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REVIEW ARTICLE

Women's embodied experiences of using wearable digital self-tracking health technology: a review of the qualitative research literature

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ABSTRACT

In this review we aimed to identify and synthesize the existing qualitative research literature on women's experiences of using wearable digital self-tracking health technology, and analytically explore the lived through and embodied aspects of self-tracking in the first-person accounts presented in this literature. Thirteen empirical studies conducted in Australia, USA, Canada, Denmark, Finland and Germany, and published within the time period 2014 to 2019, were identified through systematic searches in relevant databases, and analyzed using a method of interpretive metasynthesis. Our analysis suggests that women experienced gaining access to bodily information that was otherwise experienced as hidden through using a wearable device, and that experiencing feelings was integral to their self-tracking practices and experiences. We thus identified two core themes across the included studies: *Embodying the knowing self* and *Embodying strong feelings*. Our review contributes to the existing literature by outlining and describing an emerging body of research across different health related disciplines, and makes a theoretical contribution by highlighting the need to minimize emotional labor and to provide the opportunity for embodying agency in the context of the self-tracking activities of patients and consumers. In addition we suggests methodological ways forward in producing detailed and nuanced knowledge about the practices and implications of women's use of digital self-tracking health technology.

As exemplified by the World Health Organisation's ([Ww]orld[Hh]ealth[Oo]rganization (WHO)) drafting of a global strategy on digital health for 2020–2024, the digital transformation of healthcare is a current global phenomenon that promises improvements in quality and cost efficiency for patients and healthcare providers. In the last decade, digital

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devices that are designed to be worn on the body, and allow people to self-track and monitor aspects of their health and fitness, have become increasingly common in the everyday lives of lay people, and in the lives of patients receiving treatment for an illness or injury (Lupton, 2018). Examples of wearable devices are smart watches, rings, bands/bracelets, sensors, heart-rate monitors and pedometers. As such, wearables include products that are marketed and sold commercially, such as the Fitbit smart watch and the Jawbone UP24 band, as well as devices authorized for and utilized with patients within medical settings, for example in relation to rehabilitation treatment after injury or monitoring aspects of a chronic illness. With the help of a wearable digital device, it is thus possible for individuals to track physical activity levels, blood pressure, blood glucose, weight, sleep, eating, feelings and mood in their private everyday contexts (Berg, 2017; Fotopoulou & O'Riordan, 2017; Malicka et al., 2019). The benefits of utilizing digital self-tracking devices are often described as increased motivation for physical activity and self-care in individual users, and efficiency and cost saving in the context of healthcare services (Lupton, 2018; Neff & Nafus, 2016).

In general, digital self-tracking can be understood as having the potential to greatly benefit the individual, allowing autonomy in learning about, understanding and caring for one's own health (Rich & Miah, 2017; Sanders, 2017). For instance in the context of experiencing a chronic illness self-tracking can mean managing aspects of one's own health at home, having to attend fewer hospital visits, increasing autonomy and thus lessening the burden of the illness. Nevertheless, such digitalized practices may simultaneously serve to individualize health through the promotion and positioning of the user as responsible for their own treatment and health outcomes (Crawford, 2016; Lupton, 2013, Lupton, 2018; Moore, 2010). As argued by Lupton (2015, p. 10) digital health technologies are often presented as: "enhancement technologies, able to correct apparent deficits in the body by providing information and thus extending the capabilities of the body to monitor itself and allowing users to represent themselves as capable, responsible, illness-avoiding subjects". Hence, digital technologies are widely understood as enabling the individual to optimize their level of functioning, perform better physically and prevent ill health (Berg, 2017; Sanders, 2017; Schüll, 2016). Furthermore, the "illness avoiding subject" who takes responsibility for their health through available digital technologies is thought less likely to become a burden on health services than those who do not (Lupton, 2018). As argued by Greco, the right to health has increasingly been replaced by "the duty to stay well" in modern societies (Greco, 1993, p. 357). Based on these ideas, it can be argued that the avoidance of illness is understood as a matter of individual choice and personal sense of morality, and therefore has become integral to our embodied self-production in contemporary, digitalized society.

The global promotion and widespread uptake of digital self-tracking holds specific implications for women's embodiment. Scholars across the social sciences, and critical biology and medicine, have provided insight into the ways in which women's bodies have traditionally been seen as unruly, difficult to make sense of and in need of discipline (Bartky, 1990; Birke, 1999, 1985; Bordo, 1993; Butler, 1993; Grosz, 1994; Sanders, 2017; Shildrick, 1997; Young, 2005). As such, women's embodiment has particularly been characterized by the production of the appropriate feminine body-object in relation to size, surface and comportment. Sanders (2017, p. 50) suggests that: "The production of the feminine shape and surface requires that women learn to operate a vast array of devices, from elliptical machines to eye lash curlers to microdermabrasion kits. It demands the mastery of numerous techniques and the acquisition of highly specialized knowledge. These disciplinary technologies comprise a rigorous process by which female bodies come to code as intelligibly and desirably feminine". Women have thus been encouraged to produce appropriately feminine and physically attractive bodies - taking up, using and being visible in space in particular ways, through what can be understood as disciplinary practices (Bartky, 1990; Del Busso & Reavey, 2013; Foucault, 1977; Young, 2005). In digital society, wearable devices, which allow women to monitor, analyze and adjust their actions, represent new and sophisticated ways for women to achieve a (normalized) feminine body. Rather than just being slender, it can be argued that the current feminine body to be achieved is lean and toned, and is explicitly related to the ideal of health and healthy bodies in contemporary society (Dworkin & Wachs, 2009). In this context, wearable digital devices emerge as technologies through which normalized and traditional femininities are potentially reproduced in ways that mask disciplinary dynamics by allowing women the position of ethical and moral citizens. As such, Crain (2013) suggests that digitalization can be seen as a process of moving from a Foucauldian disciplinary society (Foucault, 1977) toward what Deleuze described as "societies of control" (Deleuze, 1992, p. 5). According to Deleuze societies of control are societies in which control is no longer exercised through disciplinary institutions, or mandated persons in positions of power, but rather where control is asserted through computers and digital technologies. As argued by Crain: "Rather than a Panopticon, with a centralized focal point from which activity is surveilled, we have a diffuse matrix of information gathering algorithms. Everything is tracked and encoded, interpreted into patterns that are either acceptable or unacceptable" (Crain, 2013, https://www.themantle.com/philosophy/living-society-control). This "diffuse matrix" may in many ways be undetectable to the individual who is "choosing" to utilize digital technologies to enhance their health, promising a healthier, and appropriately gendered,

body and simultaneously offering the position of responsible and ethical citizen.

