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RESEARCH ARTICLE

Wearable activity trackers for nurses' health: A qualitative acceptability study

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Abstract

Aim: To assess the practical, social and ethical acceptability of the use of a POLAR® H7 chest-strap wearable device to influence health behaviours among pre-registered nurses.

Design: Qualitative acceptability study including a simulated test of use reported using COREQ guidelines.

Methods: Pre-registered nurses simulated nine nursing tasks while wearing the chest strap in a clinical simulation facility in a Scottish university in 2016. Focus groups and semi-structured interviews were conducted to assess technology acceptance with participants who did and did not participate in the simulated nursing tasks. Focus groups and interviews were transcribed and analysed thematically guided by a theoretical model of technology acceptance.

Results: Pre-registered nurses thought the use of chest-strap devices to monitor their own health in real-time was acceptable. However, participants shared that it was important that the use of technology was inclusive and supportive of nurses' health and cautioned against misuse of data from wearable devices for individual performance management or stigmatisation.

KEYWORDS
nurses' health, simulation, technology acceptance, wearable activity trackers

1 | INTRODUCTION

Calls to address concerns about the health and well-being of the nursing workforce pre-date the COVID-19 pandemic (Kyle et al., 2016, 2017; Schneider et al., 2019) and have been renewed in its wake due to its impact on psychological health and well-being, and ever-increasing numbers of nurses leaving the profession (Ball et al., 2022; Couper et al., 2022; Gray et al., 2022). International evidence indicates that improvements in the health of both pre-registered and Registered Nurses are required. Pre-registered nurses' health is generally poor when they start nursing programmes (Blake et al., 2011) and worse than Registered Nurses across a range of behavioural indicators (Malik et al., 2011). As many as one in four pre-registered nurses smoke (16%–25%), two in four do not meet physical activity guidelines (24%–54%), and three in four do not meet dietary guidelines for fruit and vegetable intake (73%–77%) (Blake & Harrison, 2013; Blake et al., 2011; Evans et al., 2019; Malik et al., 2011), reflecting patterns of health-related behaviour in Registered Nurses (Schneider et al., 2019). Overweight and obesity prevalence among pre-registered nurses is 24%–47% (Blake & Harrison, 2013; Evans et al., 2019), mirroring levels of overweight and obesity in Registered Nurses (Kyle et al., 2016, 2017), which are higher than other healthcare professionals and the general working population (Kyle et al., 2016).

As the workforce of the future, the health and well-being of pre-registered nurses have become an increasing priority for governments, professional regulators, and nurse educators (Bak et al., 2020; Health Education England, 2019; NMC 2018; RCN, 2016; Scottish Government, 2017). In the United Kingdom (UK), for example, educational standards issued by the Nursing and Midwifery Council (NMC) require pre-registered nurses to "understand the professional responsibility to adopt a healthy lifestyle to maintain the level of personal fitness and well-being required to meet people's needs for mental and physical care" (NMC 2018, p. 3). Therefore, influencing healthy behaviours to enable improved health and well-being for the pre-registered and registered health and care workforce is paramount (Bak et al., 2020; Schneider et al., 2019).

2 | BACKGROUND

Wearable devices can provide real-time monitoring of health-related data for patients and healthy individuals. Their use and acceptability have been assessed in healthcare settings and within medical research across a range of patient groups (Chan et al., 2022; Wilson, 2016; Wu & Luo, 2019). In addition to the ability to monitor physical fitness, wearable devices have also been demonstrated to help empower and facilitate improved health behaviours for patients (Chan et al., 2022; Edward et al., 2020; Patel et al., 2015; Ryan et al., 2019). Ryan et al. (2019) found positive psychological effects and minimal negative consequences associated with wearing tracking devices further contributing to evidence that activity wearables are safe and appeal as tools to positively influence health behaviours. Patel et al. (2015) suggested that activity trackers offered a potential mechanism for empowering change especially if the understanding of how certain behaviours influence health is in place. In their role as health promoters, nurses, therefore, encourage and educate patients about the use and value of wearable devices (Edward et al., 2020).

However, little research has been done on the use of wearable devices to enable nurses to monitor and empower their own health (Wills & Kelly, 2017). A key barrier to this research is that wrist-based devices are not permitted in clinical settings due to increased infection control risk. However, chest-strap devices worn under uniform may be a suitable alternative and have been shown to monitor metrological parameters more accurately than wrist-based devices (Cosoli et al., 2020).

