

“My smartwatch told me to see a sleep doctor”: A study of activity tracker use

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Abstract

Purpose

This qualitative research explored the use of wearable health and fitness trackers in everyday life, and the users' own understanding and use of the data derived from these devices.

Design/methodology/approach

The study used a qualitative constructionist approach, based on twenty one-on-one interviews (alongside observations of use) with users of wearable fitness trackers.

Findings

Findings show that the fitness trackers, also known as activity trackers or lifelogging devices, have become companion tools that enable users to monitor information from their body and make some decisions about their health and fitness, thus giving them a sense of gratification and a sense of control over their own health and wellbeing.

Practical implications

The findings have implications on how health professionals can talk to their patients about how to deal with and understand the information provided by their activity-tracking devices.

Originality/value

The study adds to the lifelogging literature through a constructionist, qualitative approach rather than a positivist or technological deterministic approach.

Keywords: lifelogging devices, activity trackers, fitness trackers, information behaviour, everyday-life information seeking, health information seeking, fitness data privacy

Paper type: Research Paper

Introduction

This paper reports on a study where we investigated the everyday use of fitness trackers and explored users' interactions with the same through a qualitative lens; we studied twenty-one users of activity trackers, specifically users of wearable technologies for tracking health and fitness activities on devices such as Fitbit, Jawbone, Garmin, Apple watch, Xiaomi and so on. These fitness trackers have become a popular subset of the Internet of Things with their ability to connect to the Internet, collect, process, display and send data. The fitness trackers have become common devices for people to manage various personal fitness and health activities through monitoring their own bodies and collecting data. As a result of the popularity of these devices most technology companies have rushed to release their fitness trackers to the market over the past few years (Rose 2014). Popular brands like Fitbit (Surge, Blaze, Alta, Flex2, Charge HR, Aria etc.), Microsoft (Band), Google (Wear OS), Samsung (Gear) and Apple Watch have integrated activity trackers into their new smart watches. These devices are designed to collect various kinds of user demographics (gender, age) biometric data (photo, name, weight), relational data (email, phone number) and record various bodily parameters including heart rate, BMI, weight, and sleep data, and estimate calories burned. Additionally, the gadgets wirelessly synchronize with other devices and applications to provide information to the users in form of text notifications and graphical representation of the data. Newman et al. (2011) notes users can also share this data to online health communities for emotional support. The data collected through these devices have also become of

interest to various stakeholders, given the new synergies around them for both commercial and personal use (Carney 2013).

Following the popularity of self-tracking, a movement named “quantified-self” was founded by Wolf in 2009 for enthusiasts who used wearable technologies to monitor body activities, and this has now become a common social trend (Lupton 2016b). Communities of quantified-self aficionados have formed around major cities of the world and host conferences and “meet-ups” to discuss quantified-self practices and the new fitness technologies (Lupton 2013). These wearables now also attract a wide range of researchers, from socio-cultural perspectives referred to as digital sociology (Lupton 2015), legal perspectives (Christovich 2016), privacy and security perspectives (Zhou & Piramuthu 2014, Pingo & Narayan 2016, Pingo & Narayan 2018), human-computer interaction and information retrieval (Liu, Scifleet & Given 2014). Other research perspectives include user experience design, which may provide insights to support the design of the tracking tools for long-term goals, potential behaviour change (Liu, Scifleet & Given 2014), and health informatics (Gibbons et al. 2011).

The use of these sensor-equipped devices to collect health data/information is a potential area of research for information-seeking behaviours (Liu, Scifleet & Given 2014), for there is increased adoption of such “persuasive technologies” for monitoring personal health indicators and patients remotely (Jalil & Orji 2016). Hoy (2016) argues that information science specialists should position themselves to help in the sense making of the data, data visualization, and export to other tools, and provide insights on the data environment.

This paper explores why and how people perform self-tracking as an important part of their everyday life information behaviours. Information behaviour research studies how people interact with information, in order to understand their motivation and behaviours. Information-seeking behaviours are a major area of study within Library and Information Science (LIS), and it covers the whole of human behaviour with regards to how people interact with information. It describes “how people need, seek, manage, give and use information in different contexts.” (Savolainen 2007). It may also be described as information-seeking behaviour or human information behaviour. The contextual nature of information and different information environments means that information behaviour research has universal applicability in decision-making, in information access, and in information use. Research into information-seeking behaviour has been conducted within a wide variety of contexts, most commonly News, Health, Education, Cognitive Psychology, Market Research, Online Information and Political Communications.

In this paper which reports on one aspect of a larger research study on privacy awareness, we focused on how people use fitness trackers to seek information about their own bodies and their daily activities, and how they use the information, alongside the users’ understanding and interpretation of the data/information to make decisions about various aspects of their everyday life. To understand these practices we looked at why and what motivates people to start using the fitness trackers and how users make sense of the data for personal use, and its implications for their general wellbeing and health-related behaviours.

In this paper we use the terms fitness trackers and activity trackers interchangeably with the following definitions in mind: activity trackers or fitness trackers are electronic devices characterised by being worn on the users’ body, or devices that use accelerometer, altimeters, or sensors to track wearer’s movements and biometrics, and can upload activity data online through Internet-based applications (Hoy 2016). Some of the fitness trackers have the ability to connect to the Internet to record and provide feedback on bodily activities. These devices also synchronise with the applications or “apps” on smart phones and provide users with data in usable formats

through display interfaces that visualise the data to help users understand the collected data (Albaghli & Anderson 2016).

