

This is the peer reviewed version of the following article: Leese J, Goldman J, Zhu S, Macdonald GG, Pourrahmat MM, Townsend AF, Backman CL, Nimmon L, Li LC. Perspectives of Persons With Arthritis on the Use of Wearable Technology to Self-Monitor Physical Activity: A Qualitative Evidence Synthesis. *Arthritis Care Res (Hoboken)*. 2021 Feb 28. Which has been published in final form at doi: 10.1002/acr.24585. This article may be used for non-commercial purposes in accordance with Wiley Terms and Conditions for Use of Self-Archived Versions. This article may not be enhanced, enriched or otherwise transformed into a derivative work, without express permission from Wiley or by statutory rights under applicable legislation. Copyright notices must not be removed, obscured or modified. The article must be linked to Wiley's version of record on Wiley Online Library and any embedding, framing or otherwise making available the article or pages thereof by third parties from platforms, services and websites other than Wiley Online Library must be prohibited.

The Perspectives of Persons with Arthritis on the Use of Wearable Technology to Self-Monitor Physical Activity: A Qualitative Evidence Synthesis

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Funding

J Leese was supported by a Canadian Institutes of Health Research Doctoral Research Award. S Zhu was funded by the China Scholarship Council Visiting PhD Student Program (201706240206), National Natural Science Foundation (82002393) and the Health Commission of Sichuan Province (20PJ034). G Macdonald was supported by a Doctoral Salary Award from The Arthritis Society. LC Li is supported by the Harold Robinson/Arthritis Society Chair in Arthritic Diseases award, the Canada Research Chair Program, and the Michael Smith Foundation for Health Research Scholar Award.

ABSTRACT (Limit: 250 words; Count: 250 words)

Objective. We aim to broaden understanding of the perspectives of persons with arthritis on their use of wearables to self-monitor physical activity, through a synthesis of evidence from qualitative studies.

Methods. We conducted a systematic search of 5 databases (including Medline, CINAHL, and Embase) from inception to 2018. Eligible studies qualitatively examined the use of wearables from the perspectives of persons with arthritis. All relevant data were extracted and coded inductively in a thematic synthesis.

Results. Of 4358 records retrieved, 7 articles were included. Participants used a wearable during research participation in 3 studies and as part of usual self-management in 2 studies. In remaining studies, participants were shown a prototype they did not use. Themes identified were: 1) *Potential to change dynamics in patient-health professional communication*: Articles reported a common opinion that sharing wearable data could possibly enable them to improve communication with health professionals; 2) *Wearable-enabled self-awareness; a benefit or downside?*: There was agreement that wearables could increase self-awareness of physical activity levels, but perspectives were mixed on whether this increased self-awareness motivated more physical activity; 3) *Designing a wearable for everyday life*: Participants generally felt the technology was not obtrusive in their everyday lives, but it was speculated certain prototypes may embarrass or stigmatize persons with arthritis.

Conclusion. Themes hint toward an ethical dimension, as participants perceive their use of wearables may positively or negatively influence their capacity to shape their everyday self-management. We suggest ethical questions pertinent to the use of wearables in arthritis self-management for further exploration.

Keywords. Physical Activity, Arthritis, Wearables, Ethics

SIGNIFICANCE AND INNOVATIONS

- Our synthesis of qualitative evidence contributes early insight to foster understanding of how wearables can be incorporated successfully into arthritis self-management. We suggest ethical questions emerging from the experiences and opinions of persons with arthritis on the use of a wearable to support their physical activity participation.
- Findings draw attention to gaps in our understanding of changes to relational dynamics in clinical encounters that persons with arthritis anticipate if using a physical activity wearable in future self-management.
- Findings raise questions around benefits and downsides of an increased self-awareness of physical activity levels with the use of wearables by persons with arthritis in the contexts of research participation and usual self-management.