3 | THE STUDY

The acceptability of wearable chest-strap devices to monitor nurses' health has not been previously explored. Pre-registered nurses are ideally placed to examine the acceptability of wearable devices both psychologically and experientially as an approach to educating and motivating better health related habits for the future nursing workforce. The following study evaluated the acceptability and experience of wearing a chest strap activity tracker while conducting simulated nursing activities.

3.1 | Aims

- To assess the *practical*, *social* and *ethical* acceptability of wearing a chest strap activity tracker device while carrying out routine nursing duties.
- To explore pre-registered nurses' perceptions about the potential value of wearable devices in influencing the health and behaviours of the nursing workforce.

4 | METHODS

4.1 | Design and theoretical framework

A qualitative acceptability study was conducted in line with Sekhon et al.'s (2017) Theoretical Framework of Acceptability. This involved simulation, focus groups and interviews with pre-registered nurses to assess the practical, social and ethical acceptability of wearing a chest-strap tracking device while undertaking routine nursing activities. The study is reported using COREQ Guidelines (Tong et al., 2007).

4.2 | Participants

Pre-registered nursing students from a Scottish university were recruited from a 3-year undergraduate Bachelor of Nursing programme enabling registration with the NMC in child, adult, mental health or learning disability nursing. The programme is government funded accepting Scottish domicile participants and has wide access recruitment with an average yearly cohort of 650–750 students of whom around 90% are female. Students volunteered to participate in response to an announcement posted on the virtual learning environment (VLE) supporting the programme. The announcement was composed by a postgraduate research intern (CVS). It gave brief details of the study aims and the researcher's academic affiliation and status. CVS had no previous relationship with any of the potential participants.

4.3 | Inclusion criteria

Students in this programme were eligible for inclusion if they were current pre-registered student nurses and self-declared that they had no known health condition that would prevent them from completing simulated nursing tasks.

4.4 | Data collection

A total of 12 participants took part in the study; six in Phase 1, which included a simulated test of use and focus groups. The simulation was facilitated by CM, LH and RGK and focus group by CVS. A total of nine participants took part in Phase 2 consisting of semi-structured interviews; three of these participants had taken part in Phase 1 the remaining six had not. Table 1 summarises the data collection methods for each participant. Focus groups and interviews were conducted by CVS as part of their master's dissertation.

4.4.1 | Phase 1

Simulation

Six participants were asked to attend the University clinical simulation facility to take part in simulation of nursing activities while wearing a POLAR® H7 chest strap. The device recorded heart rate variability (R-R interval), heart rate (beats/minute), speed (km/h), distance (km), acceleration (m/s^2) and the recording time. Reliability of measures during the simulation was found to be high across all six participants (Schwab, 2016). Information detailing the purpose and rationale of activity trackers including the data gathered and relation to health status and behaviour had been shared within the research information posted onto the students' VLE. Baseline biometric data was gathered using a set of Tanita Body Composition Scales which enable BIA (Bioelectrical Impedance Analysis) (Tanita, 2022). Data collected included height, weight, BMI, hydration levels and resting heart rate. Participants were asked to complete a survey ascertaining socio-demographic data and health perceptions of the nursing workforce. These measures were taken in this way to determine acceptability of this form of data collection and to encourage immediate self-reflection on the gathering and use of personal health data, especially in a group setting. Participants then carried out nine simulated activities over the course of 3 h before taking part in a focus group. Table 2 shows how the simulation and focus groups were scheduled across the same day.

Focus groups

Focus groups followed simulation to assess immediate reaction to completing simulated nursing tasks while wearing the device. Focus groups were chosen to get insights into perceptions about practical acceptability and, more briefly, social and ethical acceptability of the tracking device (Gray, 2017; Kupper et al., 2007). The number of participants in each focus group enabled free-flowing discussion and the potential for data saturation (Onwuegbuzie et al., 2009). A total of two focus groups were conducted with half of the participants in each group. Each focus group was 2 h long, took place in a meeting room on the University campus and dialogue was recorded using an audio digital recorder. Table 3 outlines the focus group discussion rounds and participatory activities designed to encourage reflection and conversation.

4.4.2 | Phase 2

Semi-structured interviews

Face-to-face semi-structured interviews were conducted with two groups of pre-registered nurses. Semi-structured interviews were chosen to enable further elaboration and exploration of topics arising from the focus groups (Gray, 2017). Group 1 included three

TABLE 1 Data collection.