In this context, using a wearable self-tracking device can have major implications for women's lived, material and multisensory, being-in-the-world (Young, 2005; Merleau-Ponty, 1962). Digital wearable devices are strapped to the body of the wearer and is carried on the skin during sleep and physical activity, and often more generally in everyday life and as such the device becomes part of the wearer's physical body and their felt and sensed embodiment. As an extension of the wearer's material body, the device can be set to communicate information to the wearer through alerts or buzzing, telling the wearer, for example, that they have been inactive for an extended period of time and should engage in movement. For patients who carry out aspects of their treatment with the help of a device at home, the device to some extent replaces the interaction and communication with health personnel, and becomes part of everyday lived embodiment in patients' immediate personal and relational contexts. Lupton (2017a, 2017b) has argued, however, that the existing empirical literature on digital health technology is largely *disembodied*, or characterized by a lack of attention to the sensuous, material and embodied aspects of digital self-tracking experiences. Exploring these ideas further, in this review we aimed to firstly identify and synthesize the existing qualitative research literature on women's experiences of using wearable digital self-tracking health technology. Our second aim was to collate and analyze women's first-person accounts within this literature in order to contribute theoretically to understandings of how women construct the lived, felt and embodied aspects of their self-tracking experiences.

Method

Search strategy

A senior university librarian and two researchers conducted systematic searches in CINAHL, PubMed, Embase, PsychInfo, Academic Search Premier and SCOPUS. In addition, manual searching included searching relevant journals and author publication lists. We used a number of search terms, and related variants, describing the phenomenon of interest ('wearable digital device', 'self-tracking', 'self monitoring', 'digital device') and the population of interest ('women', 'female', 'girls'). The search terms were tailored to specific databases. For instance in CINAHL names of specific wearable digital devices were used to identify relevant studies. ('Fitbit', 'Apple watch'). Early searching suggested an overall low number of qualitative studies on women and wearable digital technology, and we therefore

chose to leave out type of methodology ('qualitative') and screen the methodology sections of all identified studies.

Inclusion and exclusion criteria

In order to identify studies which were eligible for this review our inclusion criteria were: (a) studies which have used qualitative research methodology; (b) studies which have included female participants; and (c) studies which have included first person accounts of engaging in digital self-tracking with the help of a wearable device. Our criteria for excluding studies from the review were: (a) non-English language; (b) no reference to "digital device", "self-tracking device", "self-monitoring device" or "wearable digital health devices" or "wearable health technology"; and (c) studies which include only men or boys as research participants; (d) studies in which the main aim was to assess or evaluate a wearable device; and (e) books and book reviews.

Data source and study selection

Systematic and manual searching, resulted in the identification of 419 potentially relevant articles. The articles were imported into Rayyan QCRI, a systematic reviews web application, and were screened independently by two researchers in accordance with the inclusion and exclusion criteria. This process resulted in 13 articles being identified as eligible for review. Two articles report separate findings from one research study, namely Esmond (2019a) and Esmond (2019b). In addition, Lupton (2019b), Lupton and Maslen (2018) and Lupton and Maslen (2019) present separate analyses from one research project. We extracted the following study characteristics from each article: types of technology explored, methodology, sample/participants, study context, theoretical approach, field of research, and country. Furthermore, the findings in the empirical articles were reviewed using an interpretative metasynthesis (Aguirre & Bolton, 2014; Bondas & Hall, 2007; Sandelowski & Barroso, 2003). In addition, we identified 128 interview extracts, within the 13 studies, which were eligible for thematic analysis (Braun & Clarke, 2006). Interview extracts were considered eligible for thematic analysis if they included women's accounts of their *lived* and *embodied* experience of using a wearable digital device. Extracts that were merely concerned with, for instance, evaluating a device or describing preferences in relation to the design of a device were not included in the analysis

Data synthesis and analytical approach

In this review we were interested in phenomenological detail in relation to the lived through felt and sensed aspects of women's digital self-tracking

experiences. We used an interpretive metasynthesis to explore the articles, paying particular attention to the detail in women's first-person accounts presented in the texts (Aguirre & Bolton, 2014; Bondas & Hall, 2007; Thorne et al., 2004). Thorne et al., (2004) suggests that:

> "Meta-syntheses are integrations that are more than the sum of parts, in that they offer novel interpretations of findings. These interpretations will not be found in any one research report but, rather, are inferences derived from taking all of the reports in a sample as a whole. Metasyntheses offer a coherent description or explanation of a target event or experience" (Thorne et al. (2004), p. 1358).

The metasynthesis in this review included coding each article, identifying lower level themes, translating the lower level themes across the articles into one another and finally deciding on two core themes to be presented in this review (Aguirre & Bolton, 2014). Furthermore, in order to conduct an in-depth exploration of the lived and embodied aspects of digital self-tracking, we elected to identify and analyze relevant first-person interview extracts presented in the articles. The collated interview extracts were coded and analyzed based on Braun and Clarke (2006) recommendations for thematic analysis. The interview extracts were coded in NVivo, and preliminary themes were generated individually by the researchers. The preliminary themes were then explored and reviewed collectively by three researchers. This included comparing coding, reviewing the content of each interview extract and exploring each extract theoretically, and finally agreeing on eight lower level themes. The thematic analysis of women's first-person accounts were then integrated into the overall metasynthesis of the articles included in the review.

Through this process we identified the following two core themes: "*Embodying the knowing self*" and "*Embodying strong feelings*". These themes are presented in section 3.2., and further explored in section 4.