In summary, we aim to understand how people use these devices as a source of information to manage their health and general body wellness, and what motivates users to keep using them. How they use the data and how they make sense of the data collected through these devices is key to understanding their role within people's everyday life information seeking behaviours. To that effect, following are some of the broad research questions we explored in this study:

1. Why do people use the activity trackers?
2. To what extent do the users think that the activity trackers/ data help improve their wellbeing?
3. How do people make sense of the data for health improvement and how?
4. What are the users' privacy concerns surrounding the collected health data from the applications?

Literature Review

The literature shows that several research perspectives have been explored in various domains to understand the aspects surrounding lifelogging or self-monitoring practices using activity trackers. These are new but ubiquitous technologies that are fast-emerging and fast evolving and have an impact on users' information behaviours, but issues such as privacy, data literacy and accuracy remain.

Lifelogging and self-monitoring practices

The capturing and archiving of entire everyday life activities is commonly referred to as lifelogging (Sellen & Whittaker 2010). This practice of self-tracking includes measuring some aspects of one's bodily activities to improve one's health and well being through self-knowledge (Lupton 2016b). Although these lifelogging practices have become popular, they are not new; people have always been engaged in such practices for years as an attempt at self-improvement and reflection; the only change is that these practices have now been enhanced by the use of new digital technologies (Lupton 2016b). The motivation and benefits of using these devices is to facilitate remembering, reflection, retrieval, recollection and reminiscing (Sellen & Whittaker 2010); activity trackers are used for the purpose of keeping track of bodily activities and workouts i.e. sleep pattern, daily steps, floors climbed, intense activities (like swimming, cycling, runs), calculating calories burned and other measures like cardiovascular workouts (Torre et al. 2017). The available trackers in the market are designed to collect various kinds of information including bodily functions, physical activities (sport activities, sexual activity, travel) medical symptoms (headache, pain, allergies), spatial (location, time, what you see) consumption (alcohol, nicotine, caffeine, water, and drug), mental health (mood, stress, alertness), and physiological statistics (Barcena, Wueest & Lau 2014). Hence, the gadgets have become important in providing a variety of usable and meaningful information to the users.

Everyday life information seeking and self-monitoring

Savolainen (1995) conceptualizes everyday-life information seeking (ELIS) as the acquisition of information for the purposes of getting through one's everyday life or to solve problems not directly related to professional work. Thus the everyday-life information seeking perspective encapsulates

individuals' efforts in trying to solve specific problems within everyday life (Savolainen 1995); these everyday concerns may include health among other interests. In the context of self-monitoring practices, people engage in these activities in an effort to know more about themselves, or to address some issues in their health. Thus lifelogging or self-monitoring takes place within a highly contextualised personal environment (Liu, Scifleet & Given 2014). The contexts involve users or groups of users, with long-term information-seeking goals and objectives (Liu, Scifleet & Given 2014). Thus Savolainen's 1995 everyday-life-information-seeking framework offers a framework for understanding users' self-monitoring and how they make meaning of this information and how they put the information to use.

Previous research in information behaviour has focused on scholars and professionals (engineers, health workers, lawyers, scientists, etc.) since these groups have rich information activities within their work environment (Leckie, Pettigrew & Sylvain 1996). However, Savolainen (1995) notes that non-work related everyday-life information seeking practices e.g. hobbies, online communities, students, patients, etc. also deserves research attention. The ability of activity trackers to collect and organize information into usable formats about daily activities presents an opportunity for research inquiry (Liu, Scifleet & Given 2014). The understanding of how people make meaning out of fitness tracker data is a vital aspect of their information seeking, which provides an important and interesting perspective for information behaviour research. Exploratory research has already emerged to understand the information seeking of specific groups using mobile wellness applications: how individuals make decisions on the application to use (Stvilia & Choi 2015), information literacy in relation to health (Lloyd, Bonner & Dawson-Rose 2014) and food logging (Cox, McKinney & Goodale 2017).

Information behaviour perspectives on use of activity trackers

Information seeking behaviour research has been concerned with how people seek, share and use information in different contexts (Liu, Scifleet & Given 2014), whereas the quantified-self or self-tracking is a new phenomenon facilitated by lifelogging technologies, which can open up opportunities for new socio-technical inquiries (Lupton 2016b; Neff & Nafus 2016). While individuals use the activity-tracker data to monitor their health and fitness with the goal of becoming "optimal human beings" (Lupton 2016b), commercial entities are interested to monitor individuals through this data for various purposes including determining the health risk of individuals for insurance purposes (Ajunwa 2015). This represents both ends of individuals' and business entities' information seeking behaviours; however, in this paper, we focus on individuals' information behaviours. We conceptualise information behaviour using Wilson's definition as 'the totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking, and information use' (Wilson 1999). Albright (2011) further adds that the study of information behaviours involve the ways in which human minds process information and make judgments. Bates (2010) notes that "information behaviour is used in information science discipline to refer to a sub-discipline that engages in a wide range of research conducted in order to understand human relationship to information"; this includes passive and active interactions with information (Case & Given 2007).