		Phase 1			Phase 2
Participant	Field of practice[a]	Simulation	Focus group 1	Focus group 2	Interview
1	Adult	●	●		
2	Adult	●	●		
3	Adult	●	●		
4	Adult	●		●	●
5	Child	●		●	●
6	Mental health	●		●	●
7	Adult				●
8	Adult				●
9	Adult				●
10	Adult				●
11	Learning disability				●
12	Adult				●
Total		6	3	3	9

[a]Pre-registered nurses in the United Kingdom elect to study one of four fields of practice at the start of their programme and join that part of the register held by the Nursing and Midwifery Council (NMC) on successful completion of their course.

TABLE 2 Simulation schedule.

	Activity	Time	Description
1	Welcome and introduction	10:00–10:30 AM	Participants met in the clinical skills lab where the research team provided an overview of the research. Information was provided in writing and verbally about what will be involved. The participants were then asked to sign consent forms if they remained agreeable to participating
2	POLAR® device briefing	10:30–11:00 AM	Written instructions were provided to participants about how to put on the POLAR® H7 chest straps. Each individual was provided with one strap and asked to put it on in an area where they had privacy. A researcher then completed a brief proforma indicating if the straps are correctly fitted and that data is being recorded accurately
3	Simulated nursing task circuit	11:00 AM–1:00 PM	Participants completed a circuit of nine simulated nursing activities, repeating those activities over the course of an hour. These activities involved the following: 1. Manoeuvre a bed table or locker 2. Turn a manikin from one side to the other on a bed 3. Simulated CPR 4. Assist a researcher to transfer from a bed to a chair 5. Do someone's shoelace 6. Manoeuvre a bed 7. Brisk walk along a corridor 8. Walk upstairs 9. Sitting down to rest
	Lunch	1:00–2:00 PM	Lunch was provided and during this time participants were requested to keep their straps on to assess longer-term comfort
4	Focus groups	2:00–4:00 PM	A focus group took place to assess the practical feasibility of wearing the POLAR® H7 chest strap devices. The focus group explored the questions to assess both practical feasibility and, more briefly, ethical acceptability. Participants were requested to keep their straps on to assess longer-term comfort. Table 3 shows the focus group schedule
5	Debrief	4:00–4:30 PM	Participants were asked to remove and return the straps and to complete a further brief proforma about their individual perceptions of the day

out of the six participants who took part in the simulation, and Group 2 included six participants who did not. Interviewing participants with and without direct experience of the device enabled differences associated with previous experience to be identified. Interviews with participants who had taken part in the simulation lasted between 21 and 41 min (average 27 min). Interviews with participants who had not taken part were slightly longer, lasting between 29 and 46 min (average 39 min). Interview questions for simulation participants were focussed on their experiences of the simulation and any changes in knowledge, attitudes, and behaviours (Table 4). Interviews with non-simulation participants drew on quotations from focus group participants to stimulate discussion (Table 5). Interviews took place in a meeting room on campus and audio recorded digitally.

4.5 | Data analysis

Analysis to examine the acceptability of wearable devices was enabled using a theoretical framework developed by integrating and expanding two existing conceptual models: the Health Information Technology Acceptance Model (HITAM) (Kim & Park, 2012) (initially derived from the Technology Acceptance Model [TAM] [1989]) and the Usability Model (UM) (Nielsen, 1994).

The TAM theorises the process and factors that influence how and when people decide to use a new technology (Davis, 1989). TAM is underpinned by the Theory of Reasoned Action model (Fishbein & Ajzen, 1974) designed to explain human behaviour; TAM focuses specifically on perceived usefulness and perceived ease of use, and users' attitudes, intentions, and actual use of technology (Buabeng-Andoh, 2018). Kim and Park's (2012) HITAM extends TAM in three important ways. First, drawing on the Health Belief Model it includes a new concept of *perceived health threat* as a potential trigger for action, which influences the perceived usefulness of technology. Second, drawing on the Theory of Planned Behaviour *subjective norms*, including peer pressure and community competition, added as a further influence on perceived usefulness. Third, *self-efficacy* (whether an individual feels confident to use the technology) and *reliability* (the quality of the technology) as antecedents of both *perceived usefulness* and *ease of use*. We further extended the HITAM by incorporating the UM (Nielsen, 1994).

TABLE 3 Summary of focus group questions and activity schedule.

	Focus group	Questions	Action
1	Debrief of the simulation	Do you feel like the simulation was a good representation of usual nursing activity? Was there anything missing?	Discussion
2	Practical feasibility	How practical and feasible was it to wear the activity tracker while carrying out nursing duties? What words come into your mind—please write these on post-it notes.	General discussion Gather the post-it notes and collectively group the words and phrases associated with the experience
3	Categorisation	1. Perceived ease of use 2. Easy to learn 3. Comfort 4. Easy to remember 5. Subjectively pleasing 6. Other Which of these would you see as most important or as a major issue?	Collectively place all the post-it notes with the help of the group in the right category. If people come up with new ideas add them on a post-it note on the flipchart

TABLE 4 Summary of interview guide for focus group participants.