INTRODUCTION

Physical activity is recommended as a crucial component in managing arthritis well (1–3). Despite this, participation in physical activity among persons with arthritis often does not meet recommendations (4–7). Current evidence suggests that using consumer wearable devices (e.g., pedometers, fitness bands) could support persons with chronic illness to be physically active (8–12). For example, systematic reviews have associated the use of a wearable in real-life environments with modest positive effects on daily step count and time spent in moderate-to-vigorous activity among persons with chronic illnesses including arthritis (8,12). While consumer wearables are popular among healthy individuals, their use in the management of chronic illnesses is limited because potential applications are in the early stages of development. Strong evidence has yet to show how to successfully design and implement wearable-based interventions to achieve long-term behaviour change, and potential strategies have been predominantly explored in academic rather than real-world contexts (13–15). If we are to learn whether and how to successfully design and implement wearable technology to support arthritis self-management, a better understanding of the perspectives of persons with arthritis on the use of a physical activity wearable in their everyday lives is essential. In a 2018 study of 157 participants with rheumatoid arthritis or axial spondyloarthritis who used a wearable over 3 months, Jacquemin et al. found the majority reported no difficulties related to wearing or setting up the device, or concerns about data security (11). Questions remain, however, about the full spectrum of experiences (positive and negative) from the use of physical activity wearables in the management of chronic illnesses, with some trials reporting unexpected negative outcomes including increased pain (12), elevated levels of depression (16), or regained weight (17) among persons with chronic illnesses. With particular focus on lived experience and opinion-based

reports of benefits and downsides, this qualitative evidence synthesis aims to broaden understanding of perspectives of persons with arthritis on the use of wearables in their everyday lives to self-monitor their physical activity participation.

MATERIALS AND METHODS

We conducted a meta-synthesis of qualitative literature to examine the perspectives of persons with arthritis on using a wearable to support an active lifestyle. Meta-synthesis aims to enlarge the interpretative possibilities of findings and construct larger narratives that are more substantive than those resulting from individual investigations (18). It is designed to advance knowledge by integrating research findings (versus raw data) from multiple qualitative studies with interpretive, rather than aggregating, intent (19,20).

Search Strategy and Eligibility Criteria

A systematic literature search was conducted by JL using Medline, Cumulative Index to Nursing and Allied Health Literature, EmBase, Sociological Abstracts, and PsycInfo from inception to January 2018. We used SPIDER (Sample, Phenomenon of Interest, Design, Evaluation, Research type), a search strategy tool to improve the sensitivity of an exhaustive search for relevant articles (21). A search strategy was initially developed for Medline ([Supplementary File I](#)), and adapted in consultation with a librarian (22–24). To compensate for deficiencies in retrieval terms, we used a “snowballing” technique, whereby reference lists of eligible articles were inspected. Peer-reviewed articles were eligible if criteria in [Table 1](#) was met. We defined “qualitative” as empirical research with human participants conducted in any research paradigm that used qualitative techniques for data collection and analysis. Journalistic

or other non-research papers were excluded (25). After eliminating duplicates, pairs of reviewers (JL, JG, SZ, GM, MP) screened each title and abstract. If eligibility criteria were met, these pairs screened the full text article. If agreement was not reached in pairs, eligibility was decided through discussion with a third reviewer (LL).

Data extraction

A template was used to extract relevant data ([Supplementary File II](#)). Investigators' interpretations relevant to the aims of this review that were written in the findings, discussion or conclusion sections of each eligible study were extracted independently by two reviewers (JL, SZ) and imported into NVivo 11 to assist with synthesis. Direct quotes from interview participants of included studies were not extracted. Extracted data was compared and discrepancies resolved through discussion with a third reviewer (LL).

