User Attitudes and Technological Adoption in Hypertension Self-Monitoring

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Hypertension is a major cardiovascular risk factor worldwide, and self-monitoring blood pressure (SMBP) is critical for its management. However, inconsistent SMBP practices persist due to unclear guidelines and suboptimal technology adoption. This research explores hypertensive patients' attitudes towards SMBP, their experiences with blood pressure (BP) technologies, and the acceptability of emerging options including cuffless devices and conceptual digital support features. We adopted a mixed-methods approach, with a survey (n=61) and five exploratory participatory design sessions. Our findings show that while patients value SMBP, traditional BP monitors can be burdensome and anxiety-inducing, while cuffless technologies offer greater potential for seamless integration into daily life. Users expressed a need for less intrusive monitoring and tailored advice, and we contribute three exploratory attitudinal profiles characterising different approaches to SMBP to inform future design. Synthesising both studies, we characterise SMBP as a boundary case for personal informatics design in which individual readings rarely afford immediate action, so supporting interpretation, reassurance, and emotionally sustainable engagement matters as much as supporting measurement itself.

CCS CONCEPTS: Human-centered computing → Human computer interaction (HCI) → Empirical studies in HCI

Additional Keywords and Phrases: Hypertension, self-monitoring blood pressure, cuffless devices, human-centred design, technology acceptance.

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1 INTRODUCTION

Hypertension, or high blood pressure, is one of the most prevalent long-term conditions and a leading cardiovascular risk factor, contributing to over half of heart attacks and strokes worldwide [94]. Despite being both preventable and treatable, blood pressure (BP) remains poorly controlled, constituting a major public health concern [40, 94]. Because hypertension is typically asymptomatic and requires lifelong management, effective BP management depends on ongoing monitoring outside clinical settings [88]. Self-monitoring of BP (SMBP) is therefore widely recommended in national and international guidelines as a cornerstone of hypertension care [87, 88].

Yet, despite its clinical importance, sustained engagement with SMBP remains difficult. Around half of people diagnosed with hypertension do not monitor their BP regularly [75], highlighting the need to optimise SMBP practices to support patient engagement and adherence, improving BP outcomes. Prior research suggests that even when devices are available, many patients struggle to incorporate monitoring into daily routines, showing that availability of equipment does not guarantee meaningful or sustained use. A 2026 study by Unlu et al. [80] found that even when patients were provided with free devices and

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personalised support, over 32% did not record BP at all, and nearly half failed to meet minimum monitoring thresholds. This highlights a critical disconnect between clinical guidelines and the practical, everyday realities of patient life. Patients describe practical burdens, uncertainty about interpretation, and emotional reactions to readings, all of which shape whether and how monitoring occurs [58].

While SMBP shares similarities with episodic monitoring of Type 2 Diabetes (T2D), it presents an important distinction for Human-Computer Interaction (HCI) research. Research has examined the sense-making, emotional, and routine-integration challenges associated with diabetes self-monitoring [28, 49, 50, 66]. However, the extent to which these findings transfer to SMBP remains underexplored. Unlike T2D, where monitoring is often linked to immediate behavioural responses (e.g., insulin dosing or carbohydrate intake), BP readings frequently provide limited guidance for immediate action and instead require interpretation in the context of long-term cardiovascular risk [58]. As a result, the design challenge extends beyond supporting measurement and interpretation to also supporting reassurance, confidence, and sustained engagement over time.

At the same time, recent technological advancements such as cuffless BP monitoring devices offer the opportunity to make self-monitoring more seamless and better integrated into daily life [33, 84]. They are less intrusive, can provide continuous or frequent BP readings with minimal user effort and are often paired with mobile health applications. When augmented with Artificial Intelligence (AI), such applications can deliver personalised feedback based on BP data and user-specific characteristics, as well as novel metrics, such as predictive BP trends or treatment success probabilities [6, 15, 77, 83]. These developments have the potential to improve people's understanding of their condition, support informed decision-making and address adherence problems. However, their effectiveness depends critically on sustained user engagement and users' ability to interpret and act upon the information provided.

Work in adjacent domains shows that self-tracking can heighten anxiety, provoke rumination, or create new responsibilities without necessarily improving outcomes [21, 22]. Such technologies are typically premised on the idea that capturing more data supports reflection and, in turn, better-informed action. SMBP complicates this premise, as an individual reading rarely indicates what, if anything, a patient should do, which is a tension we return to in the Discussion. Perhaps for this reason, evidence in hypertension indicates that SMBP is most effective when paired with supportive interventions such as education, feedback, or medication management, rather than measurement alone [29, 53, 78]. Understanding what kinds of support patients perceive as helpful, acceptable, or trustworthy is therefore critical for design.

This research addresses these gaps by (i) exploring patients' attitudes towards SMBP; (ii) examining how current BP technologies support or hinder everyday self-monitoring routines; (iii) directly involving patients in the research and design process to better understand their needs; and (iv) evaluating the acceptability of emerging technological solutions to identify design opportunities. To achieve these objectives, a mixed-methods approach was employed to support both empirical investigation and patient-centred design exploration. First, an online survey was conducted with 61 individuals with hypertension, which examined attitudes towards SMBP and experiences with BP technologies. Results showed that 49% (30/61) of the respondents did not self-monitor regularly, 44% (27/61) reported anxiety related to self-monitoring, and the majority (53/61, 87%) used traditional cuff-based BP monitors, with only a small proportion using cuffless wrist devices.

Following the survey, five individual participatory design sessions were conducted with hypertensive patients. These sessions resulted in the development of three exploratory patient profiles reflecting distinct attitudes and needs related to SMBP, including preferences for anxiety-free monitoring and personalised feedback. The sessions also supported ideation around future design concepts and gathered feedback on the acceptability of cuffless wrist monitors and AI-powered mobile application features. From an HCI perspective, this work makes several contributions. First, it characterises SMBP as an episodic and emotionally demanding self-monitoring practice in which uncertainty, reassurance, and interpretation shape engagement alongside usability concerns. While these challenges share similarities with other chronic-condition self-monitoring contexts, our findings suggest that the limited opportunity for immediate action following individual BP readings shifts the design challenge towards supporting

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confidence, long-term interpretation, and emotionally sustainable engagement. Second, it proposes exploratory attitudinal profiles that capture different approaches to SMBP and serve as design sensitisers for future human-centred design. Third, it identifies how technology acceptance, anxiety, and integration into everyday routines shape engagement with both current and emerging BP technologies. Collectively, these findings extend HCI research on chronic condition self-monitoring [10, 22, 50] by demonstrating that designing for SMBP requires moving beyond accurate measurement towards technologies that better align with patients' everyday experiences and long-term self-management needs.

2 BACKGROUND AND RELATED WORK

The transition from clinician-led measurement to home monitoring shifted responsibility for BP management towards patients, who must operate devices correctly, interpret readings and decide how to respond [87, 88]. Without sufficient education or support, this shift can generate confusion, anxiety, and suboptimal BP management, a challenge observed globally [58]. Consequently, SMBP represents not merely a technical practice, but a socio-technical change in how hypertension is monitored and managed.

Evidence suggests that SMBP alone does not consistently lead to improved BP control when compared with office-based monitoring. Rather, benefits are observed when SMBP is combined with structured support such as patient education, lifestyle counselling, or clinical feedback [53, 78]. This finding positions SMBP as most effective when embedded within a broader care strategy rather than performed in isolation, an important consideration for design.

Clinical guidelines provide limited clarity on how SMBP should be integrated into daily life. For example, the European Society of Hypertension emphasises capturing day-to-day BP variability to better assess cardiovascular risk [45, 88], whereas the American Heart Association recommends daily or weekly monitoring, or in specific circumstances, such as following medication changes or prior to clinical visits [87]. This ambiguity in guidance leaves room for interpretation, resulting in inconsistent advice from clinicians and varied SMBP practices, reinforcing the need for clearer guidance, integration strategies and better-designed patient-facing tools.

2.1 Self-Monitoring BP and its Challenges

Currently, only manual or automated BP cuffs are validated for clinical and home use [87, 88]. Although straightforward to use for untrained users, engagement remains low [32, 58, 75, 82]. Fewer than half of individuals with hypertension self-monitor regularly (i.e. at least once a week) despite recognised benefits [75]. Before automatic monitors became common in the 1980s, BP assessment was almost exclusively conducted by healthcare professionals in clinical settings. Their introduction enabled individuals to measure BP independently at home, marking the beginning of SMBP [48]. Automatic BP monitors (commonly referred to as traditional BP monitors or 'BP cuffs') are now widely accessible, affordable, and trusted. However, their use relocates responsibility for elements of clinical work to patients in domestic settings, requiring patients to manage procedures previously handled by professionals [87, 88, 94].

This is because they were originally designed for clinical use and later adapted for home settings, not specifically designed for frequent, daily self-monitoring. Previous HCI research shows that preparation requirements and protocol adherence make integration into daily life difficult: Grönvall & Verdezoto (2013) identified the socio-technical challenges faced by healthy older adults (i.e., individuals without a hypertension diagnosis) when using SMBP for prevention [31, 32], highlighting that adhering to strict measurement protocols necessary for reliable BP readings was difficult for the users due to time constraints or inconvenience, barriers that ultimately discouraged regular use. Recent evidence from a remote management programme reinforced this, showing that even initiatives providing free devices and educational support report significant non-use [80]. This suggests that the 'burden of measurement' acts as a primary barrier that access alone cannot overcome. In addition, most BP monitors typically display numeric readings without context, interpretation or actionable advice [27]. This places a significant

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cognitive burden on users, particularly those lacking confidence or understanding of BP values, discouraging continued participation [58].