Section		Question
Introduction	1.	What was your most significant experience during the simulation?
	2.	What was your most significant experience during the focus groups?
Knowledge	3.	Have you thought about your data since the simulation?
	4.	How did you feel about seeing your own health data?
Behaviour	5.	How would you describe the experience of wearing a tracker?
	6.	Has it changed your behaviour?
	7.	Did you tell people about your experience?
Attitude	8.	What is your opinion of these devices?
	9.	Do you feel anything negative about monitoring your health in this way?
	10.	Do you feel these devices are reliable and safe?
	11.	Do you perceive any stigma associated with these devices?

TABLE 5 Summary of interview guide for non-focus group participants.

Section		Question
Attitude	1.	Are you familiar with activity-tracking devices, have you ever used one?
	2.	What is your view about using activity-tracking devices to monitor health?
	3.	What do you think about the idea of nurses wearing activity-tracking devices to monitor their health; how *practical* and *acceptable* do you think this would be?

Neilson's (1994) UM comprises two core components: *social acceptability*, including normative beliefs and subjective norms, and *practical acceptability*, based on considerations such as cost, compatibility, reliability and perceived *usefulness*. Usefulness is further separated into two elements: *utility* (the ability of a system to meet needs of a user) and *usability* (the possibility of a user to use the device easily and properly). Usability has five dimensions: easy to learn, easy to use, easy to remember, few errors and the device being subjectively pleasing.

Combining these complementary models enabled us to examine the *social* and *practical acceptability* of the device in greater detail, which is essential when assessing acceptability for the first time in a new context. However, a key limitation of both the HITAM and UM is that ethical concerns are under-theorised (Chuttur, 2009; Harrison et al., 2013). Consideration of the ethical acceptability of technology is vital following high-profile data breaches (e.g. Cambridge Analytica scandal), challenges of implementation of large-scale technology programmes (e.g. care.data; Carter et al., 2015; Hays & Daker-White, 2015) and debate over the use of digital contact tracing applications during the COVID-19

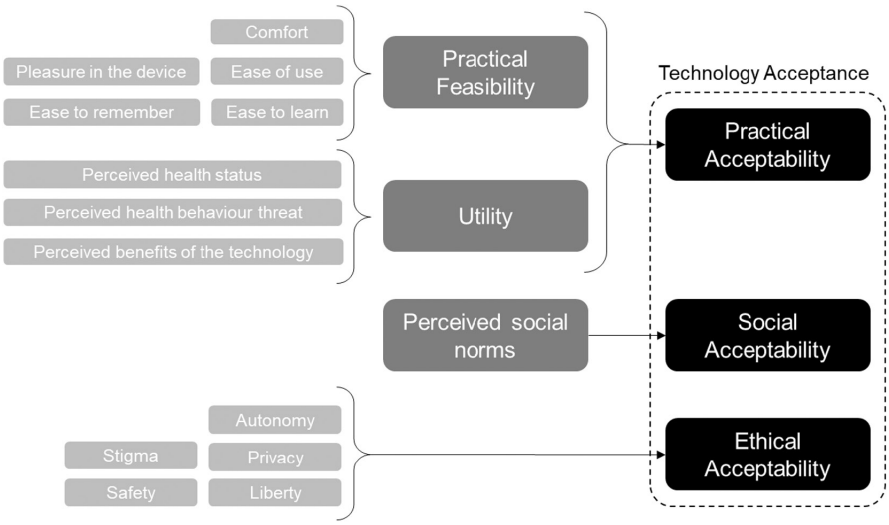

FIGURE 1 Study theoretical model [adapted from Kim and Park (2012) and Nielsen (1994)].

pandemic (Sweeney, 2020). Ethical concerns around safety, privacy, confidentiality, autonomy, liberty and potential stigma are at the core of these debates. Our final theoretical framework, therefore, included elements enabling examination of the *practical*, *social* and *ethical* acceptability of the use of wearable devices among pre-registered nurses (Figure 1).

Qualitative data from focus groups and semi-structured interviews were transcribed verbatim and entered into NVivo (Version 11) by CVS. Analysis was conducted initially by CVS and RGK then checked by CM and LH. This was done in two ways: (1) the theoretical framework developed for the study was used *deductively* to identify aspects of *practical*, *social* and *ethical* acceptability of the device reflected in the framework and (2) reading and interpretation of transcripts *inductively* identified themes not captured by the a priori theoretical framework. Both deductively and inductively derived themes are reported.