Another important area of information research that can potentially offer insights into self-tracking research is personal information management (PIM); this area of research focuses on how people use organizing tools, from slips of papers to desktop computers, PDAs, mobiles, and tablets (Narayan 2014, p. 27). The field provides a means to understand the quantified-self practices of how people adopting these new technologies collect, organise and provide information sought for multiple purposes, i.e. for health and personal wellbeing, among others. Narayan (2014) argues that personal information management is an activity people enact to reduce uncertainty, save

information for future use, and as a memory aid for recall and sense-making; this is similar to the way fitness tracking devices are marketed. Information behaviour research provides a means to understand people's health information seeking behaviours also. Drawing from this perspective, we can understand how users employ these devices to reduce uncertainty, save information for future use, and as a memory aid for recall and sense making.

Data privacy challenges around activity trackers

Despite the growing popularity of the activity trackers or lifelogging technologies, issues related to security vulnerabilities and privacy are a big concern (Lupton 2016a; Michael 2015; Neff & Nafus 2016; Torre et al. 2017; Zhou & Piramuthu 2014); the privacy issues raised include use of the aggregated data by service providers or other interested entities including employer-sponsored wellness programs (Ajunwa, Crawford & Ford 2016). Some of the retailers and insurance providers have also incentivized the use of the fitness trackers by offering to reduce the insurance premium for consumers who are ready to share the fitness tracker's data. Giant retail chains offer discounts to users if they are willing to share the health/fitness data (Pingo & Narayan, 2016; Flybuys 2016).

While lifelogging practices motivate users to stay fit, it is not clear what privacy risks or consequences they have on insurance rates for individuals or in determining the health status of individuals (Lupton 2016a, 2016b). In the past, researchers have found that wearable trackers transmit data including consumers' identifiers, address, diet, and workout information to third parties (Torre et.al, 2017; Sweeney 2014). The increased commercial need and interests around the data for predictive analytics and for behavioural analysis and targeted marketing among other purposes, raise various concerns (Crawford & Schultz 2014; Lupton 2015). Scholars have concerns over the potential use of the health data beyond data producers' knowledge and what is promised in the programs and terms of service (Ajunwa 2015; Ajunwa, Crawford & Ford 2016; Rosenblat, Kneese & Boyd 2014). Hence, while the activity trackers provide self-monitoring opportunities, they potentially also pose possible privacy risks to the users.

Research Design

The paper reports one part of a larger study to understand users' information practices and privacy across several Internet of Things and other consumer and digital technologies. We used a constructivist paradigm through a qualitative approach, and gathered empirical data using semi-structured interviews and observations. This approach provided access to participants' thoughts and feelings, making it easy to develop an understanding of meanings people attribute to their experiences (Bryman 2015; Sutton & Austin 2015). The research was conducted by the authors in Sydney, Australia between November and December 2017 with in-depth one-on-one interviews and observations with twenty-one participants, after piloting the guiding questions with five participants (not reported). The research also obtained ethics clearance from the university's ethics committee. The participants were recruited through a word of mouth, social media groups and the snowball sampling method. The participant demographics are listed in Table 1. The participant names used in this paper are not their real names and all identifying personal information has been removed. The sample comprised of twelve female and nine male participants between the ages of 19 to 59 years old. The interviews took between forty-five minutes to one hour, and participants were asked to demonstrate their interactions with the various devices while they were interviewed and these interactions were observed and noted in order to provide context to their answers. The guiding questions for the interviews were as follows:

1. When and why did you start using the fitness tracker/application?

2. What brand / type do you have?
3. For how long have you been using your device?
4. Do you use it daily? How often?
5. When you registered your fitness device, what details did you provide?
6. How did you respond to the privacy settings when you were setting up your device? [when you are prompted to give access to photos album, contacts, location or log in with other accounts]?Why?
7. Did you read the privacy policy about data management on your device or application?
8. What data/information do you collect in your application? Do you share your data with anyone else? If yes, who all do you share it with? (E.g., your doctor, friends, or family?)
9. How do you use the collected data?
10. Have you linked your fitness tracker data with any other services, fitness coaches or Fitstar? Or other organisations, or applications?
11. If your insurance providers provide a means for you to link your fitness tracker data and supermarket and other consumer loyalty cards and share the data with them for benefits, what would be your reaction? Why?
12. How comfortable are you in sharing your data with other applications?
13. Do you enable the GPS/location features on your devices?
14. If the organisation that manages your data shares your information without your knowledge and you learn about it, how will you resolve it?
15. Do you have any general concerns about the fitness trackers? Can you elaborate?