Results

Study characteristics

Wearable digital self-tracking devices
Wearable digital self-tracking devices represented in the reviewed studies included watches, bands and sensors. Nguyen et al. (2017) included Fitbit One, Jawbone UP 24, Garmin Vivofit 2, Garmin Vivosmart, Garmin Vivoactive and Garmin Smart, when they explored the acceptability and usability of consumer wearable activity trackers amongst postmenopausal breast cancer survivors. Ruckenstein (2014) collected participants' self-tracking data with a Vivago wrist watch measuring activity levels, and a Firstbeat heart-rate variability monitor in the form of two electrodes taped to the skin of the chest. Schwennesen (2017) explored what happens

when self-tracking technologies and devices are applied in a physical rehabilitation context using five sensors (two on one leg and one around the stomach) and a smartphone application with a daily training programme. Hardcastle et al. (2018) used

Fitbit Alta, Garmin Vivofit 2, Garmin Vivosmart, Polar loop 2 and Polar A300 when investigating the acceptability and utility of and preference for wearable activity trackers amongst cancer survivors. Maxwell et al. (2019) explored the potential of "a digital health tracker" in relation to increasing physical activity amongst Indigenous Australian women. In a study with elderly participants, Urban (2017) explored participants' experiences of using digital devices such as pedometers, heart-rate monitor watches, blood-pressure monitors and a bed epilepsy sensor. McCormack et al. (2019) conducted a study in which inactive adults were invited to take part in a "internet-facilitated pedometer intervention". Esmond (2019a, 2019b) collected data with women runners who used a digital wrist watch to track their running. Furthermore, in a study on the practices of self-trackers, Lupton (2019a) reports that the participants used devices such as the Apple watch. Finally, in a research project published in Lupton (2019b), Lupton and Maslen (2018) and Lupton and Maslen (2019) the participants included a number of women who used a wearable digital device, with Fitbit being the most common digital device used.

Qualitative data collection and analysis methods

Two papers used focus group interviews in combination with individual interviews (Lupton & Maslen, 2019; Nguyen et al., 2017). Seven papers used individual face-to-face interviews (Hardcastle et al., 2018; Lupton & Maslen, 2019; Maxwell et al., 2019; Nguyen et al., 2017; Ruckenstein, 2014; Schwennesen, 2017; Urban, 2017). Two papers used a running interview (Esmonde, 2019a, 2019b). Three papers used telephone interviews (Lupton, 2019a; Lupton & Maslen, 2019; McCormack et al., 2019). One paper used email interviews (Ruckenstein, 2014). Seven papers reported having used a thematic analysis to analyze the data collected in the studies presented (Esmonde, 2019b; Hardcastle et al., 2018; Lupton, 2019a, 2019b; Lupton & Maslen, 2018; 2019; Nguyen et al., 2017; Schwennesen, 2017). One paper used both a thematic analysis and a poststucturalist method of analysis (Esmond, 2019b). One paper used a typological analysis (Maxwell et al., 2019), and one paper used a Focauldian and a sensory ethnographic analysis (Esmond, 2019a). Two papers did not explicitly describe the method of analysis employed in the studies presented (Ruckenstein, 2014; Urban, 2017).

Research participants and context

Eight of the thirteen papers reviewed included only female participants, and five papers included both female and male participants. The female participants ranged from 20 to 85 years of age. Two studies were conducted in the field of medicine, specifically cancer research (Hardcastle et al., 2018; Nguyen et al., 2017). One study was conducted within the field of consumer research (Ruckenstein, 2014), and three papers presented studies that were conducted in the field of leisure research (Maxwell et al., 2019; Esmond, 2019a, 2019b). Furthermore, seven papers presented studies conducted in health research, including women's health (Lupton, 2019a, 2019b; Lupton & Maslen, 2018; 2019), physical rehabilitation (Schwennesen, 2017), sport and exercise (McCormack et al., 2019) and elderly health (Urban, 2017). The studies represent an international field of research, excluding the Asian and African continents. As such, the papers included studies conducted in Australia (Hardcastle et al., 2018; Lupton, 2019a, 2019b; Lupton & Maslen, 2018; 2019; Maxwell et al., 2019; Nguyen et al., 2017), USA (Esmonde, 2019a, 2019b), Canada (McCormack et al., 2019), Denmark (Schwennesen, 2017), Finland (Ruckenstein, 2014) and Germany (Urban, 2017).

Quality of studies

The articles were assessed independently by three researchers informed by the Critical Appraisal Skills Programme (CASP, 2013), with particular emphasis placed on examining methodological rigor, credibility and the reporting and application of reflexivity as a methodological tool. The practice of reflexivity within qualitative research can be seen as integral to producing ethical and fair research procedures and interpretations of data (Lazard & McAvoy, 2017). In defining what researcher reflexivity is Ramazanoglu and Holland (2002, p. 118) suggest that reflexivity: "covers varying attempts to unpack what knowledge is contingent upon, how the researcher is socially situated and how the research agenda/process has been constituted". We were thus concerned with the use of reflexivity as part of the overall methodology, and specifically related to the researcher as embodied being interacting with research participants, and as such co-constructing the research data and interpretations.

The researchers independently scored the articles as "low", "medium" or "high in quality". Articles assessed as low scored one point, medium scored two points, and articles assessed as high scored three points. Articles that were placed in between these categories were labeled "Low to medium", scoring 1.5, and "medium to high" scoring 2.5 points. Interrater reliability between the three authors was measured using total scores and mean

agreement. In total, author one scored 25.5 points (all included studies), author two scored 24.4 points (all included studies), and author three scored 22.5 points (all included studies). The average total score was 24.13 points, giving a mean difference in ratings of 0.75, which indicates a high level of consensus between the authors (Shadish et al., 2002). In assessing the quality of the articles, we took into account that the studies included were contextualized in significantly different research traditions (e.g. cancer research, women's health studies, consumer research). As such, we were particularly mindful of the tradition in which a paper was published in terms of its value, structure and prioritized content. In sum, five of the included papers were assessed as "medium to low" quality, four papers were assessed as "medium to high quality", and four papers were assessed as "medium quality" (Table 1).