TABLE 6 Participant characteristics.

Category	*n*	%[a]
Gender		
Female	12	100
Male	0	0
Age		
18–24	2	17
25–29	4	33
30–39	5	42
40–49	1	8
Field of practice		
Adult	9	75
Child	1	8
Learning disability	1	8
Mental health	1	8

[a]Percentages may not total 100 due to rounding.

5 | FINDINGS

5.1 | Participant characteristics

All participants were women, three-quarters were studying adult nursing with most aged between 30 and 39 years (Table 6).

5.2 | Practical acceptability

5.2.1 | Practical feasibility

Practical feasibility included five sub-concepts: (1) comfort; (2) ease of use; (3) ease to learn; (4) ease to remember and (5) pleasure in the device.

Comfort

Participants were initially concerned about the potential comfort of the device in terms of device size, position, comfort with underwear, sweat accumulation and possible differences between women and men. Participants were particularly concerned that the device would be uncomfortable at the end of a 12-h nursing shift. Despite initial concerns, most focus group participants agreed the device was comfortable. Participants were initially aware of the presence of the device but this waned the longer it was worn during simulated tasks. Similarly, initial concerns about size were met with surprise once worn: "I just didn't realise it was going to be this tiny little device" (P4). However, not all participants agreed that the device was comfortable with one noting that the clasp was irritating and another that the device slipped down during the simulation. Yet, both noted that initial discomfort eased and action could be taken to ensure a better fit to avoid discomfort and dislodging of the device.

> I found that the little clasp bit was a bit irritating at first but then it got better. Actually where the strap clasps together, so the only thing was that I could feel it sometimes on my ribs. It was only once in a while

> however. Like, oh yeah, that's it, it is there. But it was not a big deal. (P5)

Ease of use

Most participants thought the device was easy to use. Participants thought that the use of the device required little effort because it only needed to be fitted at the start and end of shifts. Participants who took part in the simulated use thought that it did not limit activity during the shift. This was echoed by those who had *not* worn the device who noted that its placement around the chest meant that the device did not 'dangle' which meant it would not get in the way or touch patients or equipment. However, participants raised questions about whether the device would be suitable for use when showering patients, would interfere with equipment, and was permitted by infection control policies.

Ease to learn

Participants noted that because the device only required instruction in fitting it was easy to learn. However, during simulated use, one participant found it challenging to find a suitable size and fit for the device. In focus groups, participants suggested providing a written step-by-step guide, a colleague who could help to adjust the device, or a short instructional video, which could help participants learn how to use the device.

Ease to remember

Some participants thought that it could be hard to remember to put the device on every day, especially given the busyness of the nurses' role. For example, one participant reflected on her experience using a personal activity tracker:

> I forgot it so many times going to the gym, and then I already got there and I had forgotten to put it on. [...] I'm sure they would try to remember to use it, like in the morning they should have to fit it in somehow. But people just forget. (P11)

Pleasure in the device

Participants were pleased that the device was small, discrete and unseen, preventing colleagues' questions. One participant noted that she was pleasantly surprised that the device did not include the electrodes and wires initially expected.

5.2.2 | Utility

Perceived health status threat

Most participants believed that nurses' health was generally poor with greater risk of obesity and other diseases. Only two participants disagreed. Nurses' poor health was a concern:

> As a nurse in three months' time, it is worrying. You do get people obviously who are really looking after their health, have really good health behaviours and things like that, but overall, I think we are quite an unhealthy group of people. (P6)

As well as being a personal health threat, participants also noted that nurses' poor health could pose a threat to patient care. For example, one participant said:

> Yeah, well if someone who was overweight, came and told me that I had to exercise, I would be a bit like, really? [...] I think some of them, some of them I hear talk nurses to patients, and I think, you have absolutely no right to say that to a person. They really are unhealthy themselves. (P8)

Participants noted that not all nurses were in poor health, but those indicating the nursing workforce was unhealthy typically noted that they were healthy, considering the problem to be for others, not themselves.