No.	Participants (Pseudonyms)	Gender		Age Range	Estimated Length of use	Activity Tracker type used
		M	F			
1	Kelly		X	30-39	4 years	Fitbit
2	Vera		X	20-29	1 year	Fitbit
3	Marcello	X		20-29	2 years	Garmin
4	Deepak	X		20-29	2 years	Garmin
5	John	X		40-49	3 years	Fitbit
6	Elaine		X	20-29	1 years	Fitbit
7	Molly		X	30-39	2 years	Fitbit HR2
8	Dolly		X	20-29	3 years	Fitbit
9	Janet		X	30-39	3 years	Fitbit
10	Sue		X	20-29	3 years, 1 year	Fitbit, Apple watch
11	Harry	X		20-29	6 years	Fitbit charge2
12	Teresa		X	40-49	4 years	Fitbit
13	Michael	X		40-49	4 years	Fitbit
14	Evelyn		X	40-49	2 years	Fitbit
15	Ivan			40-49	2 years	Fitbit
16	Lillian		X	20-29	2 years	Garmin, Fitbit
17	Pauline		X	40-49	10 years	Garmin
18	Julie			40-49	5 years	Fitbit HR
19	Daniels	X		10-19	1 year, 4 months	Xiaomi, Apple watch
20	Joe	X		20-29	1 year	Fitbit, Apple watch
21	Andrew	X		50-59	3 years	TomTom

Table 1: Demographics of the participants

Guiding interview questions

1. Why did you start using the fitness tracker/application?
2. What brand do you have?
3. For how long have you been using?
4. When you signed up for the fitness devices, what details did you provide?
5. Did you read the privacy policy about data management on your fitness /activity tracker device or application?
6. What data/information do you collection in your application? Do you share your data with anyone else? If yes, whom do you share it with?
(E.g., your doctor, friends, or family?)
7. How do you use/interpret the collected data?
8. Have you linked your fitness tracker data with any other services, Fitness coaches or Fitstar? or other organisations, or applications?
9. If your insurance providers provide means for you to **link** your fitness tracker data and loyalty cards and share the data with them for benefits, what would be your reaction? Why?
10. How comfortable are you in sharing your data with other applications?
11. Do you enable your GPS/location features in your fitbit devices?
12. How did you respond when you were setting up devices? [when you are prompted to give access to photos album, contacts, location or log in with other accounts]?Why?
13. If the organisation that manages your data shares your information without your knowledge and you learn about it, how will you resolve it?
14. Do you have any general concerns about the fitness trackers? Can you elaborate?

The interviews provided access to participants' own experiences and voices on why they started using the activity trackers, their frequency of use and the use of the collected data. The interviews were audio recorded and transcribed. The transcripts were first open-coded manually using thematic analysis, cross checked by two researchers, and later transferred to Nvivo software for further content analysis to identify and cross-check the emerging themes from the data. This approach does not let us draw inferences based on any particular demographic, but the snowball sampling method we used provides us with a broad range of user demographics within the Australian context. As the aim of the research is to provide rich descriptions of how users interact with privacy issues mainly, we have decided not to replicate other studies such as Kim (2014) that focus on the broader user experience of these technologies, or on dividing people based on gender, as these do not relate to the aims of our research.

All twenty-one participants used wrist-worn activity trackers, out of which sixteen used Fitbit, four Garmin, two Apple watch, one Xiaomi and one used TomTom, while four participants used more than one device at the same time. Some researchers have noted that most users abandon using the devices after about six months (Neff & Nafus 2016; Powell 2015), and therefore, as one of the selection criteria, we selected participants who had been using fitness trackers longer than six

months to understand what motivated them to continue and sustain the practice and how they use them.

Findings

Various themes emerged from the interview data relating to reasons or motivations for participants to start using the devices, and how they make sense of them. The interviews also revealed how people use the devices and the data to manage everyday-life, worries, hopes and interests (Rooksby et al. 2014) and were not just limited to sleep patterns, weight management, mitigation of future health risks, health behavioural change and general wellbeing.

While previous researchers have studied users of fitness trackers (Fritz et al. 2014; Hoy 2016; Lin, Althoff & Leskovec 2018), this study offers additional dimensions of everyday-life information seeking behaviours in how the information from the activity trackers are an essential factor in shaping users' health information seeking practices. We have use selected representative quotes from the interviews to illustrate important points shared among the majority of the participants, and hence not all participants' quotes are presented in the paper.

Motivation for seeking health information

The participants portrayed the range of information from the activity trackers as important in enabling them to monitor everyday physical activities and getting feedback from their bodies: daily walking distance, running efficiency, step counts, sleep cycles, heart rate, and measuring intensity of exercises etc. All participants found the activity trackers as useful tools that motivate them to monitor set goals and enable them to optimize their targets and provide evidence of the tracked activities. We also found that the information from the activity trackers was inspirational in several ways, especially in controlling fitness levels and watching bodily activities.

Most participants indicated they choose to use specific features of the devices that were valuable to them depending on their intended goals. For instance, some participants indicated they were more interested in monitoring their heart rate than the number of steps taken, while others were eager to track daily distance or number of calories burned rather than other factors. The monitoring and seeking information using the activity trackers differed from one user to other but the primary intent in seeking this information was the driver for them to use the devices, and these are described below.

Weight and weight loss

All twenty-one participants reported that the main motivation to start using the activity tracker was to keep fit, monitoring weight and weight loss through daily steps, and calories burned featured as one of the key elements. Although there is no direct correlation or causality reported between the use of the activity trackers and weight loss, users reported that the information from the applications or devices was important to motivate them to achieve their ultimate goal of weight loss.