Emotional responses, particularly anxiety, represent a further challenge closely linked to these usability and interpretability limitations. Anxiety, defined as a feeling of worry or tension over anticipated negative outcomes [9], is a commonly reported barrier to SMBP. Tompson et al. (2019) found that 26% of primary care patients (both healthy and hypertensive) reported anxiety due to SMBP [76]. A thematic synthesis of qualitative studies identified anxiety, confusion, and stress associated with "bad numbers" and unclear measurement guidance as key barriers to sustained engagement with SMBP [58]. Thus, concern about elevated readings or uncertainty about consequences may both raise BP and reduce motivation to monitor [58]. Clinicians sometimes advise reducing monitoring frequency to manage anxiety in some patients [8]. Although such strategies may lessen short-term anxiety, they undermine the goal of regular monitoring and long-term BP management. Despite its prevalence, limited research has explored the causes and impacts of SMBP-related anxiety, and how design can reduce rather than intensify emotional strain. Several of these challenges (e.g., episodic measurement, dedicated equipment, anxiety, and complex sense-making) parallel those documented in HCI research on type 2 diabetes self-monitoring, where people interpret variable readings against everyday activity to decide how to act [28, 49, 50, 66].

2.2 New Technologies for SMBP

Mobile applications, wearables, and AI tools are transforming the healthcare space by making personal health data more accessible, aiding in interpreting BP data, and offering tailored guidance for better health outcomes [33]. While many of these technologies build on design approaches from other self-monitoring domains such as diabetes or physical activity tracking, their application to SMBP presents distinct challenges. BP measurement is typically episodic, exhibits short-term variability, and may be difficult to interpret without guidance or context [32, 45, 58]. SMBP may also be associated with anxiety, which can discourage patients from regular monitoring. Together, these characteristics can complicate the direct transfer of the design insights from other self-tracking systems and highlight the need for hypertension-specific HCI research, which is reflected in the range of technological solutions described below.

In the context of SMBP, noticeable improvements have been made to the traditional BP monitors. Modern devices offer improved comfort and portability. Some devices, for example, the Omron HeartGuide, have been embedded into wearable technology, such as smartwatches to make them more convenient for daily use [62]. These wearable devices typically come with a companion mobile application that not only tracks BP but also facilitates comprehensive data sharing with clinicians [33].

However, adoption of these wearable monitors remains restricted by cost, availability, and limited clinical recommendations compared to traditional (wired) BP monitors [27, 56]. They also share the major limitation of providing only snapshot measurements which, despite evidence of daily fluctuation, fail to capture the dynamic nature of BP. BP fluctuates throughout the day, influenced by various factors such as stress, physical activity, and diet. Continuous monitoring could allow a better understanding of the patients' BP profile, facilitating hypertension management [88]. Research in cuffless technologies for continuous BP measurements shows promise in addressing the limitations of traditional BP monitors [33, 71, 72]. Devices such as wristbands and smartwatches (e.g., Aktiia wristbands and Apple Watch-based solutions) show potential for better integration into daily routines and reduce the burden of active measurement [56, 84]. Unlike traditional BP monitors which use the arm or wrist cuff for measuring BP, newer wearable devices use other methods such as photoplethysmography (PPG), a signal acquired through an optical sensor, to estimate BP continuously [20]. Early HCI research has explored the potential of continuous BP monitoring for identifying atypical patterns and supporting early detection of hypertension, highlighting challenges related to trust, data interpretation and variability in non-hypertensive populations [43]. The integration of AI into these devices could enhance their accuracy and provide personalised insights [83]. For example, Khushhal et al. (2024) demonstrated that Apple Watches, which use PPG to measure heart rate and oxygen level data, have satisfactory accuracy when compared to standard evaluation devices in patients with chronic conditions such as hypertension [44]. Although the

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accuracy of measuring BP through PPG is starting to be recognised and regulated [84], further research is needed before it can be clinically recommended.

Hypertension-specific smartphone applications have also emerged as a way to provide users with tools for self-monitoring and management, tracking BP readings over time, and personalised health recommendations. Systems such as the HERB-DH1 therapeutic system integrate SMBP data with algorithmic decision support to provide personalised lifestyle guidance and medication recommendations based on longitudinal BP data [41], which has been shown to improve BP control and encourage positive behavioural changes [42, 52, 91]. Pharmacist-led interventions similarly show gains when monitoring is integrated with tailored education and medication support [29]. Benefit therefore stems from coupling data with responsive care and support.

Mobile application capabilities can further be enhanced by emerging AI-based systems, which may support SMBP experiences by analysing longitudinal data collected by wearable devices, estimating BP, generating personalised risk predictions, and providing personalised recommendations [6, 15, 77, 83, 89]. Conversational agents are proposed to provide reminders, education, and motivation [69, 90] as a potential means of delivering the kinds of complementary support shown to be effective in SMBP interventions [29, 53, 78], rather than as standalone monitoring tools. These systems hold the promise to alleviate the burden on the healthcare systems [68, 69, 90], and could also be applied in SMBP [6, 30], though further research and validation are required before their integration into clinical practice.

2.3 Technology Acceptance Models

User adoption is crucial for the success of any technology, particularly when positive digital health outcomes depend on how technology is integrated into clinical practices or daily routines. The Technology Acceptance Model (TAM), introduced by Davis (1989) and grounded in the Theory of Reasoned Action and the Theory of Planned Behaviour [4, 26], addresses this. It identifies perceived usefulness (how much a person believes the technology will help achieve their goals) and ease of use (how effortless the technology is to use) as central determinants [19]. TAM has since evolved to capture the nuances of human behaviour and understand technology adoption across various fields, including healthcare [36, 47, 51, 56].

The Technology Acceptance (TAC) Toolkit by Nadal et al. (2022) [57] expanded upon TAM by synthesising antecedent factors from multiple validated acceptance models into 16 design cards. One of the key models contributing to the TAC Toolkit is the Health Information Technology Acceptance Model (HITAM) [46], which extends from TAM models and incorporates elements from the Health Belief Model (HBM) [38]. The HBM advocates that health-related preventive behaviour is influenced by perceived benefits, barriers, susceptibility to health risks, and severity of health issues.

More recently, Harris and Rogers (2023) [35] proposed the Healthcare Technology Acceptance Model (H-TAM), a conceptual model tailored to older adults with chronic conditions like hypertension, for whom self-management technologies are increasingly important. H-TAM identifies seven main factors influencing technology adoption: perceived benefits, perceived ease of use, perceived need for oneself, perceived need for others, relative advantage, familiarity, and advice acceptance. These factors support an understanding of how older adults approach novel technologies, which is particularly relevant to BP technologies as hypertension prevalence increases with age.

We used technology acceptance frameworks as analytical lenses rather than as predictive models. Here, these frameworks orient interpretation rather than predict behaviour, drawing attention to usefulness, effort, emotional response, and routine fit, and centring the factors important for successful adoption of SMBP technologies.

3 RESEARCH QUESTIONS

This work investigates hypertensive patients' attitudes towards self-monitoring and BP technologies and explores user needs and the potential for future design of tools to improve the practice of SMBP. Guided by prior work on technology acceptance and health behaviour, which highlights the importance of attitudes,

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perceived usefulness, ease of use, emotional responses, and integration into everyday routines in shaping engagement with health technologies, we framed the following research questions:

- RQ1: What are hypertensive patients' attitudes towards SMBP?
- RQ2: How do current BP technologies support or challenge regular self-monitoring practices?
- RQ3: What would improve hypertensive patients' SMBP experience?
- RQ4: How are emerging technological innovations for SMBP perceived?

To address these questions, we conducted two studies in sequence. Study 1, an online survey, characterised current SMBP practices, device use, and attitudes. Its findings then informed Study 2, a participatory design study, in two ways. First, the survey showed which cuffless and wireless devices participants were already aware of or curious about; we used these to ground the device discussions in Study 2. Second, the survey surfaced emotional and routine-integration needs that we translated into a set of conceptual mobile app features. These prototypes were created after Study 1, specifically as provocations for the Study 2 sessions, and were not shown to survey participants.

4 STUDY 1 – SURVEY

The survey was the first study to be conducted to capture a broad overview of attitudes and experiences related to SMBP among hypertensive participants. Given the diversity of self-monitoring practices, this method was suitable for the identification of patterns and informing the focus of the participatory design study.

The online survey explored attitudes towards SMBP (RQ1) and how technologies support or hinder BP monitoring (RQ2) among hypertensive participants. Ethical approval was obtained.

4.1 Methods

4.1.1 Materials

An online survey including (i) an information sheet, (ii) a consent form, (iii) questions, and (iv) a link for follow-up recruitment to the participatory design study was hosted on Qualtrics XM [65], and distributed through hypertension-relevant social media channels. The information sheet outlined the inclusion criteria (aged 18 or over, diagnosis of hypertension, and able to provide informed consent), and participants self-determined their eligibility before providing consent. After consenting, participants proceeded to the survey questions.

No automated bot-detection, CAPTCHA, or fraud-prevention measures were enabled, and hypertension diagnosis was self-reported rather than clinically verified. To support data quality, all submissions were manually screened and incomplete or duplicate responses were removed prior to analysis, and free-text "Other" responses were individually reviewed during coding. No financial incentive was offered for completing the survey, reducing the motivation for ineligible or repeated submissions.

The survey was organised into four sections: (a) hypertension status (5 items), (b) SMBP attitudes (11 items), (c) BP technology use (10 items), and (d) demographics (5 items). Survey items were developed by the research team, as no standardised instrument specifically captures the range of SMBP attitudes, practices, and interactions with BP devices relevant to this study. Question development was guided by study research questions and themes identified in prior SMBP and technology acceptance literature. Survey questions were designed with inclusivity in mind, following guidelines for Age and Education [37], Gender [73], and Ethnicity [23]. The option 'Other' was included to allow respondents to answer in ways that best represented them [14].

4.1.2 Participants

Purposive sampling was used to recruit 61 adults with a self-reported diagnosis of hypertension (referred to as 'p#') [7, 12]. The survey was distributed between December 2023 and July 2024 and took

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approximately ten minutes to complete. On completing the survey, participants were invited to register interest in the follow-up study using a separate form.

4.2 Data Analysis

Data from Qualtrics were analysed in Microsoft Excel and Python. Responses entered under "Other" were individually reviewed and, where sufficient information was provided, reclassified into the most appropriate existing category. "Other (unspecified)" categories shown in figures therefore represent responses that could not be further classified because no additional information was provided or the response was insufficiently specific. Multi-choice items were split, and proportions were calculated.