Women's experiences of using a wearable digital self-tracking device

Our aim for the interpretive metasynthesis conducted in this review was specifically to identify and explore descriptions of the lived through and embodied aspects of women's self-tracking experiences. As such, we identified two core themes across the included articles: *Embodying the knowing self* and *Embodying strong feelings*. Extracts from women's first-person accounts are used to illustrate the two themes below.

Embodying the knowing self

Women suggested that using a wearable self-tracking device increased their knowledge about their bodies. As such, the device allowed access to information which was otherwise experienced as *hidden* or *inaccessible*. The device was thus understood as contributing to improved bodily awareness, making women more alert to aspects of their bodily functioning and, in some instance, even experienced as confirming women's own experiential interpretations. Furthermore, women in the studies suggested that this increased knowledge allowed them to reflect upon, alter and improve ways of being and carrying out physical activities to best suit their bodies.

Several of the women in the studies recognized shortcomings and limitations to the device they had used, suggesting for example that: "… we all know that it is just an algorithm, it is just a machine, it is not a human being" (Schwennesen, 2017, p. 6), and: "Sometimes he (the device) just doesn't know what he is talking about" (Schwennesen, 2017, p. 5). More commonly, however, women expressed that the device provided useful insight that was needed in relation to their health. For example in a study on heart rate variability and personal digital analytics, one woman

Table 1. Study characteristics.

Article	Research methods	Wearable technology	Partisipants	Study context	Country	Key Findings
Esmonde (2019a)	Running interview. Sensory ethnographic analysis	GPS watch	10 women, age range 26-45.	Leisure studies	USA	Themes relating to an interweaving of bodily sensations, place and data: space, quantified fitness geographies, feeling and data, conversation pace and race pace
Esmonde (2019b)	Running interview. Thematic and poststructuralist analysis		10 women, age range 26-45.	Leisure studies	USA	Themes comprised of four strategies of resistance that participants used to distance themselves from their data: "Labelling some forms of data excessive"; "Choosing not to track every day"; Acknowledging that they cannot be perfect" and "Valuing feeling over data"
Hardcastle et al. (2018)	Interview. Thematic analysis	Wearable activity trackers: Fitbit Alta, Garmin *Vivofit 2*, Garmin *Vivosmart*, Polar loop 2 and Polar A300)	14 women (2 men) Mean age 63 (SD 13)	Cancer research	Australia	Four themes identified: "Increasing self-awareness of physical activity and sedentary behavior", "Prompts and feedback", "Accuracy and registry of activities", "WAT preferences and features"
Lupton (2019a)	Semi-structured telephone interview. Social theory driven thematic analysis	Wearable device: Apple watch	20 women (20 men) Participants ages ranged from below forty to 75 years	Health/ Leisure studies	Australia	Five themes identified: "Knowledge, awareness and problem-solving", "Taking control", "Feeling better", "The burden of self-tracking" and "Disappointments and frustrations"
Lupton (2019b)	Face-to-face interview, focus group, telephone interview Inductive thematic analysis	Most common wearable device: Fitbit	Study 1: 36 women (age range 21-63) Study 2: 30 women (age range 22-74)	Women's health	Australia	Three themes identified: "Health and fitness app and wearable device use", "The limitations of apps and wearable devices" and "Ideas for future apps and wearable devices"
Lupton and Maslen (2019)	Focus group, face-to-face interview, telephone interview Inductive thematic analysis	Most common wearable device: Fitbit	Study 1: 36 women (age range 21-63) Study 2: 30 women (age range 22-74)	Women's health	Australia	Three themes identified: "Health information websites", "Online discussion forums and social media" and "Health and fitness apps and wearable devices"
Lupton and Maslen (2018)	Focus group, face-to-face interview, telephone interview Interpretive thematic analysis	Most common wearable device: Fitbit	Study 1: 36 women (age range 21-63) Study 2: 30 women (age range 22-74)	Women's health	Australia	Three themes identified: "Discovering and uncovering bodily information", "Identifying patterns and correlations" and "Embodied learning and digital devices"

Study	Method	Device	Participants	Field	Country	Findings
Maxwell et al. (2019)	Focus group, Individual interview Typological analysis	Digital health tracker	8 indigenous women. Four women in 18-30 age range, two women in 21-50 age range, two women in 50+ range)	Women's health and leisure	Australia	Five themes identified: "Adoption of the digital health trackers", "Increased health literacy", "Increased motivation for activity", "Increased accountability to self" and "Barriers"
McCormack et al. (2019)	Telephone-administered semi-structured interview. Content analysis	Pedometer	19 women (4 men). Age range 24-68	Sport and exercise	Canada	Four themes identified: "Creating (in)activity awareness", "Commitment to physical activity", Incorporating activity for transportation" and Importance of nature and changing scenery"
Nguyen et al. (2017)	Focus group. Thematic analysis approach	Digital tracker: Fitbit One, Jawbone Up 24, Garmin *Vivofit 2*, Garmin *Vivosmart*, Garmin *Vivoactive* and Polar A300	14 women. Age range 51-64	Cancer research	Australia	Five themes identified - "Theme 1: WATs increased self-awareness and motivation of physical activity", "Theme 2: confidence and comfort with wearable technology", "Theme 3: preferred and disliked features", "Theme 4: concerns related to cancer", "Theme 5: strategies for application in breast cancer survivors"
Ruckenstein (2014)	Email interview, face-to-face interview, survey. (no method of analysis mentioned)	Vivago wrist watch, Firstbeat heart rate monitor	36 participants (men and women – number of women not stated)	Consumer research	Finland	Account of results presented under four subheadings: "Being monitored", "Visualizing and interpreting life", "Making sense of recovery" and "A slice of larger life"
Schwennesen (2017)	Interview, etnography. Thematic analysis	Five sensors attached to the body and connected to a smartphone application for a daily training programme	23 participants (men and women – number of women not stated. Age not stated)	Physical rehabilitation	Denmark	Three themes identified: "Bodily movements in physical rehabilitation", "Misaligned temporalities and negotiated authority" and "Shared care and moving bodies".
Urban (2017)	Semi-structured narrative interview. MAX QDA software analysis	Wearable fitness trackers: digital pedometer, heart rate monitor. Home monitoring devices – chronic illness	27 participants (men and women – number of women not stated). Age range 65-84	Elderly health	Germany	Account of results presented under two subheadings: "Doing age *via* digital health technologies" and "Wearables and health apps in the context of fitness activities"