The immediacy of the feedback from the devices was also important in monitoring weight loss through the number of calories burned and distance walked. For example, Harry indicated that he had shed a significant amount of weight and used his activity tracker to monitor his progress

towards achieving this goal, and later on shifted his focus to maintaining his current status and monitoring his heart rate. He stated that:

“the motivation for the first Fitbit; in high school I was a little overweight and then I kind of hit my peak in senior year and I got kind of bombed when my aunt and uncle came in and they were like, oh we’re starting the 90x work outs back home. So I started getting into that and I really enjoyed it so I thought by using the Fitbit I’d be able to track my fitness better so I can get more progress and here I am. I really did, especially with trying to get a minimum walking distance every day.” (Harry)

Similarly for all participants the information from the activity trackers functioned as an enabling tool to achieve their overall objective of weight loss. The device and applications were vital in communicating to the participants how they were progressing in their exercise activities, with a consequent effect and influence towards achieving their set goal(s).

Monitoring heart rate and exercise intensity

Some of the activity trackers with heart-rate monitoring capabilities provide live displays of the heartbeat per second on the device and a graphical or visual representation of the captured data on the device applications. Some of the participants were interested in recording and monitoring the heart rate during exercising as an indicator of reaching the fat-burning “zones” versus normal resting.

“I can check my heart rate overnight, and I can see my resting heart rate. And it also tracks my intensity minutes so I can see that on Monday I went to the gym, on Wednesday I went to the gym, last night I went for a swim and I can see how much I’m working and I was trying to kind of keep the goal” (Sue)

“I have the Fitbit Charge 2, the one with the heart-rate monitor. I really like how it has the heart rate tracker, so at the time I was super hardcore into fitness. So I would track the steps or check my heart rate doing workout, so that way I knew I was hitting my target zones.” (Harry)

Other participants focused on measuring the intensity of the physical exercises to achieve the optimum results for their set weight loss goals as determined by the amount of fat burned as indicated by the activity trackers. For instance, Julie regularly uses her waterproof tracker to measure the intensity of her swimming activities.

“I think the main thing I wanted to do was see how hard I was working in the pool and in my workouts and say what sort of workout I was getting in a different exercise” (Julie)

In this way, the activity trackers provided the participants with information to make comparisons about their daily workouts and make decisions on what workouts were ideal for their individual bodies.

Monitoring sleep quality

Out of the twenty-one participants, only two participants monitored sleep patterns, while the rest cited discomfort wearing their trackers overnight or a lack of interest in monitoring sleep. The two participants who tracked sleep patterns were wanting to make sure they had enough sleep in a week as an intervention to modify their sleeping behaviour. For instance, Sue had sleeping problems, and

therefore used the activity trackers data to extract necessary indicators to understand and adjust the irregular sleeping pattern or problem. Sue also indicated that she shared the sleep data with her physician to understand better what was happening, which later resulted in a recommendation for a sleep study to understand her condition. Sue explained:

“So in the past I actually had pretty shocking sleeping results. I showed it to my doctor and she was like “Oh that's not so good”. I think we should do a sleep study or something.”
(Sue)

Hence, the data helped Sue and her doctor to understand her sleep patterns and use them as an indicator to inform their decisions on how to manage Sue's sleep and take other crucial steps to solve the problem. Sue's sharing of the data with her doctor was a response to help her solve the problem even though she has had concerns over the data accuracy issues. The participant explained further:

“but obviously it [fitness tracker] is not a proper diagnostic thing so just like a take away benefits sort of thing. But yeah the doctor considered it when I brought it up. I did actually have a referral for a sleep study but I didn't go, I just don't have time. The Fitbit has also suggested I should have a sleep study done but...” (Sue)

The sharing of data with doctors reflects the participants' seriousness in the self-monitoring activities, and indicates how they conceptualize the data derived from the activity trackers. Although the activity data is not formally used to make any clinical decisions, it helped with some form of informed decision-making to undertake a formal clinical procedure in relation to the sleep problem.

In contrast to the participants who use the sleep-monitoring feature, some participants had no interest in monitoring their sleep even though their activity trackers had sleep monitoring capabilities. The participants actively avoided measuring or paying attention to the sleep monitoring functionality. This can be attributed to a variety of reasons, not limited to lack of accuracy, but also the discomfort of wearing the tracker while sleeping. For instance, Teresa has been using the activity tracker for more than 4 years; at the beginning she tried but it was uncomfortable to wear while sleeping, hence forcing her to stop, said that:

“I did try using the Fitbit that I had on, tried to use it to monitor my sleep but it was so annoying to wear that I couldn't stand having it on, so I no longer track my sleep.” (Teresa)

Pauline reported having no interest in tracking sleep quality or using the feature, attributing it to lack of comfort in wearing the trackers while sleeping, while others had no interest in tracking such data. Pauline has used a range of trackers for more than 10 years.

“I don't wear it to sleep and I don't want to wear it for sleep tracking and I don't care about my sleeping”(Pauline)

Michael has been using the activity tracker for more than 4 years. He used one with sleep monitoring functionality, but indicated little interest to monitor his sleep. He explained his reasons for not using the functionality due to accuracy issues in measuring the sleep quality:

“I don't really pay much attention to sleep data. I don't pay attention to that because it's not a true indication of the sleep quality of your sleep and how long you were asleep.”

