e	Describe any sensitivity analyses	n/a
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	6-12
Participants	#13b	Give reasons for non-participation at each stage	n/a
Participants	#13c	Consider use of a flow diagram	n/a
Descriptive data	#14a	Give characteristics of study participants (eg demographic,	7

		clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	6-12
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	6-12
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	6-12
Main results	#16b	Report category boundaries when continuous variables were categorized	6-12
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	6-12
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	6-12
Discussion			
Key results	#18	Summarise key results with reference to study objectives	12-13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	13

Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	13
Generalisability	#21	Discuss the generalisability (external validity) of the study results	13

Other Information

Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16