An 11-point scale of perceived importance, widely used in behavioural change practice [1, 67], was used during data collection to allow for more nuanced responses, without the constraints of fewer categories. For analysis and reporting, however, responses were grouped into a 5-point scale (Table 1). This conversion was necessary to address sparse cell frequencies inherent in a small sample size; for instance, only one participant selected '1' and '4' respectively on the 11-point scale. This grouping facilitates clearer interpretation and comparison across participants [34, 39, 79].

Table 1. Conversion of an 11-point scale to a 5-point scale of the importance of regular SMBP.

Level of importance index	Label
0	Not important
1-3	Slightly important
4-6	Moderately important
7-9	Very important
10	Extremely important

Age ranges were further clustered into three groups to represent different life stages: young adults (18-44 years), middle-aged adults (45-64 years), and older adults (over 65 years), matching the distributions found in hypertension prevalence trends [2].

Qualitative data from the open-ended questions were analysed using inductive thematic analysis [13]. All coding and theme development were conducted by the first author, whose dual positionality as a Medical Doctor and HCI researcher informed the interpretive process, particularly in distinguishing clinically expected monitoring practice from the lived burden reported by participants. Reflexivity was practised through reflexive memos in which the first author recorded where clinical expectations might diverge from participants' lived accounts. The third author, who is not a clinician, reviewed the coding structure as a critical reader, challenging clinically inflected interpretations. Coding decisions and theme revisions were discussed and documented in an evolving codebook. Consistent with reflexive thematic analysis, inter-rater reliability was not computed [13]. Descriptive statistics, including frequencies and proportions, were used to analyse closed-ended questions. Fisher's exact test was applied to assess the statistical significance ($p < 0.05$) of contingency tables due to expected counts below five, and Cramér's V was computed as a measure of effect size to convey the strength of association [3].

4.3 Survey Results

4.3.1 Demographics

Most participants were women (42, 69%), over 45 years old (49, 80%), UK-based (44, 72%) and of white ethnicity (56, 92%).

4.3.2 Hypertension Status and Attitudes Towards SMBP

All participants had hypertension, and 28 (46%) reported uncontrolled BP or were unsure of their BP status. This was particularly true among those in their first year of diagnosis, where 13 of 17 participants (76%) were either uncontrolled or unsure (Figure 1), reflecting early adjustment to the condition and highlighting a period of uncertainty that may shape subsequent self-monitoring behaviours.

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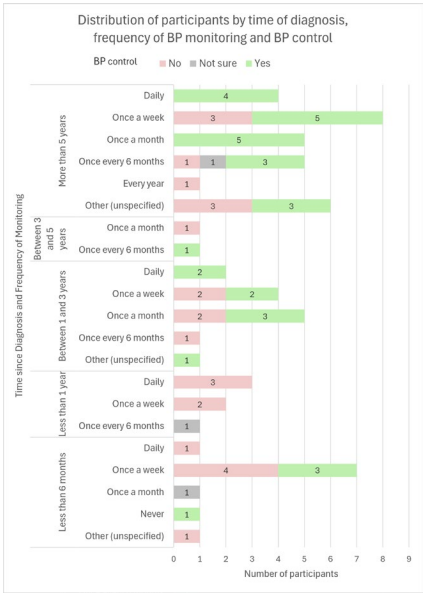

Figure 1. Distribution of participants (n=61) by time since diagnosis, frequency of BP measurements, and BP control status. "Other (unspecified)" represents responses that could not be further classified because no additional information was provided.

Most participants (52, 85%) engaged in SMBP at least occasionally; one participant reported never monitoring their BP and eight did not specify a frequency. Ten participants (16%) reported measuring their BP daily or most days; 31 (51%) measured at least weekly; and 43 (70%) measured at least monthly (Figure 2). However, 49 (80%) expressed a preference for measuring their BP at least once a month, suggesting that intent modestly exceeds practice.

Most respondents (53, 87%) considered regular SMBP at least moderately important, which significantly correlated with frequency of measurement (Fisher's exact test, $p = 0.024$; Cramér's $V = 0.42$, indicating a moderate association [16]) (Figure 2).

The main motivation for SMBP was the desire to keep BP under control (35, 57%). This was followed by the doctor's recommendation (27, 44%) and general health concerns (24, 39%). 44% (27) of participants reported feeling anxious before taking their BP, a proportion that rose to 74% (45) if the resulting BP was perceived as elevated (Figure 3).

Recognising that anxiety can raise BP, 79% (48) of participants reported using relaxation strategies to manage elevated BP. Few sought medical advice (2, 3%), suggesting that the majority of participants attempted self-management. However, only three respondents (5%) felt confident in managing their BP (Figure 3).

These findings suggest that some patients often approach SMBP already in an unsettled emotional state, potentially impacting the overall experience of SMBP as negative.

One participant [p11] with uncontrolled BP reported intense anxiety throughout the SMBP process to the point of avoiding measurement: *"My partner takes it for me regularly as I am very anxious about doing it". "It's a really scary thing to do."* [p11]. This avoidance strategy can create a vicious cycle, where anxiety about SMBP persists and potentially worsens over time.

In contrast, another participant [p60], whose BP was controlled, reflected on possible influencing factors for their elevated BP: *"[I] look at what factors may have affected my blood pressure. I am still peri-menopausal and that may cause significant rises in blood."* [p60]. Such confidence and calm may contribute to a more positive self-monitoring experience.

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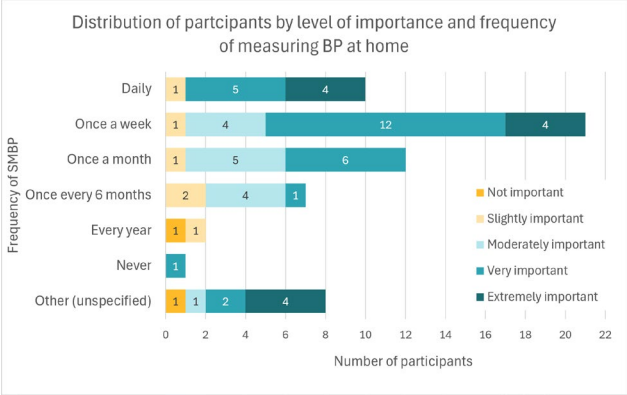

Figure 2. Distribution of the level of importance of measuring BP by the frequency of measuring BP. "Other (unspecified)" represents responses that could not be further categorised because no additional information was provided.

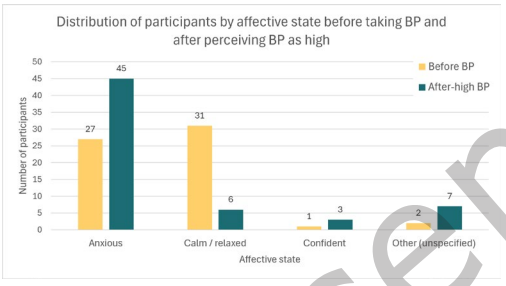

Figure 3. Respondents' affective state before BP measurement and after perceiving BP as high.

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4.3.3 Technology in Use – Challenges and Usefulness

Nearly all participants (59, 97%) used cuffed monitors, mostly traditional wired arm cuffs (53, 87%) (Figure 4). This was expected, as cuff devices remain the only clinically recommended option, with wired devices typically the most affordable option. Four participants reported using cuffless devices, with one participant relying solely on their smartwatch for SMBP. Participants tracked BP using paper (25, 41%), device memory (12, 20%), or mobile apps (22, 36%). Apps, typically paired with Bluetooth devices, were praised for automation and trend insights: *"I can see the trend and work out averages"* [p15]; *"I have full history of my blood pressure readings [...] rather than worrying about an odd high reading."* [p61].

Standard Arm Cuffed Monitor

Of the 61 participants, 42 (69%) reported no issues using BP cuffs, while the remaining 19 (31%) reported challenges, grouped into three themes (Table 2): (i) user-related challenges, in which anxiety was the most recurring sub-theme; (ii) cuff-related challenges, highlighting the discomfort caused by the arm cuff, and (iii) device-related challenges, where participants expressed uncertainty about whether they used the correct technique, which raises concerns about the reliability of the readings.

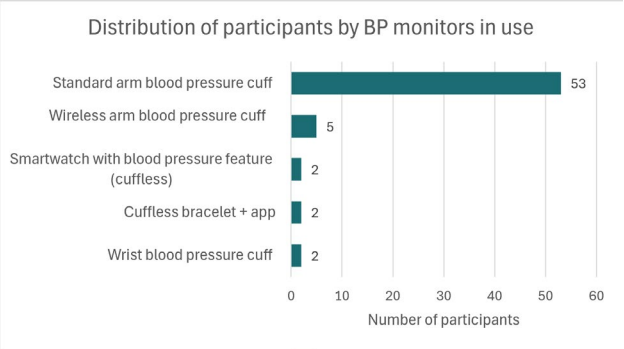

Figure 4. Distribution of BP devices used by the participants.

Table 2. Nineteen participants provided open-ended responses describing challenges with BP cuff use.

Theme	Sub-theme	Count
User-related challenges	Forgetfulness	1
	Anxiety	4
	Awkwardness	2
Cuff-related challenges	Painful	4
	Quality	3
	Size adequacy	2
Device-related challenges	Technical issue	3
	Technique difficulties	3
	Erratic readings	2
	Inconvenience (size)	1

Most participants (51, 84%) found traditional BP cuffs useful (Table 3), reporting increased autonomy and better BP understanding. About 79% (48) of participants trusted their readings.

Table 3. Themes and sub-themes generated from the reasons for usefulness of the traditional arm cuff device.

Theme	Sub-theme	Count
User autonomy	Allow BP control	22
	Helps understanding	4
	User empowerment	2
Device performance	Accurate	8
User experience	Easy to use	8
	Easy to access	4
Other	Approved device	2
	Share with doctor	1

Although participants generally found traditional BP monitors useful and trustworthy, reported challenges may hinder sustained engagement over the long term. The success of SMBP, therefore, depends on addressing these challenges to improve user acceptance and experience.