Perceived health behaviour threat

Participants identified three specific health behaviour threats of nursing practice and, specifically, the working environment. First, the job was intense and stressful. Long 12-h shifts and the physical nature of the role could lead to physical health problems. Staff shortages and increasing responsibilities compounded stress resulting in mental health issues. Second, participants noted that nurses' dietary behaviours were generally poor due to lack of preparation of healthy food for work leading to snacking (on chocolate) and skipping breaks. Participants also noted that nurses were often dehydrated and did not drink enough water during shifts. Third, nurses tended to neglect themselves and put others' needs ahead of their own. This meant that if a patient was in need, nurses would potentially skip breaks to provide care. As one participant said:

> Yeah, because we as nurses forget to look after ourselves. We try to get a patient to drink all day, and you are like wait a minute have I had a drink today? [...] We need to make sure we take the time to take care of ourselves. (P5)

Only two participants did not think nurses' health-related behaviours were problematic and noted that many nurses are able to live healthily and have common sense to adapt to the challenges of the working environment.

Perceived benefits of the technology

Three benefits of the devices were shared. First, wearing the device could enable tracking of personal health data to see the impact that nursing was having on their health. Participants said that seeing their data would be satisfying and interesting and may encourage people to start thinking more about the impacts of their work, leading to

increased knowledge about their own health and positive health-related behaviours.

Second, participants discussed whether the device could lead to behaviour change, although this was more controversial. Most noted that seeing the outcomes could lead to behaviour change but also stated they would change their behaviour themselves. Participants who had experienced using the device said they did not change their own behaviour when asked in follow-up interviews. Participants thought this was because they perceived themselves to be healthy, but also because they recognised behaviour change was a complex process, especially in the context of the challenges of nursing practice.

Third, participants noted that data from the device could act as an early warning sign for healthcare settings showing, for example, which wards required more staff due to high stress levels, thereby supporting improvements to the organisation of nursing work and nurses' working lives. Less frequently, participants mentioned a benefit where the device could act as a reminder to nurses to take time out to de-stress or drink water, and that it could improve patient care as nurses were in better health.

Views on reliability of the device

Participants did not express concerns about reliability of the device but trusted that it was working and collecting data accurately. This was related to their perception that other similar devices are commonplace, and they rarely considered their reliability.

5.3 | Social acceptability

5.3.1 | Perceived subjective norm

Most participants thought nurses should be interested in wearing the device. This was supported by evidence from their experience where nurses were seen with step counters clipped to their pockets or shirt. Participants thought that implementing the use of chest-strap devices could tap into this wider trend and existing practice and that nurses should be open to wearing the device because their role requires them to be educators and role models. For example, one participant said: "The nurses are educators, so should be open to wear it" (P3). Another noted that because nurses encourage others to be healthy, they should be open to wearing a device that may support their health.

However, participants also noted some potential scepticism or reluctance to use the device among their colleagues. Participants reflected that aversion to change was normal among nurses with whom they had worked and that nurses may feel 'funny' about it. As one participant said:

> I feel that people are very reluctant to things like research. It will have to involve a lot of education, and explanation for people why this is important. [...] so it would have to be very well explained. The reason behind the study. (P2)

5.3.2 | Social environment

Social environment was identified as a theme in analysis rather than the theoretical framework. Participants interviewed after wearing the device noted they had discussed their involvement in the study with nursing colleagues. These discussions confirmed participants' earlier reflections in focus groups that using the device in a practice environment would be a 'talking point'. Interviews highlighted the specific focus of these discussions and two factors emerged: *social pressure* and *competition*.

Social pressure to wear the device if others on the same ward were doing so, especially if one ward was and another not, had potential to be a positive motivator, but could also be exclusionary. As one participant said:

> It is a difficult thing, for nurses [...] People influence each other. They don't want to be seen as the odd one out. That's kind of the thing, people want to connect with others. (P5)

However, other participants downplayed potential social pressure associated with wearing the device through reference to the social norm that pedometers were becoming part of the culture of nursing.

> I don't think it would be that much, I mean, there is different people that got the Fitbits and stuff right now. There is just a couple of them and it is not that everybody raced out to get them. They don't feel pressure to do it. They do it if they want to do it. (P11)

Competition between nurses was considered. Participants thought nurses could be competitive, as step-count challenges between individuals and wards proved. Some believed that competition could motivate nurses whereas others felt it could be demotivating. Others noted that nurses' attitudes that focussed on not judging or the restrictions in their working day meant that competition could not be taken too seriously: "I don't think we've got enough time to be competitive" (P9).

5.4 | Ethical acceptability

5.4.1 | Autonomy

All participants agreed that implementation should not be compulsory. As one participant said:

> Yeah because everybody got their own opinions on it. Nothing should be forced upon you. Yeah, obviously we wear uniforms and stuff. But those things are fine. (P11)

Compulsion to use the device was considered to compromise nurses' responsibility for their own health. Autonomy over data

from the device was also exerted by participant nurses, and this was framed within a right to know what the data would be used for.