experienced a sense of relief when her measurements confirmed to her that interactions with a supervisor caused her stress: "I clash with my closest supervisor. His behavior is annoying. The measurements prove that I'm stressed when I'm in contact with him" (Ruckenstein, 2014, p. 79). The data thus confirmed to her that her own experiential interpretation of physiological stress was accurate, "proving" beyond doubt that the symptoms she had experienced, such as headache and stomach pain, were not imagined or exaggerated, and that they were specifically related to her interactions with her supervisor.

In contrast, other women described the digital device as allowing them to discover information about their bodies and actions that was not easily visible to them. One woman who participated in an internet facilitated pedometer intervention, for instance, suggested that she had been unaware of how sedentary her lifestyle had become: "it really gave me and eye opener … I think it's excellent in showing people, giving people a reality check" (McCormack et al., 2019, p. 4). Women thus described that gaining insight and becoming more bodily aware inspired them to change their way of being in their bodies, and in particular carrying out physical activities. For one elderly woman, using a heart rate monitor meant that she was able to *see* and keep track of an otherwise *inaccessible* and worrisome part of her body: "my heart rate monitor shows the heart, my heart" (Urban, 2017, p. 6). She described that by monitoring her heart while out walking she could avoid harming her heart, which in turn meant that she could continue to live unassisted in her own home. Another woman, who took part in a study on self-tracking practices during running, suggested that the data produced by her digital watch provided an opportunity to reflect upon and understand her physical actions better: "the data is a gateway to like, what did I do that made this number (heart rate) the way that it is?" (Esmonde, 2019a, p. 812). She also explained that using the watch: "helps you establish a routine at a pace that works for your body" (Esmonde, 2019a, p. 813).

The women represented in the studies reviewed here experienced wearable devices as not only making visible to them aspects of their bodies, which increased their knowledge and understanding, but also as providing useful insight that could be utilized to alter and develop ways being and doing physical activity that better suited their bodies. Hence, the knowledge provided by the device was embodied by women through the changes they made to their everyday practices, allowing women in turn to embody a felt sense of agency. Nevertheless, in several of the articles women experienced frustration and exercised resistance in the context of their self-tracking practices, and the particular wearable device they had used. The theme *Embodying strong feelings* is explored below.

Embodying strong feelings

Women described that using wearable digital devices involved experiencing feelings directed toward the device or, at times, toward themselves. As such, they reported instances during their self-tracking experiences that generated strong feelings directed toward the equipment, due to its inadequacy, or disappointment in themselves for not reaching their goals or remembering to use the device.

In the study mentioned above on heart rate variability, some participants experienced unease about wearing a heart rate measuring device that included electrodes attached to the body. One woman said that: "the measuring equipment suddenly started physically annoying me quite a lot. I would have liked to rip it off" (Ruckenstein, 2014, p. 75). Similarly, another woman in the study commented that carrying the device made her feel like she had just been discharged from the hospital, thus having a negative effect on the way she felt in her body. In other words, the physicality of the equipment, and having technology attached to the body, caused women to experience bodily discomfort and annoyance.

In a different study where cancer survivors used a variety of smartwatches worn on the wrist, the participants did not describe physical discomfort relating to the device itself, but some of the participants noticed shortcomings in the functionality of the device that they found annoying. As such, they reported that the smartwatch they were using was unable to record relevant and important physical activities such as swimming and gardening, but could be tricked to record activity erroneously, for example by shaking the arm (Hardcastle et al., 2018). One woman described an instance where this made her feel irritated: "I could have gone up the escalator but I elected to go up the stairs … and then I was cross because it didn't show (record stairs climbed)" (Hardcastle et al., 2018, p. 5). The shortcomings in the device's ability to record relevant activity was thus experienced in concrete and specific situations where women had expected the device to function differently. Hence, the disappointment in the device not recording their effort led women to experience annoyance and anger.

Furthermore, in a study with women who used a smartwatch to track their running, one woman described her previous unease related to experiencing disappointment in herself on the days that she didn't reach her goal of steps per day:

> "… Before I was really tied to it (step goals) … And I kind of got to the point where I was like, I don't like that I'm disappointed that I didn't take 15,000 steps today … . If I want to spend Sunday on the couch, I can spend Sunday on the couch and have a hundred steps (laughs)" (Esmonde, 2019b, p. 10).

The participant described being reliant upon reaching her step goals to the extent that she would walk on the treadmill before bed, and that wanting and giving herself a day off often resulted in a feeling of disappointment in herself. Her unease about the disappointment she experienced in herself, however, made her aware that she had become too rigid in her approach and thus enabled her to relax the demands she put on herself. Similarly, in several of the studies feelings of stress and pressure were reasons for women to avoid using the device (Esmonde, 2019b; Lupton, 2019b; Maxwell et al., 2019). Nevertheless, other women described relying on or finding a sense of security in using a wearable digital device, and experiencing frustration and insecurity when they failed to remember to use the device as planned (see Table 2 below). Insecurity and disempowerment was also experienced when women encountered mixed messages from health personnel and the device, and when they were unsure of how to use the device correctly (Maxwell et al., 2019; Schwennesen, 2017).