Data synthesis

Our meta-synthesis was guided by inductive methods of thematic analysis and thematic synthesis (26–28). After reading and re-reading extracted data from included articles, JL and SZ independently created initial line-by-line codes. JL and GM next looked for similarities and differences between these initial codes in order to sort them into descriptive themes. Next, JL and CB met to review and refine descriptive themes, seeking data that complicated or challenged them. Through further discussion with co-authors, abstract themes were defined and named. With an aim to remain faithful to primary studies, the heterogeneity of included studies based on contextual differences was considered throughout. We checked whether understandings gained

in one context from one theoretical perspective transferred to another, and whether some findings could be attributed to a particular context or perspective.

Quality Appraisal

Quality appraisal is an area of debate in qualitative research because no consensus exists about the notion of quality in qualitative research (18,20). No articles were excluded therefore on the basis of ill-conceived or debatable notions of quality. Our quality appraisal aimed to indicate how trustworthy each article's contribution was to our research question. JL, CB and LL independently appraised quality of included articles ([Supplementary File III](#)) using the McMaster Critical Review Guidelines for Qualitative Studies (29). After synthesis was complete, we examined the relative contributions of each article comparatively and found poorer quality studies did not contain unique themes in our synthesis.

Assessing the confidence of the review findings

JL and LL assessed the confidence of each review finding using the revised version of the Confidence in the Evidence from Reviews of Qualitative research (CERQual) tool ([Supplementary File IV](#)) (30). This tool provides a transparent method for a reviewer to assess confidence in each individual review finding, which may facilitate the use of qualitative synthesis findings to inform decisions and shape policies.

RESULTS

The systematic search retrieved 4358 records (after eliminating duplicates) and 4264 of these did not meet eligibility criteria. Of the 94 full-text articles assessed for eligibility, most

were excluded because they did not involve the use of qualitative research methods or analysis. Seven articles from 6 studies were included for a full review (Figure 1). Sample characteristics of included studies are presented in Table 2. Across all studies, there was a total of 134 participants, varying in age between 23 and 84 years old, and 94 (70%) were women. 102 (77%) lived with osteoarthritis (OA).

Three articles reported on participants' experiences of using a wearable, which was an existing product (31–33) or in prototype form (32), in their own environments during research participation. Of these studies, one explored the perceptions of 21 participants of a randomized controlled trial who used a pedometer over 70 minutes per week for at least 9 weeks of 12-week walking program with supervision from a physiotherapist (31). Another was a mixed-methods evaluation that examined the perceived acceptability of five consumer wearables, based on the experiences of 21 participants who used each for at least 3 days over 15 days (33). The last explored the experiences of 14 participants who used an accelerometer (Sensewear Pro3 Armband) and a wearable under development simultaneously to self-monitor physical activity in the home setting over 7 days in a clinical study (32). Features of the wearables are described in Table 2.

Of the remaining 4 articles, two reported the opinions of 21 participants (the majority of whom had not used a wearable) about their hypothetical use of wearable technology in general, after being shown a prototype wearable during a focus group (34,35). Two articles reported on participants' experiences of using a wearable as part of their usual self-management, varying from 1-2 times per year to 1-2 times per week (36,37). Three articles reported opinions about the hypothetical use of wearable technology from participants who had no previous experience of using a wearable (34,35,37).

[Table 3](#) presents theoretical and methodological characteristics of included articles. Three studies were introduced as examinations of “user” acceptance of wearable technology, based on participants’ opinions about their hypothetical use of a prototype (34), experience of using a wearable in development (32) or an existing wearable in their own environment during research participation (32,33). Authors introduced these studies with concepts of user-centered design or technology acceptance, with the idea that findings on user perspectives had implications for the design of future wearables (33,34) or the implementation of existing wearables for patient benefit in rehabilitation (32–34). Two studies provided insights into participants’ experiences of using a wearable to change behaviour for improved health outcomes (e.g., reduced knee pain) during research participation (31) or self-management (36). Authors concluded these insights could aid in the development of programs to support changing patient behaviour during rehabilitation. Authors of the remaining two studies took a psychosocial approach, aligning their findings with concepts of patient-doctor communication (35,37).