There's no way that a device like this can truly measure the quality of the sleep that you have.”(Michael)

Michael further added that having undertaken a sleep study in the past contributed to informing his decision of not tracking his sleep using the activity tracker. He explained his concerns as:

“Well I've had a sleep test before at a hospital so I know what a proper sleep test does. And the sophistication of the equipment that is used in terms of measuring the quality of people's sleep and the observation and all the other stuff that goes into it. So to actually just have something on your wrist while you sleep that kind of measures if you move around and how long you were actually asleep and your pulse, it's not a true reflection of ...your sleep quality.”(Michael)

Data literacy

Researchers have indicated a growing need for people to develop data literacy – the ability to identify and solve everyday problems through data (Deahl, 2014). In relation to lifelogged data, Deahl (2014) explains that ‘data literacy helps individuals learn to illuminate real-world phenomena through data: this learning should be project-based, problem-driven, and culturally relevant’. The activity trackers applications are designed to enable users to monitor and evaluate activities through the visual representation of the metrics. Most of the activity trackers provide data in usable visual and graphical forms from the collected data physical activities. The data display facilitated users interpretation or making meaning out of the everyday activities by answering questions such as “how many steps did I walk today? What does each specific data display mean to my fitness? Did I achieve the set target today? What does this heart rate and zones mean? What is the optimum heart rate of fat burned? What does burned calories mean? And so on” Thus interpretation of the data from the trackers is important for users to fulfil their inquisitive nature that motivates the adoption and continual use of the activity trackers.

In response to use or interpretation of the collected data, the participants indicated that the applications or apps were easy to use because the graphs are simple to interpret. The presentation of data in graphs enables users to easily understand the undertaken activities in a simple way. For example, Sue said:

“Understanding Fitbit app is pretty easy I think. When you open it up you can see it's like a graph. You know it's got three different colors with dates that represent sleep, restless sleep, and awake during the night. And I think you can say it's kind of like a timeline and you can see it quite visually but it also tells you like you had this much hours on these days... and you wake up this many times. So it's quite user friendly and doesn't really require a lot of extra interpretation.” (Sue)

Also the participants combined the activity trackers with other applications to have a better understanding of the monitored indicators. These additional applications support users to meet their end goals of staying healthy and fit. As Harry said:

“I typically record because it can now pair with my Fitness Pal. So I just typically put in the food for the day to track my macros, my steps, what my average heart rate is, throughout the day. It was during my workouts to see if, say for instance I'm trying to stay within a certain heart rate zone so I can physically see through the app and if I reach that goal and how long I was in that zone for. So typically stuff like those and the amount of steps I get in a day.” (Harry)

The participants displayed some knowledge about data interpretation in deciding what information was important for them. Although participants raised data accuracy issues, most of them thought the data was meaningful to them and their goals. This shows that the users can make their own meaning out of the information before deciding if it worth sharing with physicians in order to take the next course of action. This sharing or discussion of the data with physicians reflects a growing need to re-interpret and use the data to respond to individual health needs. The participants who shared the data with physicians were particularly concerned about the sleep and heart rate data – this kind of data was previously not accessible to people in their everyday lives, and shows a shift in how such information can either motivate or worry people about their health.

Activity tracker data record as a memory tool

Some of the participants said that they were using activity tracker data as a memory tool. This reiterates Sellen & Whittaker's (2010) description of activity trackers as tools that enhance retrieval of information for inferential purposes and as a tool to reflect on and review past experiences. This was evident in participants' experiences and expression of the importance of using the recorded data as a document for future reference. For example Sue who used both an Apple Watch and a Fitbit to record her sleep and heart rate, said:

“[The] one thing I am interested is recording my own health data. See how it could help me to improve my exercise and I like it to be in the record. So I like to have a record of when that didn't work out, what my heart rates have been like over the day. How much sleep I have had in the week.” (Sue)

Joe who also had two activity trackers (Fitbit and Apple Watch) used the data to reflect on past activities and in making comparisons of current and previous activities through the data. For example, Joe indicated:

“So for the Fitbit it was mainly just the step count that I was interested in and also if I did a run then recording where I went on that run; for the Apple Watch it's a little bit different because it's got the heartbeat monitor and I'm actually quite sort of interested in that. And it's quite interesting to look at it over a week and sort of try and sort of map it to what I was doing in the week that would have caused it to leap up at a particular point. So like for example when I go to yoga it's in a very hot room and it's sort of a high-pressure. So I find it quite interesting to look at the heart rate during that time because it kind of peaks there.” (Joe)

The participants used the heart rate data to reflect on other non-exercise activities. For example, after attending a job interview, Joe later looked up his heart rate just to see how his heart rate fared during the interview.

“ I went for an interview a few weeks ago and I looked at my heart rate and it was very high. And also I went to watch the Star Wars movie last week and you know this is a film that I really care about. So I find it quite interesting to reflect on what sort of a week I had, and map out and reflect where my heart rate was based on what I was doing.”(Joe)

Marcello specifically uses the data recorded in the activity tracker to evaluate his training.