Although some of the participating women suggested that they found the alerts and messages communicated by the device motivating, having the effect of getting them to move around more frequently than they otherwise would have, other women described specific instances of experiencing shame in relation to the messages communicated by the wearable device they were using. In particular, the alerts and buzzers communicated by the device caused emotional reactions such as feeling offended, and feeling like they were being told off or shamed. In a study of how women use digital technologies in relation to their health, one woman used a smartwatch to track her sleep: "I got those notes that your sleep is really irregular, and I was like, "Because I'm pregnant! …It's almost like it's shaming you" (Lupton & Maslen, 2019, p. 7). The smartwatch thus alerted the participant to the fact that her sleep was irregular, not taking into account her pregnancy, making her feel like she was not doing well, or even failing at being healthy, for not managing to optimize her sleep.

Table 2. Themes and sample participant extracts.

Theme	Sample participant extracts
Embodying the knowing self	"the tracker provided education, it increased my knowledge" (Maxwell et al., 2019, p. 11)
	"I'm a very awake person and constantly moving, and I didn't realize that. It's made me a lot more aware of stuff like that" (Lupton, 2019, p. 72)
	"I still haven't managed to forget about the equipment. I'm still more alert to how my body feels than usual" (Ruckenstein, 2014, p. 75)
Embodying strong feelings	"Recently, when I had forgotten to put the chest strap on, I had a completely insecure feeling» (Urban, 2017, p. 6)
	"He (the device) says that I have to stretch the knee, but I cannot stretch the Goddamn knee more than I already do, see? I can get so angry with him (the device)!" (Schwennesen, 2017, p. 5)
	"I would be stopped at a stoplight and I would pause my watch and then I would forget to turn it back on … and then at that point I don't know how long, or what distance I had been running. And that's frustrating. . . . then that's when I get annoyed" (Esmonde, 2019a, p. 810)

Furthermore, other participants found that the messages communicated by the device did not match those that were given by their treating physician. For example, one woman who participated in a study on remote-monitored home training after having had hip replacement surgery, suggested that the feedback was often negative and contrasted with the feedback she had received from hospital staff: "At the hospital they told me I was really good at this! He (the device) just tells me off" (Schwennesen, 2017, p. 5). The training thus included wearing five sensors connected to a smartphone while performing physical rehabilitation exercises, and getting instant feedback from a digital voice. In contrast to the feedback she had received when treated in hospital the first week after surgery, the digital voice was experienced as a disapproving authoritarian who more often than not "told her off". Similarly, one woman who participated in the study mentioned above about physical activity and recovery from cancer, suggested that the feedback from the smart watch she had used was somewhat offensive: "It buzzed at you and went MOVE … even had an exclamation mark, it's like 'seriously' you get slightly offended" (Hardcastle et al., 2018, p. 5). In other words, the feedback was not gentle and encouraging, but rather experienced as forceful and rude and consequently served to generate a negative and emotionally charged reaction in the participant.

Women across the studies synthesized in this review experienced strong feelings in the context of their self-tracking practices. Such feelings were embodied in terms of experiencing themselves, others and the device in negative and burdensome ways that required them to process and work through their feelings in order to continue self-tracking or changing their practices.

Discussion

Our synthesis of the articles included in this review suggests that the themes of *knowing* and *feeling* were central in women's embodiment of digital self-tracking . In addition to further interpreting and exploring these themes below, we consider some of the methodological challenges inherent in attempting to produce experiential accounts, which includes embodied detail of women's self-tracking experience.

Knowing and feeling in women's embodiment of digital self-tracking

Viseu (2013, p. 129) suggests that: «a body that knows itself becomes an informed body with a responsibility to act within intensified self-knowledge, self-improvement and bodily control». Indeed, the women in the reviewed studies described their digital self-tracking experiences in terms of increased bodily awareness, and the ability to gain information

and get to know otherwise inaccessible aspects and parts of the body (e.g. "it shows the heart, my heart"). Furthermore, several of the women suggested that this knowledge contributed to their ability to change and improve the ways in which they were physically active and cared for their health, and as such their ways of being in and moving around in the world of spaces, objects and others. In this manner, rather than being *just* technical equipment, the use of wearable digital self-tracking devices had specific implications for women's processes of becoming and embodied sense of self.

It can be argued that the specific instances of becoming aware and getting to know the body described by the women who took part in the studies, were experienced as *moments* of embodying agency. The embodiment of agency can be understood as being constructed in process with the spatial world, and through our ability to utilize the potential of objects or "things" (e.g. a digital device), and move toward and away from other people in our practices (e.g. taking part in a running group). As argued by Denzin (2007, p. 58): "The person takes space in and determines her own locations, making room for herself as she moves about and draws things near". In these terms, the agentic embodied person engages with and makes use of what is present and accessible spatially and materially, in order to pursue and accomplish their own projects and lived experiences. Similarly, in suggesting that embodiment is full of potential, and created and constructed, as opposed to limited and constrained by that which is considered the organic body, Deleuze and Guttari (1988) have introduced the concept "body-without-organs" (BwO) (Fox, 2011, 2002; Garlitz & Kellner, 2014; Thanem, 2004). As argued by Smith (2018, p. 107): "The body without organs is supposed to designate all of those things that an organic body could do, but that it is prevented from doing because of its homeostatic self-regulation processes. The body without organs is the full set of capacities or potentialities of a body prior to its being given the structure of an organism, which only limits and constrains what it can do …". The body without organs can thus be considered as the "totality of the myriad of assemblages" (Fox, 2011, p. 326), or relations with for example spaces, objects, others, social and relational dynamics and affects, which a body is partaking in. These assemblages provide the context for embodiment and lived experiences, and, in the process of becoming, provide the grounding for the possibilities of what a person can do and become (Fox, 2011). In contemporary societies digital technologies and devices are inevitably part of such assemblages, and wearable self-tracking devices may therefore be considered part of the BwO "as a spontaneous, experimental and creative force" (Thanem, 2004, p. 204) in people's lives. Women who take up and utilize digital devices in relation to tracking and looking after their health,

may therefore embody experiences of becoming knowledgeable and aware agentic selves. As argued by Lupton (2017b), Hayles (2012) and others, digital technologies are permeating most aspects of human life, and thus inevitably contributing to the production of human embodiment and agency in contemporary societies.