Five studies involved focus groups and two involved interviews (lasting an average of 15 mins in one study). Six studies used methods of thematic analysis, and one used constant comparative analysis. We identified three abstract themes, including: 1) *Potential to change dynamics in patient-health professional communication*; 2) *Wearable-enabled self-awareness: a benefit or downside?*; 3) *Designing a wearable for everyday life*. [Supplementary File V](#) presents an overview of our theme development, and [Table 4](#) presents illustrative data for each analytic theme.

Theme 1: Potential to change dynamics in patient-health professional communication

In 3 articles from 2 studies, authors reported participants imagined their use of a wearable in the future could possibly improve communication with health professionals in their self-management (Table 4, #1-3) (34,35,37). In two of these articles, participants were asked to comment on a wearable prototype during a focus group (34,35), the majority of whom had never used a wearable. Participants of the other study had no experience of using a wearable with a health professional (37). Across these 3 articles, there was agreement in participants' opinions that sharing wearable data with a health professional in future could inform and improve the quality of clinical consultations (Quotes #4-6) (34,35,37). Belsi et al (35) reported participants viewed their future use of wearable technology could support "a more patient-centered character of consultations" and "shared decision-making"; building a partnership "rather than following a purely paternalistic model" during a clinical consultation (Quotes #1, #4, #7). Leese et al. highlighted some participants anticipated the quality of their relationship with a health professional could play a role in whether they would feel comfortable sharing wearable data in future, with one participant anticipating a negative response if they were to share wearable data with their health professional (Quote #8) (37). Based on participants' opinions, these authors identified a need for better understanding of patient needs and preferences to guide how persons with arthritis could successfully begin to use a wearable with health professionals in self-management (Quotes #9-13) (34,35,37).

Theme 2: Wearable-enabled self-awareness: a benefit or downside?

It was reported many participants experienced benefits from using a wearable regardless of whether they used the technology during research participation (Table 4, #14-16) (31-33), or

as part of self-management (Quotes #17-18) (36,37). Participants shown a prototype wearable during a research focus group, which they did not actually use, also envisaged benefits (Quotes #19-20) (34,35). Across articles, benefits included becoming more aware of activity levels and more in control of arthritis management (Quotes #14-20) (32–37). Among participants who used a wearable in their own environments during research periods of 7 days (32) and 12 weeks (31), psychological benefits, such as improved confidence, distraction from symptoms, feeling reassured, were also reported (Quotes #16, #21). However, in the study where participants used 5 different wearables (each for 3 days), the authors highlighted individuals' negative feelings (e.g., guilt) as they became more aware of their physical activity levels (33). They “either wondered or worried that they were not as active as they should be” (Quote #22) (33).

Authors reported contrasting perspectives from participants on whether heightened self-awareness of physical activity levels could motivate them to be more active (Quotes #23-28) (32–35,37). While some participants felt motivated to keep working at increasing their activity levels (Quotes #23, #28), regardless of whether they used a wearable during research participation (32) or in self-management (37), Tierney et al. also identified other participants who “would have liked to increase their activity levels” discovered it “might not have been possible” due to circumstances they could not control (e.g., a flare of symptoms) (Quote #29) (32). Leese et al. reported that some participants, who used a wearable as part of their self-management and were already active, experienced their wearable as a “nice reinforcement” to “push themselves a bit further” (Quote #28) (37). Leese et al. also emphasized, however, their participants' opinions that wearables would be ineffective at prompting an active lifestyle among persons who were not already motivated to make a change (Quote #28) (37).