Other BP monitors

Wireless cuff users valued automatic syncing to apps: *"It automatically sends readings to the app so I don't need to record anything […]." [p61]; "gives me 3 readings each sitting and takes the best automatically. Makes routine easy."* [p27]. Cuffless monitors were praised for passive, convenient use and easy integration into daily routine: *"24-hour monitoring, no squeezing"* [p36]; *"Don't have to think about it"* [p41]; *"I already have it on so it's easy to check my BP"* [p55]. Around 66% (40) of participants believed that cuffless monitors could ease SMBP, though 20% (12) distrusted new technologies and preferred traditional cuffs.

This study expands the existing literature by exploring SMBP-related anxiety as a potential deterrent to SMBP engagement and shows that some patients adopt unvalidated cuffless monitors in search of convenience.

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5 STUDY 2 – PARTICIPATORY DESIGN STUDY

5.1 Objectives

This participatory design study aimed to (i) understand participant attitudes and experiences during SMBP (RQ1-2), (ii) identify SMBP design opportunities through user needs (RQ3), and (iii) explore participants' views on the acceptability of the cuffless devices reported in the survey, and of conceptual mobile app features (RQ4). As outlined in Section 3, the survey findings informed the design of the Study 2 materials (Section 5.2.3).

5.2 Methods

5.2.1 Researcher Familiarisation (Methodological Background)

Following the survey and prior to the participatory design study, the first author engaged in first-hand use of common SMBP technologies reported in the survey to develop familiarity with BP monitoring routines, device interactions, and practical challenges associated with daily SMBP. This phase served as methodological preparation: it was neither part of the empirical study nor analysed as participant data, but it supported the design of the study's participatory activities and aided the interpretation of participant input.

This familiarisation focused on understanding the effort involved in measuring BP, the way devices integrate into daily routines, and the challenges related to feedback, emotional demands, and trust in readings. Insights from this phase informed the selection of devices presented to participants.

Researcher positionality for familiarisation. The first author, who conducted the familiarisation, is a medical doctor with experience in hypertension care but does not have a diagnosis of hypertension. The first author is also an HCI researcher. This medical experience informed attention to device usability, clinical routines, and practical considerations relevant for hypertension self-management, while remaining distinct from the patients' lived experiences explored in Study 2.

SMBP technologies and monitoring routines. Three BP devices were used (Figure 5): (A) an automatic BP cuff (Omron M2 Basic), validated for home use by the British and Irish Hypertension Society (BIHS) [27, 93]; (B) a cuffless bracelet-like BP device (Aktiia), which passively takes BP and automatically logs it into a mobile app, validated but not yet approved by BIHS [5, 84]; and (C) a low-cost, unvalidated smartwatch (Solonsuo, model F57l), which claims to continuously measure BP readings.

Standard BP monitoring protocols for diagnosis and reassessment were followed over several days using the cuffed device [59] (Figure 5, device A), while the cuffless devices (Figure 5, devices B and C) were worn to experience passive and continuous monitoring in everyday contexts. Observations from this experience informed the choice of the devices discussed with participants and the emphasis placed on effort, challenges, routine integration, emotional burden, and trust during the participatory design study. Detailed reflections from this work are not reported, as they were used to support study design and interpretation.

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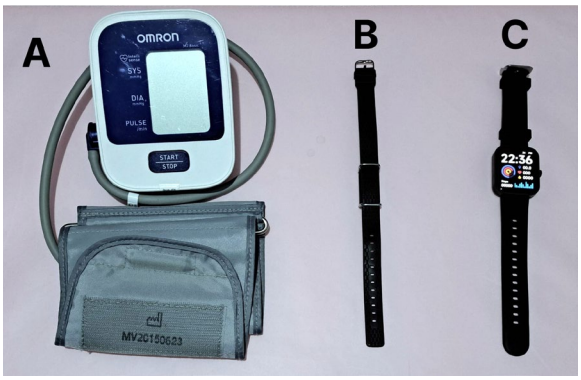

Figure 5. BP devices used during researcher familiarisation phase. (A) automatic BP monitor, Omron Healthcare M2 Basic; (B) Aktiia 24/7 BP monitor; (C) Smartwatch.

5.2.2 Participants

Recruitment occurred through follow-ups with participants from Study 1 who had expressed interest in a second study as well as further online recruitment via Prolific [63]. Eligible participants were hypertensive adults who engaged in self-monitoring BP, regardless of monitoring frequency.

Ten participants completed the Study 1 survey, which served as the intake survey, and were invited to take part in the participatory design study. Five participants (referred to as 'P#') completed the participatory design study. Four were 65 or older (two men, two women), and one was a woman aged 45-64. All reported prior experience with cuff-based SMBP; levels of confidence with digital tools varied.

5.2.3 Materials

Study 1 was completed prior to this study and informed the selection of technologies and the development of materials used during the participatory design sessions. Survey findings, together with insights gained during researcher familiarisation, guided the choice of devices and conceptual features explored with participants. These materials were introduced exclusively in Study 2 as prompts for discussion and evaluation and were not presented during the survey.

An online whiteboard, Miro [54], was set up with structured activities to facilitate collaborative exploration as well as editable spaces for annotating, rearranging and extending materials (Section 5.2.4 Procedure).

Four different solutions were presented to participants:

a) *Wrist Wearables and App Examples:* photos of wrist wearables (Figure 6) and screenshots of the Aktiia app both captured by the first author during the researcher familiarisation phase, were shown. These included:
   i. *Aktiia Cuffless Bracelet Monitor:* This wearable uses PPG signals to acquire BP readings without manual measurement initiation, which are displayed on the app every two hours.
   ii. *Smartwatch as BP Monitor:* This device also uses PPG to automatically estimate BP, with manual measurement options, and includes smartwatch features such as time display and step counting.

These device options were selected based on technologies that Study 1 participants reported awareness of or interest in (Section 4.3.3), together with insights gained during researcher familiarisation.

b) *Conceptual Designs for BP Management:* Two AI-enabled mobile app features to support BP management through personalised advice:
   i. *Predictive BP with Personalised Recommendations:* Forecasted BP levels for the coming week are displayed, accompanied by AI-generated recommendations (Figure 7 A). The prototype showed

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an elevated BP prediction with three suggested tasks, which were personalised to users' demographics (e.g., age).

ii. *Conversational AI Agent for BP Response and Advice:* A chatbot concept (Figure 7 B) where the AI agent, 'Amy', responds to BP readings and user notes. For example, after a high BP reading linked to coffee consumption, Amy recommends a re-measurement in 15 minutes and suggests relaxation exercises.

These prototypes built on the first author's prior user-centred design projects, with the AI features developed after Study 1 and the researcher familiarisation phase. They were used as provocations and conceptual prompts during the sessions to stimulate critique, comparison, and redesign rather than as finished solutions.

TAC Toolkit cards [57] were used to motivate discussion, and TAM's adapted questions were used to assess perceived usefulness and ease of use on a 7-point scale (ranging from 'Strongly Disagree' to 'Strongly Agree') [19].



Figure 6. Researcher wearing Aktiia BP monitor (left) and smartwatch (right) during the researcher familiarisation phase. Photographs taken by the first author.

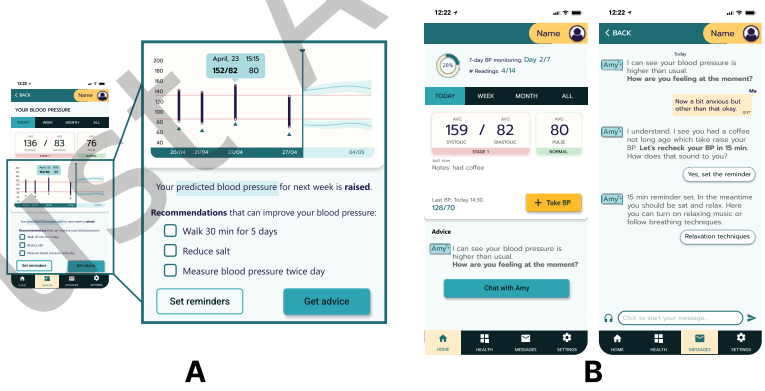

Figure 7. (A) Prototype of the visualisation of past BP entries and BP predictive bands. Personalised action plan based on the predictive values. (B) Conversational AI agent that provides advice based on the BP readings to support handling slightly high BP readings.

5.2.4 Procedure

After providing consent and completing the pre-survey, five participants individually took part in virtual design sessions lasting 90 to 120 minutes. Conducting sessions one-to-one with each participant enabled deep individual insights by providing a comfortable and private setting, with sessions conducted in each participant's preferred language. Participants were offered breaks if needed and received an Amazon

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voucher (£10/hour) for their time. The participatory design interviews followed a three-stage structure [74]:

1. *Initial Exploration:* Participants' *a*ttitudes towards self-monitoring (RQ1) were explored by expanding on their survey answers. Journey maps were co-created with participants modifying the representations to explore their experience with BP technologies (RQ2).
2. *Discovery Process:* User needs were identified (RQ3) and reframed into 'How might we' questions to encourage ideation [18].
3. *User Feedback:* The four technologies were discussed sequentially and rated for usefulness and ease of use, informing how hypertensive patients perceive and accept emerging SMBP technologies (RQ4).
    - Each stage served a distinct analytic function, addressing different research questions, so the three are reported separately in the results (Sections 6–8) and then drawn together in the Discussion rather than treated as independent results.

5.2.5 Ethical Considerations

The recruiting survey was hosted on Qualtrics XM [65] and distributed on Prolific [63]. Only participants with signed consent were contacted for the sessions. Each survey was mapped to a unique survey identifier, used during the co-design session. After the session, this mapping was discarded and the survey was added to the Study 1 analysis. The co-design sessions were video and audio recorded, and recordings were deleted after transcription, which was pseudonymised. Ethical approval was obtained from the University College London Ethics Committee.