Nevertheless, in the studies reviewed here moments of embodying agency contrasted with other experiences recounted by women as specific instances of feeling, for example, insecurity, frustration and shame. Hence, in the same studies women were critical of and expressed resistance toward the digital device and the practices they were engaging in. This represents tension and contradiction in women's embodied experiences, and suggests that digital self-tracking was not experienced as a continuous process of agentic being in the world, but rather as complex emotional and sensory processes of engagement and disengagement involving specific and concrete moments of embodying agency. Lupton suggests that: "assemblages of flesh, code, data, device, place, space and time generate feeling" (Lupton, 2017a, p. 6) , and thus: "responding to personal data is a highly sensory experience, involving people to engage in complex negotiations between assessing the information they receive from their embodied senses and that generated from digital devices" (2017b, p. 1600). As presented in Table 2 above, one such negotiation was illustrated by a woman who participated in a study of patients' experiences with remote-monitored training after surgery: "He (the device) says that I have to stretch the knee, but I cannot stretch the Goddamn knee more than I already do, see? I can get so angry with him (the device)!" (Schwennesen, 2017, p. 5). Another participant, who had experienced symptoms of stress in relation to a work supervisor, understood the measures obtained from the digital heart rate monitor she was using as "proof" that she had accurately interpreted her felt and sensed experience (see section 3.2.). Schüll (2016) suggests that consumers of wearable self-tracking technology are sold the idea that factual information about the physical body is only accessible to the experiencing subject through digital technologies, and that the self is ultimately understood as a database. Reviewing the marketing of wearable devices she suggests that the body is presented in such discourse as: "not a sensing organ through which one gains self-knowledge but, instead, a data generating device that must be coupled to sensor technology and analytic algorithms to be known" (Schüll, 2016, p. 326). The feeling and sensing phenomenological body is thus insufficient as the grounding for perceiving and knowing oneself and the world (Merleau-Ponty, 1962), and that which is "felt and sensed in the flesh" must be interpreted and verified using digital technology (Young, 2005, p. 7).

Although a digital self-tracking device can be part an assemblage that offers potential and possibilities in women's lives, allowing for instance a

"knowing and acting self" (Viseu & Suchman, 2010), the melting together of person and device can, on the other hand, also generate processes of becoming where the body is disempowered and undermined. As previously outlined, drawing on Deleuze (1992) enables an understanding of digital-ized society as a "society of control", where the mechanisms and conse-quences of digital tracking and encoding are invisible. Deleuze (1992, p. 5) argues that in societies of control: " … the numerical language of control is made of codes that mark access to information, or reject it. We no longer find ourselves dealing with the mass/individual pair. Individuals have become "dividuals," and masses, samples, data, markets, or "banks". Hence, the embodied person in digital society can be seen as a "dividual", who is made up of an endlessly shifting collection of dividable data points that can be tracked, monitored and surveilled by oneself or others (Garlitz & Kellner, 2014; Schüll, 2016). The use of a digital device to track parts of the body, and its processes (e.g. fat, food-intake, heart-rate, sleep), can thus serve to fragment the felt and experienced body into parts in need of track-ing for information gathering purposes. The body's parts can be enhanced, molded and altered with the help of technology and analytic algorithms, rendering the body's own sensing capacities at risk of being seen as second-ary to or being replaced by the quantified data being produced. What is controlled, and undermined, is thus the *whole* body as a highly competent and skilled feeling and sensing organism, and the person's capacity to access this *whole* body. Indeed, in a study of the Moodmetric and Oura smart rings, which measure stress, wellbeing and rest, Berg (2017, p. 4) found that the Moodmetric was launched as: "giving detailed feedback on your emotional energy and helping you to successfully manage your emo-tional world". Berg (2017, p. 8) asserts that the implication of the way in which these rings are promoted is that bodily experience is: "positioned as remote, intangible and perhaps even impossible to make sense of … ". People's capacities for understanding and interpreting their own feelings and sensations are in other words rendered inadequate, and they are conse-quently encouraged to rely upon digital technology to understand and interpret their own lived experiences. Furthermore, in relation to women's embodiment, the idea of the *incomprehensible body* may be particularly powerful. As outlined in the introduction to this paper, women's embodi-ment has historically been constructed as difficult to make sense of and in need of discipline and augmentation, particularly in relation to women's biology, size/surface and comportment (Bartky, 1990; Birke, 1985; Bordo, 1993; Butler, 1993; Grosz, 1994; Sanders, 2017; Shildrick, 1997; Young, 2005). Nevertheless, as explored above women's utilization of digital self-tracking technology can represent possibilities for embodying agency. Our analysis suggests that women's engagement in wearable digital self-tracking

practices, both in the context of healthcare delivery and the everyday lives of consumers of technology, often involve complex sensuous, emotional and relational experiences that have important implications for how women come to know, understand and experience their felt and sensed embodiment (Young, 2005). In particular, in the context of healthcare practice that require patient to digitally track and manage their health at home, the literature suggests the need to minimize patients' emotional labor and to provide the opportunity for embodying agency in the context of patients' self-tracking activities.

Methodological challenges and future directions in qualitative wearable digital self-tracking research

The 13 articles reviewed in this paper consisted of a number of recently published studies conducted in 6 different countries and a range of health related research contexts such as cancer research, physical rehabilitation and leisure and fitness. These studies illustrate the current global widespread uptake and utilization of wearable digital self-tracking technology, both in healthcare delivery and in the everyday lives of consumers. Producing knowledge about what it is like to use and embody digital technology can thus be of great importance in developing understandings of the benefits and pitfalls in making available, developing and implementing wearable digital technologies in relation to people's healthcare and wellbeing. As such, a number of the studies included theoretical concepts and approaches explicitly concerned with embodiment and sensory experience (Esmonde, 2019a, 2019b; Lupton, 2019b; Lupton & Maslen, 2018; 2019; Schwennesen, 2017; Urban, 2017). Nevertheless, our synthesis of the overall articles and the included interview extracts suggest that the current qualitative literature is limited in terms of taking account of women's lived, material and multisensory being-in-the-world, and thus *what-it-is-like* to monitor, manage and live through health related experiences digitally. Rather than providing rich detail in relation to specific and concrete lived through experiences in felt and sensed terms, the majority of the extracts presented in the articles represent *talk about* the device or experience. It is important to note, however, that we did not have access to the full data sets, and consequently our analysis of women's accounts is based on the extracts selected by the researchers and presented in the individual articles. Nevertheless, it can be argued that the application of traditional data collection methods and methods of analysis (e.g. face-to-face interviews, focus groups, content analysis, thematic analysis), with the exception of Esmonde (2019a, 2019b) who used a running interview, presents a limitation to the research reviewed here.