Theme 3: Designing a wearable for everyday life

Papi et al. and Belsi et al. reported that participants who had been shown a wearable prototype, but did not use it, typically felt positively about the possibility of using wearable technology in future (Table 4, #30-31) (34,35). Papi et al., however, emphasized these participants anticipated they would appreciate a discreet design which they imagined would prevent them looking ‘*too out of the ordinary*’ if they were to use wearable technology in their own environments (Quote #32) (34). It was also highlighted these participants would prefer not “to put on a specific clothing item just because a sensor would be attached to it”, because specific clothing “could be identified as ‘patient clothing’, thus bringing in concerns of being ‘labelled as patients’”, and they would prefer “to wear their usual outfit with no constraints and no identity intrusion” if they were to use wearable technology in their own environments (Quote #32) (34).

Among participants who used multiple wearables during their research participation, they generally felt positively about their experiences of incorporating wearable technology in their everyday lives, continuing “to live normally and unaffected” (Quotes #33-34) (32,33). Based on participants’ experiences of ‘trying out’ 5 commercially available wearables (for 3 days each) over a 15-day research period, Mercer et al. identified that a waterproof design reduced worry of accidentally damaging a wearable when performing everyday activities (Quote #35) (33). Participants who used a wearable under development suggested that developers change the design so persons with arthritis would not need to wear the device on their thigh (secured using microporous tape and an elasticated bandage) if they were to use it in future (Quote #36) (32). Participants’ reasons for suggesting this change in design were not captured, but Tierney et al. speculated reasons “might have been related to the ‘physical dimension’ of obtrusiveness or

perhaps to embarrassment or stigma” that participants may have experienced in their own environments (Quote #36) (32).

DISCUSSION

Findings suggest that, across the included articles, participants felt generally positive about their experience of using a wearable, whether during research participation (31–33) or as part of their usual self-management (36,37). Regardless of whether they had used a wearable to self-manage or not, they commonly held the opinion that starting to share wearable data with a health professional would enable them to improve communication during clinical visits (34,35,37). There was agreement that the use of a wearable increased self-awareness of physical activity levels whether during research participation (31,31,32) or self-management (36,37), although perspectives on the impact of this heightened self-awareness varied. For example, while some felt reassured by becoming more aware of their physical activity levels during research participation, others worried they were not as active as they felt they should be (32).

Participants typically did not find using the technology to be obtrusive or an imposition to living normally and unaffected in their everyday lives during research participation (32,33). Participants who were shown a prototype they did not use (34,35) and who used a wearable under development (32) did, however, suggest changes to inform the future design of these devices. Tierney et al. and Papi et al. speculated these changes may serve to better obtain unobtrusive monitoring by preventing unwelcome experiences of being “labelled as patients”, embarrassment or stigma among persons with arthritis if these wearables were to be used in everyday environments in the future (32,34).

Across these findings, attention is directed to participants' experiences and opinions on how their use of wearable technology can influence their own capacity to shape their self-management. For example, it was envisaged in our findings that the use of wearable technology could possibly support the capacity of persons with arthritis to shape their self-management by improving communication during a clinical encounter, and wearable-enabled self-awareness was experienced by some participants to support their capacity to shape their self-management by motivating them to be a bit more active. Autonomy, understood by multiple accounts as shaping one's own life, choosing for oneself or being one's own person, is therefore a prevailing issue across findings (38,39). Participants' perspectives on how their use of a wearable influences their autonomy in their self-management, however, is not explicitly examined or elaborated upon in any of our included articles. To guide future examination of this understudied issue of autonomy emerging in our findings, relational ethics offers an appropriate conceptual lens because of its particular emphasis on the pervasive influence of interpersonal relationships (e.g., between patient-health professionals) on one's capacity to shape one's own life and choose for oneself in everyday environments (38,40). Indeed, taking a relational ethics approach has previously facilitated nuanced examinations of how autonomy may be supported (or otherwise) in the complex web of personal and institutional relationships in a health care context (41,42).