5.3 Data Analysis

Over 8.5 hours of recordings were transcribed and analysed using reflexive thematic analysis in NVivo [13, 60]. First, transcripts were reviewed, corrected and anonymised using Microsoft Word (familiarisation phase), then imported to NVivo for coding using both deductive and inductive approaches. The initial codebook incorporated findings from the survey (Study 1), alongside deductive codes informed by TAC Toolkit and H-TAM factors, which oriented the analysis towards established acceptance constructs [35, 57]. While TAC factors were broad, H-TAM factors provided greater coding granularity. Inductive coding remained open to emergent, hypertension-specific themes such as anticipatory anxiety. Themes were refined iteratively and mapped in Figma [24]. The same reflexive stance and analytic roles described for Study 1 (Section 4.2) were applied where coding was conducted by the first author, with the third author acting as a non-clinical critical reader and decisions discussed to consensus. Consistent with reflexive thematic analysis, inter-rater reliability was not computed [13]. Each of the three co-design stages was analysed separately, with Likert-scale data from Stage 3 quantitatively assessed for perceived usefulness and ease of use.

5.4 Results of Participatory Design Study

The results of the participatory design study are discussed in the following sections, organised by the stage of the participatory design study (defined in Section 5.2.4 Procedure): Stage 1, Initial Exploration, in Section 6; Stage 2, Discovery Process, in Section 7; Stage 3, User Feedback, in Section 8.

Reporting conventions differ across studies. Survey results (Study 1, n=61) are reported using percentages to describe response distributions, and findings from the participatory design study (Study 2, n=5) use raw counts and qualitative descriptions, as percentages would be misleading for such a small sample.

6 STUDY 2 RESULTS – INITIAL EXPLORATION

As described in the Procedure (Section 5.2.4), the participatory study's three stages are reported in turn across Sections 6–8 and drawn together in the Discussion. This section presents the first stage.

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Six themes generated through thematic analysis highlighted key aspects of the SMBP journey (Figure 8). The themes were aligned with the 5W1H framework ('who', 'why', 'when', 'where', 'what', 'how') often used in design research [92]. This framing highlights that participants' experiences of SMBP extend beyond the act of measurement itself, including motivations, emotional preparation, device interaction, and responses to results.

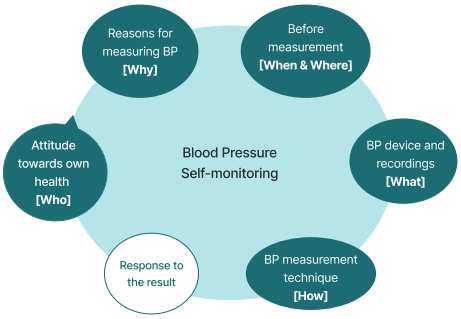

Figure 8. Themes generated from thematic analysis from the co-design sessions identifying key components of the self-monitoring process. Filled circles represent themes that were mapped to the 5W1H framework.

The identified themes and their corresponding 5W1H component were defined as follows:

1. Attitude towards own health – defines 'who' is self-monitoring, based on their views over their 'health status' and 'health beliefs and concerns' from TAC Toolkit.
2. Reasons for measuring BP – reports on 'why' participants engage in SMBP (motivations and goals).
3. Before BP measurement – a broad theme covering the preparation required and affective state before BP measurement, identifying 'when' and 'where' participants typically measure their BP at home.
4. BP device and recordings – focuses on 'what' is used to take a BP reading and strategies to record it.
5. BP measurement technique – explores 'how' participants measure their BP.
6. Response to the result – explores participants' reactions and attitudes towards their BP readings.

6.1 Themes 1 & 2: Attitude Towards Own Health and Reasons for Measuring BP

Theme 1 explored participants' attitudes towards their health and role in SMBP. Past personal or family BP-related events, health beliefs and self-perceived control, shaped how participants engaged and experienced SMBP. This theme provided insight into why participants chose to monitor their BP (theme 2), leading to three attitudinal profiles. Given the small, exploratory sample, we present these as sensitising concepts that may inform future design work, rather than as representative user types:

6.1.1 Profile 1: Proactive Manager – "I want to self-monitor because I want to control BP and do something about it".

'Proactive Managers' actively monitor their BP to inform lifestyle decisions. *"It is good to be able to control the blood pressure […], I would like to check after lunch and see if there was variation", "If I knew my readings during exercise, I could adjust it if BP was too high"* [P5].

6.1.2 Profile 2: Cautious Monitor – "My lifestyle is already very good so I self-monitor to confirm control and share results with the doctor who will manage it".

'Cautious Monitors' want to have an optimised lifestyle and monitor BP mainly to inform their doctors. "*Just exercise and my diet's always been quite good.*" [P3]; *"I mean, nothing major to be honest [regarding lifestyle changes], just making sure that I am active*." [P4]. *"So, I go to him [doctor] and say these are my readings this week and he'll say that's good."* [P4]. Participants who are 'Cautious Monitors' are mostly driven to measure BP to inform the doctor, but can also self-monitor as a reassurance tool.

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6.1.3 *Profile 3: Dependent Monitor – "I don't know what I can do to improve my BP so I self-monitor to share the results with the doctor who will manage my BP".*

'Dependent Monitors' rely on doctors to interpret results and control the condition, unsure of their own role in management. *"If I see that BP is a bit out of control I will mention it to the doctor. Don't even know what I could do about it"* [P2].

These profiles illustrate variation within this small sample and should be understood as heuristic starting points for design and further inquiry rather than stable categories. They suggest that attitudes towards responsibility, confidence, and uncertainty may influence not only monitoring frequency but also emotional responses to SMBP. Larger and more diverse studies are needed to determine whether these patterns represent stable user groups and to explore how attitudes and engagement with SMBP may change over time.

6.2 Theme 3: Before BP Measurement

Participants' experiences leading up to a BP reading were grouped into three sub-themes: (i) triggers for BP measurement, (ii) preparation, and (iii) anxiety prior to measurement. To understand how emotional experiences unfold across the SMBP process, emotional journey maps were created with the participants, one of them being illustrated in Figure 9.

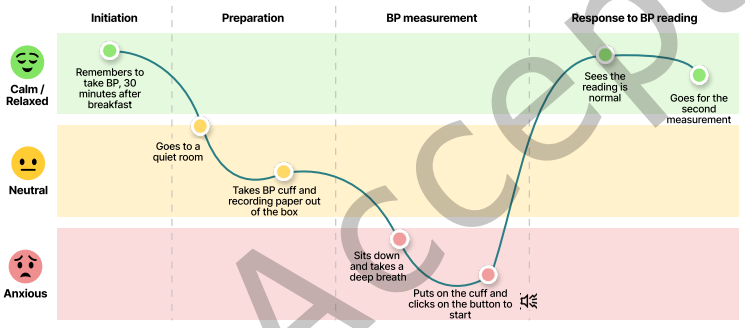

Figure 9. Emotional journey map for the BP measurement process from P4. The map is divided into four stages. (1) Initiation – P4 remembers to take their BP and they are calm; (2) Preparation – Series of steps required to get ready for the measurement. P4 does not feel as relaxed as before; (3) BP measurement – Stage marked by intense anticipatory anxiety, triggered by the uncertainty about the BP results and device's noise; (4) Response to BP reading – P4 returns to a relaxed and relieved state upon observing a normal BP result and maintains this calmness and confidence as they proceed to the second measurement.

6.2.1 *Triggers for BP Measurement*

Participants relied on memory to initiate self-monitoring, with frequency ranging from daily to every few months, depending on their attitudes. None used reminders; instead, some responded to external triggers, such as visual cues, e.g., keeping the monitor visible, despite finding it annoying; or medical prompts, like prescription renewal or an upcoming routine appointment.

6.2.2 *Preparation for Measuring BP*

Participants followed a similar self-monitoring process (Figure 9): they typically remembered to measure BP, picked up the monitor and the recording tool of their choice, settled in a quiet space, and tried to relax before positioning the arm cuff. Anxiety often grew during this phase.

6.2.3 *Anxiety Prior to BP Measurement*

Anxiety affected 44% of the survey participants (Section 4.3.2) and was further explored through the development of an emotional journey map (Figure 9), which offered insights into when anxiety occurs and underlying causes. Two main reasons emerged: (i) *expectation of high BP or uncertainty about the results,*

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even for participants with well-controlled BP, and (ii) *noise from the BP cuff.* SMBP experience was compromised by this anxiety, leading to avoidance behaviours:

a) Avoidance of frequent SMBP: *"The reason I don't [measure more often] is because it worries me a lot."* [P3].
b) Avoidance of looking at the monitor during measurement: *"I try to not look at the display."* [P2].
c) Keep BP cuff out of sight: *"I usually have it away out of sight so I cannot see it, but in the week that I [take* BP*], I have it out ready in a spare room […] I just leave it there and shut the door."* [P4].

These negative experiences prevented participants from fully integrating BP monitoring into their daily lives, despite their desire to maintain BP control.

6.3 Theme 4: BP Device

All participants used BP cuffs. The codes generated, whether inductively derived or defined by H-TAM factors, were further organised under the TAC Toolkit antecedent factors, which were upgraded to sub-themes. Figure 10 illustrates that while BP cuffs were perceived as reliable and clinically trustworthy, negative experiences related to integration, effort, and emotional burden were raised in relation to their suitability for regular use.

Positive feedback on BP device acceptability: Participants found BP cuffs easy to use (Objective Usability) and felt they generally performed as expected (Perceived Reliability), with one participant trusting the device after receiving advice from a pharmacist (Trust).

Negative feedback for regular use of BP cuff: *Integration and Technology Enjoyment:* Anxiety, forgetfulness, and the preparation involved in measuring BP make BP cuffs challenging for regular use. *"It's a nuisance, actually, to keep remembering to do it"* [P3]*; "I have to unpack the device, wait for a bit and relax[…] to do it more often I would have to have it more at hand*" [P2]. Additionally, the wires were inconvenient and lacked adaptability for outdoor use cases: *"I am not going for a walk with the monitor, can only check it at home."* [P5].