“Through the device, I can record the daily statistics, and through my iPhone application, I can check it to see the last months, weeks, days. I can have the overview of the whole

period. I wanted more in the sense of to have a reference on how I am training. I am used to competing against myself, not other people.” (Marcello)

This sense of competing against oneself, or using the data to help motivate oneself, is something that came up with several participants. In a way, it provides either a validation or a checkpoint for their own instincts. Pauline uses it for accuracy rather than just trusting her instincts:

“So it's to be able to assess my fitness more accurately and not just trusting my instinct. So it's a balance of giving me some fact to say yes actually today I'm not pushing myself, but when my head is not in it, or sometime I would say oh my heartrate really gets high when I just get really upset with my boss. It's really ridiculous to be continuing at this level of heart rate.”(Pauline)

In a way, the activity trackers function not just as a tool to record information for later use, but also to provide validation to participants' own instincts.

Activity trackers as preventive health tools

Although the fitness trackers are not medical devices, some participants used them for diagnostic purposes by monitoring heart conditions and sleep. Some participants reported to have some family members with a history of heart conditions, and for them the use of the fitness trackers was a strategic tool to minimise and monitor any risks or proneness to these conditions. The use of the devices was a tool for monitoring heart rate and to understand their current condition and enable them to avoid any heart-related problem in the future or detect it early. Therefore the use of the fitness trackers was perceived as a form of preventive health measure. For example, Harry stated that:

“I mostly monitor my heart rate because in my family a lot of my family members, as they got much older, they started developing heart issues so they needed pacemakers or having to see a cardiologist. So I'm just really trying to be proactive now. So I hopefully workout more so that I don't run into those problems later in life.” (Harry)

Teresa who shares her fitness data with her doctor expressed that the intention to do so was informed by her current heart condition based on the activity tracker's data. She said:

“My doctor and I have been looking at the app dashboard on my iPhone about my heart because there is a family history of heart disease. And she tells me that my data is within the normal parameters at the moment. So I like to know for example if I'm in the fat burning zone, which I am at the moment at 87 beats per minute. How long I've been in it and that sort of thing”. (Teresa)

These findings indicate participant perception of the activity trackers or the data as a health-monitoring tool even though some expressed accuracy issues on the devices and the data. Regardless of the concerns of accuracy, the devices are helpful in some way to motivate users to achieve their set targets and allay the anxiety of developing heart related conditions. Thus the devices and their derivative data help the users in reducing their health-related fears.

Data accuracy and reliability issues

Four of the twenty-one participants used more than one activity tracker simultaneously. The use of the two devices was to complement and compensate for the accuracy of the data collected by the

separate devices in order to make decisions, and to check the data accuracy. Hence, although all the participants used the activity trackers to record information, they also expressed reliability and accuracy issues of the data in their respective activity trackers; they simply used the data as an indicator of their exercises and other activities. The accuracy concerns were specifically related to heart rate and sleep data functionalities. Sue who uses both Apple watch and Fitbit said:

“I kind of know what it means, and what not to take so seriously, and how to then incorporate it in and move on in terms of my health – which way to move it. For example, if my heart rate’s setting is quite high, I’ll go, “Hey, I need to change my exercise regime to this type of intensity to bring it down.” (Sue)

The participants expressed awareness of the lack of accuracy in the activity trackers and hence most respondents used the data as an indicator of what they track rather than as an accurate representation of the measured parameter. Dolly, a sports management student, explained that her accuracy concerns are informed as a result of her professional expertise and previous use of heart rate monitor tools:

“When I do exercise, I guess I am trained enough to understand where my heart rate is. When you look at the fitness tracker, it’s overly low for the kind of exercise I am doing, and what I am actually feeling. So I don’t particularly trust it.” (Dolly)

Hence Dolly uses the activity monitors as an indicator to motivate her and as a record to help her exercise rather than using it as a true health measurement tool. Dolly added:

“If the heart rate monitor was a little bit more accurate, I would definitely be interested in my resting heart rate or my day-to-day heart rate, on how it tracks. But I’ve seen the data, and it’s not very accurate” (Dolly)

This lack of accuracy has driven some respondents to use the activity trackers as just as a reference point rather than as an accurate representation of the tracked parameter. Julie also expressed similar accuracy sentiments:

“for instance like with this one that I have, I think it always tells me a higher heart rate than what I actually have. It sometimes starts measuring automatically whether I’m doing a sport or not, I think its telling me... many times that I’m doing sport while I’m just maybe walking. It’s not accurate in this sense, I do not trust my results but I think it helps while I’m training. If I’m like increasing my heart rate, or if I’m decreasing, or keeping track of how long I’ve been training for. I would say like the stats at the time of training and then look at it afterward...It’s not very good. This will say I have slept for eight or nine hours. I know that I woke up before 6:00 and I went to bed at 11 pm. Like oh yeah whatever. So I can look at it occasionally but it isn’t much.” (Julie)

The findings are important in reflecting the participants’ awareness of the accuracy issues over the data collected on their activity trackers. But this does not necessarily discourage use of the devices, for they are used as pointers or indicators for reflection rather than as accurate readings to be taken seriously.

Activity trackers as prompting devices

Activity trackers are essential tools with a potential for behavioural change toward better health. The trackers have the ability to provide regular reminders on planned activities and achievements

of daily targets. This enables users to respond to some of the cues i.e. move around after sitting for a long period of time, track the amount of calories consumed or burned, the amount of water consumption, distance walked, exercise intensity and so on. For instance Sue indicated her regular response to the reminder from her trackers:

“One of the features on the Apple Watch is that it prompts me to stand up for at least a minute every hour, and if you haven't done it in an hour, it'll tell you; give you a little buzz – I usually try to listen to that and do actually stand up if I've been sitting for a long time. I think it's just because you can see like your movement and your exercise data over the day, it definitely motivated me to actually put a little bit more effort to get those steps now to get more. So I would think that has changed my everyday activity.” (Sue)

This shows that many participants use the activity trackers like a timer or a prompting device to enable them to remember what they should be doing or hope to be doing.