Traditional qualitative interviewing and methods of analysis more often than not produce descriptive data, characterized by participants' tendency to speak in "*aboutness*" terms, thus talking about an experience as opposed to speaking from *within* the experience, remembering and recounting specific and rich detail of its felt and sensed lived through aspects (Shotter, 1993). Speaking from *within* requires methods which allow participants to tap into, remember and communicate their experiences in rich detail to the researcher. In contrast to generating information through an interview where the participants answers the researcher's questions one after the other, methods that can be considered more experiential or creative can allow participants to actively engage in producing their data. Visual methods, memory work group methods, diary-writing methods and drawing methods, for instance, are data collection strategies that often generate detailed and rich narrative accounts that are grounded in specific and concrete lived experiences (Del Busso, 2020; Del Busso et al., 2018; Elliot, 1997; Gillies et al., 2005, 2004; Jacelon & Imperio, 2005; Maratos et al., 2016). Firstly, diary writing allows participants to write detailed accounts close to the time of having lived through experiences relevant to the topic of research (e.g. self-tracking while walking in the woods) (Elliot, 1997). As such, the researcher can encourage participants to consider and pay particular attention to the felt and sensed aspects of their experiences when recording their accounts. After a set period of time, when the diary-writing is completed, the participant can be given time to reflect upon their diary, and finally meet with the researcher to further explore its content. The data thus consists of diaries and the conversation between the participant and the researcher. Secondly, in memory work group research, as opposed to the traditional focus group, a group of participants decide on a *trigger* in relation to the research topic at hand. The participants then write a detailed yet short account of one specific remembered experience in the third person, avoiding interpretation and including as much concrete detail as possible. In the next stage of the research, the memories are read and analyzed collectively by the group over the course of a number of sessions, with the aim of identifying and understanding the content of experience in relation to the topic of research (Gillies et al., 2004; Del Busso et al., 2018). In this context the participant are thus simultaneously participants and researchers, setting the research agenda, deciding the trigger and analyzing their own experiences (e.g. experiences of digital remote-monitored training in physical rehabilitation). Lastly, visual methods may include participants drawing or producing photographs in relation to a research topic, or participants exploring their own existing photographs that are relevant for the research (Del Busso, 2020; Del Busso & Reavey, 2013; Gillies et al., 2005; Maratos et al., 2016). These materials can be explored in an unstructured interview

or conversation between the researcher and a participant, or in the context of a group of participants, with the purpose of giving participants the opportunity to *show* the researcher what their experiences are like, to elaborate on their lived experiences and to generate participant reflections in relation to that which was felt and sensed during their experiences.

It can thus be argued that experiential and creative methods, to a greater extent than the traditional interview, encourages women to produce accounts of what it is like to use and embody wearable digital self-tracking technology that are rich in experiential detail. Participants are in addition given opportunities to critically reflect on their lived experiences and the data they have produced. In the context of this approach participants are thus contributing to setting the research agenda, due to their active role in the data production, and providing their own reflections and interpretations, which further enrich the materials to be analyzed and written up by the researcher. Furthermore, as mentioned in section 3.1.5. of this paper, critical reflection or reflexivity on the part of the researcher can be considered integral to producing qualitative research of high quality (Burns,2003; Del Busso, 2007; Lazard & McAvoy, 2017; Ramazanoglu & Holland, 2002). The articles reviewed in this paper are, however, severely limited in providing detail about researcher reflexivity, for instance in relation to important methodological issues such as interactions with participants and the co-construction of data. Some of the articles reviewed were explicitly concerned with the themes of embodiment and sensory experience, and employed methods that required interacting with participants beyond the traditional interview (e.g. running interview, Esmonde, 2019a, 2019b), but none of the papers mention embodied researcher reflexivity or outline the application of other forms of reflexivity in presenting their methodological approach and research strategies. Nevertheless, as outlined above the qualitative research reviewed here does have important implications for consumers of wearable digital technology, as well as patients who are expected to monitor and look after their own health. Future research on wearable digital technology could, however, benefit from adopting more experiential and reflexive methodological approaches in order to produce knowledge that offer further complexity and nuance, both in relation to the digitalized health experiences of consumers who voluntarily utilize self-tracking devices, and importantly in relation to patients who are expected to take greater responsibility for their own healthcare treatment.

Conclusions

We had two aims for the literature review presented in this paper: to identify and synthesize the existing qualitative research literature on women's

experiences of using wearable digital self-tracking health technology, and to analytically explore how embodiment is constructed in the first person accounts presented in this literature. Our analysis suggests that women experienced becoming bodily knowledgeable, agentic selves through their digital self-tracking, and that the embodiment of feelings was integral to their self-tracking practices and experiences. Searching the literature resulted in the identification of studies conducted in Australia, Europe, Canada and the US. Furthermore, the studies included consisted of a number of recent publications, indicating wearable digital self-tracking as a new and emerging topic of research across a number of research contexts such as cancer research, physical rehabilitation, leisure and fitness and elderly health. The limited number of studies distributed across different research contexts, however, did not allow a thorough exploration of wearable digital self-tracking in any one of these research context. Nevertheless, the assessment of study quality in the current review identified several methodological issues that can inform future research strategies, such as the need for utilizing nontraditional and reflexive data gathering and methods of analysis in order to generate in-depth and nuanced knowledge of what it is like to embody wearable digital self-tracking technology.

Disclosure statement

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