Perceived Reliability: While most trusted their monitors, technical errors raised doubts. "*But it's kind of annoying* [errors]*. As I say it's making you question the reliability."* [P4].

Resistance to Change: Despite challenges, one participant defended BP cuffs due to familiarity. *"[current process] doesn't help with controlling BP* [but] *I got used to what exists* [and] *it is like a ritual."* [P2].

6.4 Theme 5: BP Measuring Technique

Hypertension guidelines recommend resting for five minutes before taking BP in the morning before medication and in the evening before dinner, ideally daily or at least weekly [87]. However, participants followed these instructions loosely, varying when BP is taken, the number of measurements per session, the resting time between measurements, and frequency ranging from every few days to once every six months. "*I measure BP when I remember that I haven't done it for so long*." [P2].

6.5 Theme 6: Response to BP Results

Participants felt reassured by normal readings, while reactions to high BP varied according to their attitudinal profile. 'Proactive Managers' (P1 and P5) with controlled BP approached SMBP calmly, expecting normal readings. If the BP result was high, they reflected on potential causes. *"I might start thinking, are the tablets still working? If it's just a one-off […] I just think to myself that can happen anyway."* [P1]. Most participants would repeat the measurements, as subsequent readings were usually lower, and consulted their doctor if readings remained elevated: "I'll just measure it until it's low. I'll just keep taking it until it's right." [P3]. If anxiety arose after seeing a high result, participants commonly used relaxation strategies such as deep breathing, positive thinking, self-talk or taking a walk to help regulate the anxiety: *"I try to think about something pleasant."* [P3]. The 'Dependent Monitor' almost showed indifference, often not acting over high readings, only informing their doctor if the reading seemed too concerning.

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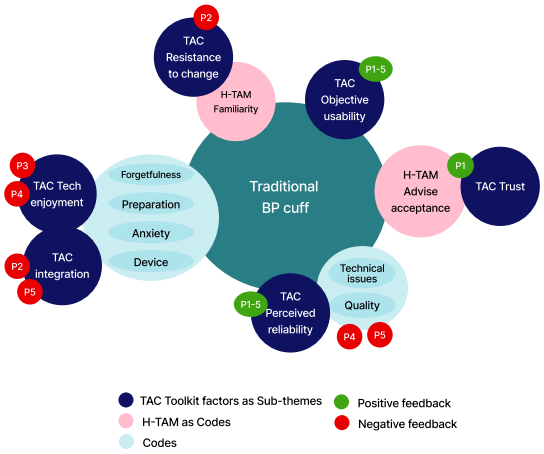

Figure 10. Thematic map of participants' experiences with BP cuff, grouped by codes and sub-themes. Visual representation of positive (green) or negative (red) participants' feedback (P) towards the TAC factors (dark blue). TAC - Technology Acceptance Toolkit; H-TAM - Healthcare Technology Acceptance Model.

7 STUDY 2 RESULTS – DISCOVERY PROCESSES

7.1 User Needs

Figure 11 places the identified user needs within different stages of the SMBP process, illustrating how needs emerge at specific points rather than uniformly across the experience. These user needs are interpreted alongside the attitudes and experiences identified during Initial Exploration (Section 6), so that these findings extend rather than restate that earlier material. The needs map onto the attitudinal profiles: for example, the need for interpretation and actionable guidance is most pronounced for Dependent Monitors, while Proactive Managers foreground tracking that supports their own decision-making. Addressing one need, like education or empowerment, could improve participants' attitudes and engagement. Some needs are interdependent; for example, providing tools to track BP over time can help participants understand their patterns, boost confidence in managing their condition, and in turn, reduce anxiety associated with SMBP.

7.2 Brainstorming Ideas

Four 'How might we' questions were developed based on frequently expressed challenges and needs identified in the survey (Study 1) and issues raised during the initial exploration of the participatory design study (Study 2): a) How might we increase calmness during BP measurement? b) How might we enhance BP feedback quality? c) How might we support BP tracking during daily activities? and d) How might we raise awareness of the importance of BP control? Figure 12 presents the ideas generated during the co-design sessions, organised by the user needs they address. The distribution of ideas highlights areas of convergence across participants, as well as needs that prompted more individual design responses.

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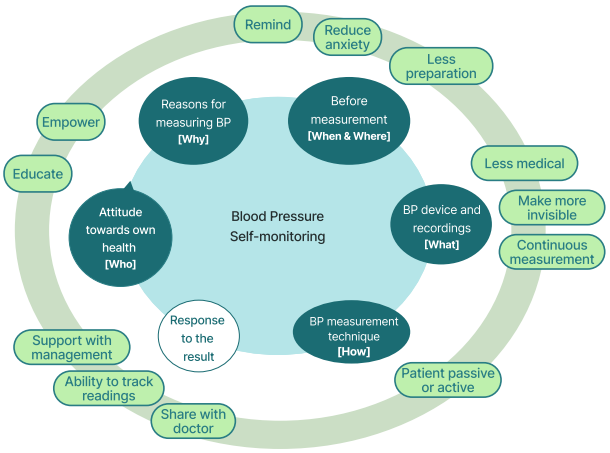

Figure 11. Thematic map of the self-monitoring process with the user needs (light green) situated across stages of the SMBP process.

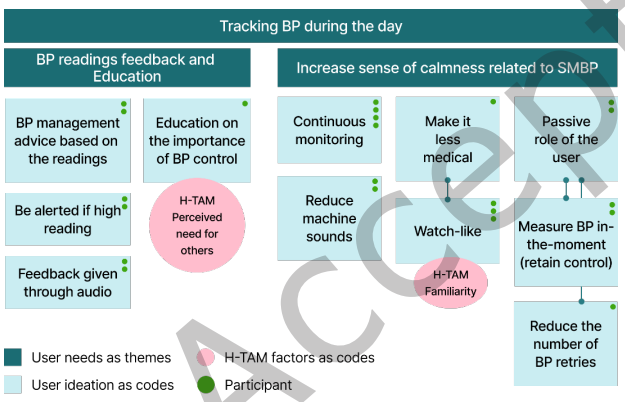

Figure 12. Thematic map illustrating the user needs and participant-generated ideas during the participatory design sessions. Each dot represents a participant-suggested solution.

7.2.1 BP Readings Feedback and Education

The themes of 'BP readings feedback' and 'Education' were combined due to overlapping ideas. Participants wanted actionable advice based on BP readings and reminders about the importance of BP control (a 'Perceived need for others' factor from H-TAM): *"People would like a reminder about how important it is to have lower BP."* [P1].

While some participants worried that high BP alerts could be anxiety-triggering, they agreed on timely notifications: *"I think the most important thing is if you've got high blood pressure, you need to know"* [P4].

7.2.2 Increase Sense of Calmness Related to SMBP

Participants suggested that a calmer SMBP experience could be supported through improved device design, particularly continuous monitoring.

a) ***Continuous monitoring through a watch-like device:*** Several participants expressed a preference for the watch-like BP monitor. These preferences mapped onto several technology acceptance factors:
(i) *Perceived benefits (H-TAM):* It was seen as simplifying SMBP and reducing the burden of active engagement. *"In an ideal world, if there was a continuous monitor..."* [P1].

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- (ii) *Technology Enjoyment, Integration (TAC Toolkit) and Familiarity (H-TAM):* Those already using smartwatches found the idea appealing and easy to integrate. *"If I could just have it [BP] on my watch, that would really help or, anything really, that I could wear perhaps."* [P3].
- *(iii) Self-Image (TAC Toolkit):* For some participants, the watch format felt less medical and more socially acceptable. "So it's quite cool to wear a watch" [P3].

b) ***Passive role of the user:*** While passive monitoring was valued, participants still wanted the option to manually check their BP when desired*. "I would like to see the BP reading after lunch or during exercise, just to check it"* [P5].

7.2.3 Tracking BP During the Day

Participants saw wearable devices as ideal for facilitating BP tracking throughout the day with minimal effort. They also valued receiving summaries of their BP readings along with tailored advice: *"Ideally, the device would measure BP automatically and I would receive a summary information about it, instead of having to analyse it myself"* [P5].

8 STUDY 2 RESULTS – USER FEEDBACK

Participants were presented with four solutions (Section 5.2.3 Materials) to evaluate their perceived usefulness and perceived ease of use, based on the TAM. The study explored key acceptance factors from the H-TAM and TAC Toolkit. The two wrist wearables, Aktiia bracelet and smartwatch, were discussed in relation to participants' needs for continuous monitoring, anxiety associated with BP cuffs, and facilitating daily BP tracking. The two AI-enabled mobile app concepts – predictive BP readings with personalised recommendations and an interactive AI model for BP feedback – were discussed in relation to improving BP feedback and education.

Given the small sample size (n=5), these results are presented descriptively to support qualitative interpretation rather than to indicate prevalence or comparative advantage. These solutions were assessed in terms of participants' perceived potential for real-world adoption.

8.1 Perceived Usefulness

Participants evaluated the technologies' ability to improve SMBP practices (Perceived Usefulness) and ease of operation (Perceived Ease of Use) using a 7-point Likert scale, ranging from 'Strongly Disagree' to 'Strongly Agree'. While all four solutions were perceived as easy to use, there were mixed reactions to their usefulness. Figure 13 illustrates the diversity of participants' perceptions of usefulness across the four solutions, highlighting areas of agreement as well as divergence.

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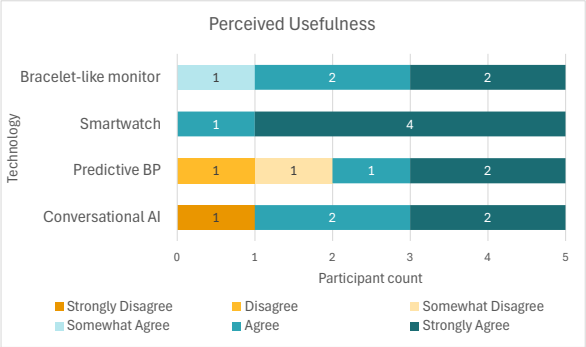

Figure 13. Participant responses on the Perceived Usefulness of four different technologies for BP monitoring, measured on a 7-point scale ranging from 'Strongly Disagree' to 'Strongly Agree'. Results are shown descriptively due to the small sample size (n=5). For clarity, only selected categories are shown.