Data Privacy in activity trackers

As people seek information through the fitness tracking devices, they provide and connect with other third-party applications to track and access additional services. For example, the participants linked up their trackers with popular applications such as: *Strava*, *Lose it!*, *Fitstar*, and *My Fitness Pal*, among others, to track the physical routes used, food logging, diet and burned calories, tracking weight loss etc.

Although the applications allow users to share some of the information on social networking sites like Facebook or Twitter, only two out of twenty one participants indicated to have used this feature to share the data; they did so just to proudly share their achievement in preparation for the forthcoming marathon, which aligns with earlier research findings that people used them to collect rewards points or share achievements (Rooksby et al. 2014). One participant who regularly shared her fitness data on Twitter indicated that she was careful about her privacy, and therefore uses an anonymous account just to have people respond with positive comments without knowing her struggles with being overweight.

Four of the participants used or linked the activity trackers to other applications, while the majority (seventeen) of the participants had no interest in making such connections; they expressed satisfaction over the information they accessed on their fitness applications, and therefore had no additional need to use or link to other applications like *My Fitness Pal*. While some expressed concerns over sharing data with other applications due to privacy concerns, one of the participants applied protective strategies to avoid giving permission to some of these third party applications to access information through apps. Kelly was concerned about how the information might be used against her in the future, and stated that:

“I don't like applications taking personal information about other people and then using that information to do whatever they want to do without my knowledge.” (Kelly)

As indicated in the literature review, the synergies created around the fitness trackers (Flybuys 2016), the activity trackers allow sharing of the data collected with other external parties through apps. Some participants indicated a willingness to share the data with health insurance providers if they saw any benefits for themselves. For example, Julie indicated that:

“if actually sharing my information was going to reduce my premiums, I absolutely would do it but I don't know if that would be the case. It might actually take my information and

go 'well, you're overweight. Therefore we're going to increase your premiums'. I think for me, the insurance companies should be happy that someone who is overweight like me with my family history with both my parents overweight as well, that I'm actually exercising as much as I am" (Julie)

On the contrary, some participants expressed concerns about the potential misuse of the data to inflate their insurance premiums. Hence, they were not willing to share their data even if they were presented with such incentives. Pauline expressed her concerns:

"I know you could share but I don't want to share anything because it's my business. It's only my business what I do, I don't use it to promote myself. It's personal-self help and not a social or promotional, or ego satisfaction. So no I never wanted to share it. And I'm very cautious with my privacy so that's also one of the reasons I only use it for my own purpose to check my own record, my data and to look at it and so on" (Pauline)

All participants expressed privacy concerns and lack of trust on how third parties are likely to repurpose the use of health data with example of data brokers and insurance providers. This calls for service providers to protect and use the personal and health data collected within the contexts of the original collection purposes.

Discussion

This study provides a foundational understanding of people's changing information practices with the increased use of fitness trackers to fulfil some of their everyday information needs. With the use of activity tracking applications and devices, one does not have to go to a doctor's office to check on several of the bodily indicators of health and fitness. Instead, these smart devices give that information to users in a way that they themselves can decide if they need to go to a doctor. In a way, the activity trackers have influenced a change of behavior in participants by providing some evidence of their health, and they are taking more precautions and acting on some of their instincts in regard to their health and wellbeing.

The participants exhibited a healthy awareness of privacy issues in regard to the data collected by the activity trackers with most saying it was highly personal with a potential for negative implications to them. These concerns are in alignment with extant literature over the privacy concerns related to health data from fitness trackers (Christl & Spiekerman 2016; Sweeney 2014). The main area of concern for the participants was the health data itself, which they were not sure how to interpret, other than using it as a prompt for keeping them on track on some of their physical activities.

The findings have implications on how health and information professionals can support patients and users of fitness trackers to understand the information from their activity-tracking devices and how they can integrate them with their self-management practices in regard to their health. As the findings indicate, some participants in the study already discuss this data with their health professionals. Given this, healthcare professionals may want to engage with patients who use these devices in order to gain additional knowledge of their patients' activities. Information professionals can also position themselves to provide additional support to users to make sense of or interpret the data through promoting health data literacy.

Conclusion

Although this was an exploratory study with twenty one participants, the rich data from the one-on-one interviews points to the need for alternative approaches to studying lifelogging from qualitative perspectives in order to understand how people are seeking and using information generated by their own bodies from within their everyday lives, and how they conduct their physical activities in their everyday life. People have integrated activity trackers into their everyday life as important tools to enable them to optimize their health and general wellbeing, but privacy literacy and data literacy are important for the users to meaningfully interpret fitness tracker data. This was reflected in participants' concerns about the accuracy of the data, with most taking caution in considering the data as serious; rather, most of them used it as an indicator to seek further professional intervention to address specific questions about their bodies and health.

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