5.4.2 | Privacy

Privacy related to seeing, sharing and reporting data from the devices. Participants agreed that they needed to see the data from their own device, but this should not be open data. Anonymising data was considered essential, and participants proposed specific solutions to enable the benefits of the data to be realised while preserving privacy. As one participant said:

> The more I think about that, if you have a competition going on, does it become, like a ladder you know. Like there is a top employee and there is one at the bottom performing. They have got an asterisk at their name because they're not hitting their mark. I think you should structure this. It doesn't matter how many steps somebody puts in as long as it contributes to the team something like that. Or maybe we don't see each other's and maybe better just a final figure of everybody's steps. And nobody knows how many we've all done. (P10)

Sharing data was considered by participants to be an acceptable use provided that informed written consent was in place and data uses were explained and understood. Participants thought reporting data should be done anonymously or at an aggregated group level.

5.4.3 | Liberty

Participants reflected on the way wearing the device could lead to a feeling of being watched. Most did not consider this to be problematic because nurses are used to being observed and technology that tracks movement is widely accepted. Some noted the unobtrusiveness of the device meant that, over time, they would forget it was being worn and monitoring health. Others, however, sketched the limits of this monitoring, alluding to suggestions of surveillance by 'Big Brother' if their manager could see the data or if it tracked them during breaks, for example:

> So, I wouldn't have a problem with it, but I could appreciate that some people might find it intrusive. If it was monitoring things like how long you took for a break. If it starts to look at different… you know, what time is that? oh that was during a break, oh they were on a break for longer than they should have been. (P10)

5.4.4 | Stigma

Stigma was discussed in three forms: self-stigmatisation, stigma of overweight people; and stigma of the general nursing workforce. First, participants thought nurses may single themselves out for criticism as wearing the device could lead to greater awareness of their own health. Second, participants felt by introducing devices into the healthcare setting it put a spotlight on health and those who were overweight may feel stigmatised, compounding self-stigmatisation. As one participant said:

> I think, it could lead to stigma in the sense that, the data, depending on how it was kind of handled obviously. Like the nurses who have higher BMIs and have higher body fat percentages are generally overweight and because of the weight, probably are also less active. […] And then people will start to look around and say she is like fat and then go back to that kind of identifiable stuff. (P8)

Third, participants thought that by using devices only with the nursing workforce, nurses, in general, could be stigmatised, which may lead to stigmatisation of individual nurses by association. As one participant said:

> Potentially, because, if there is stigma, like nurses have poor health already, and then they have to monitor it as well, it could be a bit like, oh they are not very fit and they are nurses, they have to be role models for people and now they even get their heart rate monitored for stress things. It could be that kind of stigma, but then other people could actually think oh they are trying to improve their health and that is a good thing, they could also see it in a positive way. (P11)

5.4.5 | Safety

Participants' main concern around safety was that it did no harm to themselves or patients. As the device was non-invasive participants believed it would not be personally harmful. Opinion was divided around whether wearing the device and being aware of their health would encourage nurses to push themselves beyond their limits, potentially causing harm.

5.4.6 | Misuse

Participants noted that the device could raise suspicion among nurses if the device and its data were misused, especially by managers. Misuse of the device as a performance management tool to single out nurses or deny career progression opportunities based on health was specifically discussed. As participants said:

> Though you're going to get suspicion. You're going to get, I'm getting monitored I'm getting this, getting that, I think that people might get a bit concerned. […] Yeah because there is a lot in the press just now.

> Nurses seem to get quite a bit attacked just now, about their weight, about everything that is going on and things like that, so it might get suspicion. (P12)

Participants thought that clear guidance and reassurance that the data would be used appropriately were essential.

5.4.7 | Sensitivity

Participants thought that different types of data were more sensitive than others which altered the acceptability of collecting it. Activity-tracking data (e.g. step count, heart rate) were considered less sensitive than data gathered from body scales (e.g. weight, body fat percentages, body water percentage, muscle mass, metabolic age and visceral fat levels). As participants said:

> Things like my weight and my bodyfat, that I wouldn't like. But seeing how many steps you make during a day, and heart rate... [...] I think this is more kind of matter of fact like, what you do, I do the steps today, whereas this, your body fat percentage depends on who you are. You might get embarrassed about it. (P8)