8.1.1 Wrist Wearables

Participants' ratings indicated that both wearables were perceived as useful and user-friendly tools for BP monitoring. Table 4 highlights the participants' preferred device and their main reasons for choosing them, based on technology acceptance factors. Two participants preferred the smartwatch due to 'Familiarity' and 'Perceived Benefits', respectively. Both wearables were seen as offering a 'Relative Advantage' (H-TAM) over the BP cuff.

Table 4. Participants' attitudinal profile, preferred choice of the cuffless device, and primary technology acceptance factor influencing device preference. P - Participant.

P#	User Profile	Preferred device	Main influencing factor
P1	Proactive manager	Bracelet	Self-image (aesthetics)
P2	Dependent monitor	Bracelet	Perceived benefits for anxiety (simplicity)
P3	Cautious monitor	Smartwatch	Familiarity, Integration
P4	Cautious monitor	Smartwatch	Perceived benefits for anxiety (to be in control)
P5	Proactive manager	Smartwatch	Familiarity, Perceived benefits for tracking BP

8.1.2 AI-Enabled Mobile Features

The purpose of this activity was to gather initial feedback on AI-powered tools for SMBP.

Predictive BP Reading Feature with Personalised Recommendations: This concept elicited mixed reactions from participants (Figure 13). One participant expressed concern that a prediction of elevated BP could induce anxiety, motivating or discouraging patients from being proactive, depending on their mindset. This participant also felt that the action plan provided would not be useful to them personally, but might be helpful for others: *"I think some people might like it, but I'm not keen."* [P1]. In contrast, another participant viewed the concept as the ideal solution. Mapping BP predictions to actionable plans could help them prevent the predicted outcome: *"This would help because a person would be constantly informed of the problem. An interpretation of the readings and then tell me what could I do [...] that is of utmost importance"* [P5].

Conversational AI Agent for BP Response and Advice: While this idea was generally well-received, one participant rejected this solution, comparing it to past frustrating experiences with chatbots: *"My experience with these chatbot tools is ... 'don't bother me'"* [P2]. Conversely, another participant saw it as familiar, which could facilitate adoption: *"Now everywhere we call, a chatbot answers it first"* [P5]. Most participants valued receiving immediate feedback, with some suggesting an audio-chat feature for convenience: *"I like the fact that it's got the AI Interface that you've got almost like talking to somebody."* [P1]; *"I suppose if you could speak it in rather than have to type it, it would be easier to use."* [P3].

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8.2 Solutions in the Context of the User Needs

Participants discussed how the proposed solutions could help address their identified needs:

1. *Bracelet Wearable* – Some participants appreciated the passive monitoring, which would help reduce the anxiety typically associated with BP cuffs.
2. *Smartwatch and Predictive BP Values and Action Plan* – This combined solution could potentially help to manage BP expectations, reduce anticipatory anxiety, and support daily BP tracking.
3. *AI Chatbot for BP Response and Advice* – Participants valued its ability for immediate support and reassurance. It was also seen as a useful tool for improving feedback and education on hypertension management.

9 DISCUSSION

Hypertension is a major cardiovascular risk factor contributing significantly to global mortality, particularly in ageing populations, placing an increasing burden on healthcare systems. While SMBP alone is not sufficient to consistently control BP, evidence demonstrates its effectiveness when combined with additional forms of support; however, its practice remains inconsistent, leading to suboptimal outcomes [53, 78]. This work studied patient attitudes and BP technology use to identify barriers to effective SMBP and explore design opportunities to support sustained engagement with SMBP. Specifically, we examine how people living with hypertension understand and manage self-monitoring of blood pressure in everyday life, and how emerging technologies may better support that work.

By combining survey findings with participatory design activities, the research provides insight into attitudes towards SMBP. Together, the studies form a nested argument. Study 1 specifies the practical and emotional demands of SMBP, establishing it as an emotionally demanding, routine-embedded practice rather than a technical adherence task. Study 2 explains how different patients manage those same demands, along dimensions of responsibility, confidence, and tolerance of uncertainty. The survey revealed substantial heterogeneity in how patients relate to monitoring that it could not itself explain, and Study 2's exploratory profiles address that gap. These profiles should be understood as design sensitisers that illustrate variation within our small participatory sample, not stable user categories. Together they let us connect the demands of SMBP to the design responses most appropriate for different patients. In this section, we interpret these results in relation to prior HCI and clinical literature, with attention to how they refine existing models of technology acceptance and inform the design of future patient-centred monitoring tools.

9.1 Hypertensive Patients' Attitudes Towards Self-Monitoring of Blood Pressure

Participants generally recognised the importance of regular SMBP, but their practices varied widely, from daily to yearly monitoring. This inconsistency likely reflects unclear medical guidelines, differing recommendations, and personal motivations. Survey results aligned with a large-scale prevalence study, which found that only half of patients monitor regularly, despite its benefits [75].

9.1.1 Patient Profiles Based on Attitudes

SMBP frequency and consistency are influenced by patient attitudes and behaviours. Analysis of the data coded under 'Health Status' and 'Health Beliefs and Concerns' from the TAC Toolkit, tied to the Theory of Reasoned Action and Health Belief Model, revealed patterns of similarity in attitudes [25, 26, 38, 57]. Four factors influenced SMBP behaviour: (i) perceived BP control, (ii) responsibility for BP management, (iii) personal and family history of BP-related events, shaping perceived threat level, and (iv) hypertension knowledge, influencing perceived benefits and barriers. Based on these insights, three exploratory attitudinal profiles were developed to characterise different ways participants approached SMBP: **Proactive Managers** (self-motivated to monitor BP, confident and calm in approach), **Cautious Monitors** (anxious monitoring due to past BP events, fearing high readings), and **Dependent Monitors** (lacking confidence and knowledge, and relying on doctors for BP management).

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'Proactive Managers' appeared most likely to engage in regular SMBP, while 'Dependent Monitors' appeared least likely to initiate monitoring independently. Profiles may shift as antecedent factors change. For example, improving education could help a 'Dependent Monitor' become a 'Cautious Monitor'.

As exploratory design sensitisers, these profiles offer a heuristic lens for human-centred design by helping surface candidate user needs and patterns of engagement. However, validating them as stable design targets would require larger and more diverse studies [64, 86]. The profiles complement existing technology acceptance perspectives by illustrating how responsibility, confidence, and tolerance of uncertainty can shape different approaches to SMBP.

9.1.2 Challenges with SMBP

While most survey participants did not find SMBP difficult, adoption barriers emerged across user-, cuff-, and device-related challenges.

User-related challenges, particularly anxiety, were associated with avoidance of SMBP in both this study and prior studies [58, 76]. Notably, these avoidance behaviours can be understood as adaptive coping strategies in response to emotionally demanding monitoring practices, rather than as non-adherence. This suggests that anxiety can reshape when, how and how often patients are willing to engage in SMBP. Even with free equipment and support, many individuals still avoid monitoring [80], suggesting that disengagement may represent an attempt to limit emotional strain. Approaches to managing this anxiety vary: clinicians sometimes recommend reducing monitoring [8], whereas cognitive-behavioural approaches advocate gradual exposure [17]. Continuous, automated BP monitoring may support the latter approach by normalising regular contact with BP data while reducing the effort each measurement demands.

Cuff-related challenges, such as discomfort, and device-related issues, like uncertainty about proper technique, have been widely reported in the literature and continue to persist due to the reliance on traditional cuff monitors [32]. These challenges can lead to inaccurate BP readings and discourage regular monitoring. Though cuffless options remain under validation for clinical use [87], they show promise in mitigating these challenges and reducing the burden.

9.2 BP Technologies' Role in Regular Self-Monitoring Practices

Technology acceptance is an important component of effective SMBP. Findings from the participatory design indicate that participants' engagement with BP technologies was shaped by acceptance-related considerations, including perceived usefulness, ease of use, emotional responses (e.g., anxiety or reassurance), and integration into everyday routines [19, 57]. Different acceptance factors mattered to different individuals, influencing whether SMBP practices felt manageable or burdensome in daily life.

Participants consistently favoured technologies that reduced disruption, required less active involvement, and fitted more naturally into everyday routines, while remaining sufficiently trustworthy to support confidence in BP monitoring. Although participants recognised advantages and limitations across both existing and emerging BP technologies, no clinically recommended alternative to conventional cuff-based monitoring currently offers the combination of convenience, reassurance, and clinical confidence they desired, highlighting an important opportunity for future innovation in SMBP technologies.

9.3 Design Opportunities for an Improved SMBP Experience

Prior HCI research on self-monitoring, particularly in type 2 diabetes [28, 49, 50, 66] and fitness tracking, has emphasised optimisation, frequent feedback, and sustained goal-directed engagement. Although SMBP shares several characteristics with these domains, participants in our study highlighted uncertainty, anxiety, and the need for reassurance as central to their monitoring experience. These concerns, together with trust in BP readings and integration with daily life, often outweighed the perceived benefits of increased data. For some participants, frequent or detailed feedback was not inherently motivating and

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could itself become an anxiety trigger. As developed below, SMBP differs from these domains in ways that reshape the design challenge.

We conceptualised the SMBP process across six components mirroring task analysis approaches in instructional design [85]: (i) attitudes towards own health, (ii) reasons for monitoring, (iii) pre-measurement tasks and emotions, (iv) recording BP, (v) measurement techniques, and (vi) response to results. From this analysis, three key user needs emerged and are discussed below.

A) Increasing calmness during SMBP: Participants preferred less clinical and less attention-demanding systems such as smartwatches for continuous monitoring that reduced active involvement. The familiar and non-invasive nature of smartwatches made them appealing for routine use [56, 81]. These preferences can also be understood in relation to the social visibility of BP monitoring and the desire to avoid overt medical signalling in everyday life, aligning with prior HCI work on concealment of wearable medical devices [61]. Rather than constant or highly salient feedback, participants favoured passive forms of monitoring that normalise BP variability without inducing anticipatory stress or rumination [11, 21]. Unlu et al. [80] conclude that innovative methods which are "less burdensome" are essential. Extending this perspective, our findings suggest that successful technologies should minimise anticipatory cues (e.g., device noise, countdowns, alerts), helping patients sustain long-term monitoring without emotional cost.

B) Providing personalised feedback and education: Participants valued timely, actionable advice to support BP management. Personalised digital interventions can enhance SMBP effectiveness [41, 42, 52, 91]. However, unlike self-tracking domains focused on behavioural optimisation [10, 11, 70], participants in our study valued personalisation primarily to understand normal BP variability, contextualise one-off deviations, and build confidence in deciding when action is warranted. This suggests that personalisation in SMBP should support reassurance and interpretive confidence.

C) Enabling BP tracking*:* Participants envisioned an ideal SMBP system that combines continuous monitoring with personalised insights to enhance understanding and confidence over time. While fitness tracking relies on goal attainment and regular checking [10, 70], SMBP tracking was valued for confirmation and emotional regulation. These findings suggest that the value of tracking in SMBP lies less in encouraging frequent interaction and more in supporting confident interpretation of long-term trends; tools should prioritise interpretability and trust over regular engagement, as excessive checking or poorly contextualised data may amplify worry.

Together, these findings highlight a distinction between SMBP and adjacent chronic care domains. HCI research on type 2 diabetes self-monitoring has documented the sense-making and emotional work generated by episodic measurement, dedicated equipment, and short-term variability [49, 50, 66]. In diabetes self-management, readings typically afford a proximate corrective response, orienting monitoring towards determining the right action. In contrast, a BP reading rarely affords immediate action; it acquires meaning only against a longer horizon of cardiovascular risk. The central question for patients becomes not what to do, but whether any response is warranted at all. This shifts the dominant emotional work from optimisation towards tolerating uncertainty and seeking reassurance.

This positions SMBP as a boundary case for personal informatics design. While personal informatics systems are commonly designed to support reflection, sense-making, and behaviour change through self-tracking data [10, 22, 50], SMBP presents a setting in which additional measurement does not straightforwardly yield insight and can instead amplify worry and rumination [21]. The design objective is therefore not to maximise engagement but to calibrate it, supporting interpretation and reassurance, and at times supporting users in not acting on benign variability, while avoiding the over-monitoring that drives disengagement [22] and emotional burden [21]. These priorities complement rather than replace optimisation goals: maintaining BP within target ranges remains clinically important, and most Study 1 participants valued regular monitoring for its role in BP control.

As has been cautioned in adjacent digital health contexts, overly comforting systems risk delaying recognition of situations that genuinely warrant action [55]. In SMBP, reassurance-oriented design must therefore help users distinguish safe, transient BP fluctuations from sustained increases requiring clinical escalation. This distinction is itself an open design problem. Designing for reassurance risks normalising a

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genuinely rising trend, while designing for sensitivity recreates the burden patients want to escape. Whether this threshold should be fixed, personalised to a patient's profile, or shifted towards clinical escalation when confidence is low, is a central design tension for future SMBP technologies rather than one we resolve here.

9.4 Hypertensive Patients' Perception and Acceptability of Emerging Technological Innovations for SMBP

Technology acceptance models [19, 35, 57] were used as analytical lenses to explore the five design-session participants' perceptions of acceptability and potential adoption of four presented solutions: a bracelet-like BP monitor, a smartwatch, an AI-powered BP prediction tool with personalised action plans, and a conversational AI agent.

9.4.1 Perception and Acceptability of Cuffless Monitors

Both the bracelet-like monitor and smartwatch were well-received. Participants appreciated them for their familiarity, reduced user involvement, and the perceived benefits of continuous monitoring. The bracelet appealed to those who preferred a passive role, while the smartwatch attracted users seeking more control and flexibility. This suggests that there is potential market space for multiple device types, reflecting different acceptance priorities rather than a single optimal solution. Prior literature indicates that familiarity and past experiences influence the adoption of health technologies [35, 81], supporting the likelihood that wrist-worn devices may be well-accepted for some individuals.

9.4.2 Perception and Acceptance of BP Predictions

The AI-powered BP prediction prototype, offering future BP forecasts and action plans, received mixed reactions. While some participants valued the personalised action plan, others were sceptical about the accuracy of BP predictions, expressing concern that such forecasts might increase anxiety or discourage engagement with BP management. Conversely, other participants recognised the potential benefits of forecasted BP values, which could enable proactive behavioural adjustments to manage their BP.

Research into machine learning models for predicting BP based on daily activities is ongoing [83, 89], and could be enhanced by continuous data inputs. However, the lack of clinical validation of continuous BP monitors may delay the introduction of such tools in SMBP practice and contributed to participants' caution towards predictive features. A lived experience study also revealed challenges in scepticism and sense-making about forecasted glucose levels [11], indicating that further work is required before BP predictions can be effectively incorporated into self-monitoring and widely accepted by patients.

9.4.3 Perception and Acceptance of Conversational AI Agents

The conversational AI agent for real-time BP feedback was generally well-received, with participants appreciating the personalised advice, particularly when immediate access to healthcare might be limited. This aligns with existing evidence that SMBP is most effective when combined with additional support strategies [53, 78]. Conversational AI agents have shown promise for supporting patients in mental health and oncology [69, 90], and prior work has demonstrated favourable usability and acceptability of chatbots for hypertension self-management [30], while noting that resistance to chatbot-based interactions should be considered when designing these tools.

Participants' expectations of conversational agents aligned with elements commonly discussed in SMBP support, including timely interpretation, reassurance, and guidance on appropriate next steps, rather than full clinical decision-making. Based on both participant feedback and current conversational system capabilities, such agents appear well-suited to supporting interpretation of readings, encouraging re-measurement, providing brief educational explanations, and helping users decide when to seek professional input. However, they are not yet positioned to replace clinician judgement, particularly for

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medication management or diagnosis, and must be carefully designed to avoid increasing anxiety or reducing trust in care.

Overall, the solutions presented were found to be relevant to the user needs explored in this project. The bracelet-like monitor was seen as a solution that would reduce anxiety associated with SMBP. The smartwatch, combined with a BP prediction tool, was considered as supporting active engagement, better BP profile understanding and expectation management. Finally, the conversational AI agent was perceived to provide valuable personalised feedback and education to support interpretation of BP readings. Taken together, these findings suggest that a range of emerging technologies – including passive monitoring devices, predictive systems and conversational interfaces – may complement rather than replace clinical care by supporting interpretation, emotional regulation, and informed engagement between clinical encounters.

10 LIMITATIONS AND FUTURE WORK

The online survey recruitment, primarily via social media, may have introduced sampling bias, favouring internet users, predominantly white UK participants. The small sample size limits representativeness. Anonymity might reduce social desirability bias, but self-reporting could still lead to recall bias. The survey also did not employ automated bot-detection or fraud-prevention measures, and eligibility was self-determined, so we cannot fully exclude ineligible or duplicate responses. We consider this risk limited, as recruitment targeted hypertension-relevant communities, no incentive was offered for survey completion and responses were manually checked for completeness and internal consistency before analysis. Nonetheless, the survey results should be read as indicative of attitudes within a self-selected sample rather than as precise prevalence estimates. Future work could strengthen participant authenticity through panel-based recruitment (e.g., Prolific, as used in Study 2) with built-in attention and identity checks.

Given the small sample size, findings from the participatory design study were intended to inform design understanding and exploration, rather than to support prevalence claims or generalisable comparisons between technologies. The resulting attitudinal profiles and technology perceptions should therefore be interpreted as exploratory and used as sensitising concepts for design rather than as stable user categories.

The online format may have restricted participant interaction compared to in-person sessions. Presenting technologies in the same order during user feedback could have introduced order effects, influencing participants' views.

Future work should validate and refine the identified attitudinal profiles through larger surveys or diary studies to understand their connection to long-term SMBP engagement. Human-centred design research can focus on these profiles to identify specific needs and challenges, promoting proactive SMBP practices. Additionally, future work should investigate how emerging technologies, including predictive and conversational systems, can support SMBP while balancing reassurance with appropriate clinical escalation.

11 CONCLUSION

This work investigated how people living with hypertension experience self-monitoring in everyday life and how emerging technologies might better support sustained engagement with SMBP. The research gathered insights into user needs, explored preliminary design concepts, and elicited user perspectives on future technological approaches to supporting SMBP.

The findings suggest that although patients recognise the value of SMBP, regular monitoring is shaped by anxiety before and after measurement, uncertainty about how to act on a reading, and the effort of fitting it into everyday routines. Participants identified opportunities for technologies that integrate more naturally into daily life and facilitate understanding of BP patterns over time.

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The study makes three contributions to HCI and health research. First, it characterises SMBP as a self-monitoring practice in which measurement is largely decoupled from immediate action, distinguishing it from adjacent domains such as type 2 diabetes and positioning it as a boundary case for personal informatics design, one in which supporting interpretation, reassurance, and emotionally sustainable engagement matters as much as supporting measurement itself. Second, it develops exploratory attitudinal profiles that illustrate how responsibility, confidence, and uncertainty may shape engagement with SMBP, providing design sensitisers for human-centred design. Third, it identifies design opportunities for SMBP technologies that balance calmness, sense-making, and reassurance alongside clinical optimisation, thereby extending personal informatics and self-management perspectives in the context of hypertension.

More broadly, this pattern is unlikely to be unique to blood pressure. Wherever a measurement carries meaning only against a long-term risk horizon rather than a proximate corrective response, the same design demands should follow, and the SMBP case offers one account of what they involve. This study's findings provide a foundation for the design of future SMBP technologies that better reflect patients' lived experiences while supporting long-term self-management.

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