6 | DISCUSSION

Our study found that the use of a wearable chest strap device to support pre-registered nurses' health was practically, socially and ethically acceptable. Practically, participants found the device easy to use, comfortable and subjectively pleasing. Its small, unseen nature meant that it did not interfere with nursing tasks and did not attract attention or questions from colleagues. However, instructional videos were requested that presented a step-by-step guide to putting the device on to gain a good comfortable fit, and which provided reassurance that the technology would not interfere with clinical equipment. Socially, participants felt that the use of wearable devices tapped into a popular trend in nursing to wear pedometers to track steps which had led to step-count challenges between clinical teams. However, participants cautioned against an overly competitive environment that could single-out individuals for non-participation or stigmatisation. Culture and relationships within healthcare teams and participant cohorts, therefore, need to be carefully considered before wearable devices are used to ensure the use of technology is supportive and inclusive. Ethically, participants noted that retaining autonomy over what and how personal data from wearable devices are shared with others was essential as there was potential for nurses to be stigmatised if data were misused to judge personal health or performance rather than inform individual decision-making and, if appropriate, support. Protocols, therefore, need to be put in place that safeguard legitimate data use for personal and educational purposes that ensure anonymity.

Given the mandate from professional regulators, such as the NMC in the United Kingdom, for pre-registered nurses to maintain good health (NMC, 2019) it is essential that nurse educators and healthcare leaders find ways to illuminate and illustrate the links between nursing practice and health. Nurses already play a key role in promoting the use of wearable devices to support patients (Wu & Luo, 2019), and wearable devices have been shown to increase health awareness among patients (Chan et al., 2022; Edward et al., 2020; Ryan et al., 2019; Wilson, 2016). Wearable technology has the potential to increase pre-registered and Registered Nurses' awareness of their health, and how this changes over the course of their education and careers. Longitudinal research with a cohort of 207 pre-registered nurses in Scotland has shown that their physical activity and mental health decreased over the course of their 3-year programme (Evans et al., 2019). An interventional study of pre-registered nurses in England to assess options for improving health found that only 11% of the 189 participants issued with an accelerometer uploaded accelerometer data (Wills & Kelly, 2017). Wearable technology may overcome this challenge of uptake and provide an opportunity for pre-registered nurses to monitor their health to bring benefits for both their physical and mental health (Evans et al., 2019) and enable nurse educators to heed calls to embrace the change and challenge to our pedagogy technology brings (Murray, 2018).

6.1 | Strengths and limitations

First, the study included only 12 pre-registered nurses, only half of whom participated in the simulation. However, as the focus of this study was exploring acceptability it was considered vital to prioritise depth. Second, only women volunteered to take part and it may be that the views of men are different. Third, although the device was worn for over 6 h, only 1 h of simulated nursing practice was included during the day. This may not reflect the reality of 12-h shifts, typical in Scotland. Further research is needed to address these limitations by including a larger number of participants that includes men, to test use over a longer period, ideally during real-world rather than simulated nursing practice.

6.2 | Recommendations for future research

Our study examined the acceptability of the use of a wearable chest-strap device in a simulated setting in an educational institution. Future research is now needed in two areas. First, building on our simulation developed for research purposes, exploring the simulation's educational potential to encourage and enable conversations about health with pre-registered students is needed. This can be achieved through refinement of the debrief used in the study and, specifically, its redirection towards students' reflections on how the simulation influenced their learning and health. Second, repeating the simulation with Registered Nurses in an educational setting

to investigate acceptability is required. This is an important next step before considering use of the device in real-world healthcare settings.

7 | CONCLUSIONS

Pre-registered nurses felt that the use of chest-strap devices to monitor personal health parameters in real-time healthcare settings was acceptable. Participants considered it important that the use of the technology was inclusive and supportive and cautioned against misuse of data from devices for individual performance management or stigmatisation. Nurse educators and healthcare leaders should explore applications of real-time health monitoring using wearable devices as part of strategies to support the health and well-being of pre-registered and Registered Nurses and the wider health and social care workforce. Involving pre-registered and Registered Nurses in the process of developing these educational and practice-based interventions is essential.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data for this study are not publicly available. Kyle, Mahoney, Hoyle and Van Splunter confirm that they had full access to all the data in the study, and take responsibility for the integrity of the data and the accuracy of the data analysis.

ETHICS STATEMENT

The research ethics committee in the School of Health and Social Care at Edinburgh Napier University approved the study in April 2016. Simulation participants were provided with lunch, and all participants were given a £10 Amazon voucher in recognition of their time. To maintain safe clinical practice, a Registered Nurse was present throughout the data collection. Due to the potential sensitivity of the study's focus on student health and well-being, students were informed in the participant information sheet that they could withdraw from any activity during the simulation, focus groups, or interviews at any time. To ensure anonymity before analysis participants were allocated an identification number (e.g. P1).

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