Further research would allow opportunity to explore ethical questions regarding patient autonomy raised by the opinion commonly held amongst participants that sharing wearable data would possibly improve communication with a health professional (34,35,37). One of these ethical questions, for example, is whether the wearable may be deferred to as an "objective knower" during a consultation, providing objective data that may be viewed as more credible than subjective accounts of lived experience. The impact of discrepancies between wearable data

and subjective perception of physical activity on patient autonomy in communication with a health professional is also unclear at this early stage of potential integration of wearable technology in arthritis self-management. When we consider the likelihood of discrepancies, these questions are particularly relevant. For example, a recent systematic review concluded that Fitbit is unlikely to provide accurate measurement of steps in adults with mobility limitations in free-living environments (43). The possibility of lending wearable data more credence than accounts of lived experience in a clinical encounter may risk undermining the experiences of persons with arthritis as a valid source of knowledge in communication with a health professional and restrict the capacity for persons with arthritis to shape the consultation in ways they choose based on subjective accounts of their lived experience. Further research is needed to explore questions regarding patient autonomy based on experiences among persons with arthritis when using a wearable in the context of patient-health professional communication which is laden with power dynamics.

Ethical questions regarding patient autonomy are also raised by the contrasting perspectives we identified on whether wearable-enabled self-awareness increased physical activity during research participation. Some participants found that wearable-enabled self-awareness motivated them to increase their activity, thereby enhancing their autonomy by supporting them to direct their own choices about their physical activity. It is unclear, however, whether wearable-enabled self-awareness may undermine the autonomy of others identified who were unable to increase their physical activity (e.g., due to low motivation, a flare). For instance, guilt evoked by wearable-enabled self-awareness may lead some persons with arthritis to stop trying to reach physical activity goals or nudge others towards increasing physical activity at times when they do not wish to but do so anyway because they feel they should. A fuller

understanding of how persons with arthritis experience wearable-enabled self-awareness positively (as autonomy-enhancing) or negatively (as autonomy-undermining) could guide appropriate strategies for incorporating patients' use of wearables in self-management in ways that maximize benefits and minimize downsides under different conditions.

Ethical questions related to patient autonomy are also prompted by speculation in included articles that participants may have felt embarrassed, stigmatized or "labelled as patients" if using certain prototypes in their everyday environments without changes in their future design (32,34). The possibility that social factors (e.g., feeling stigmatized) involved in the use of these prototypes could undermine the efforts of persons with arthritis to form, maintain or re-establish their social identities is an important issue concerning autonomy, because it highlights possible disruption to the 'self' that is self-determining. There is a well-established body of chronic illness literature indicating that threatened identity is an important form of suffering among chronically ill persons (44–49). Further research is needed to tease out how the use of wearable technology may impact one's social identity positively or negatively from the perspectives of persons with arthritis, in order to provide a detailed picture of this issue of autonomy and guide best practices for designing wearables to incorporate into arthritis self-management in future.

This study has several limitations. As is the case with meta-synthesis, our findings constitute interpretation that is at least three times removed from voices represented in raw data. Findings of included articles are also not based entirely on first-hand accounts of lived experience of using a wearable. Of the 5 included articles that did report first-hand accounts of this lived experience, 3 involved participants using a wearable within a context of research participation (only one of which involved participants using a wearable with a clinician). Using a

CERQual assessment tool, we also placed low confidence in our synthesis findings, identifying serious concern regarding the adequacy (or degree of richness or quantity) of supporting data (50). These limitations indicate that further research is needed to guide decision-makers in the design and implementation of wearables in a context of usual everyday self-management. Meanwhile, our choice to conduct a meta-synthesis aligns with our current aspiration to broaden understanding of the perspectives of persons with arthritis, such that lessons may be learned to shape research and contribute to ongoing conversations in clinical practice at this early stage of potential integration of wearables into arthritis self-management.

Our findings contribute an additional perspective from a relational ethics lens to foster understanding of how wearables can be incorporated successfully into arthritis self-management. We identified issues of relational autonomy that emerged across prior studies and proposed a relational ethics lens through which to further unpack these issues in future research. Issues raised have implications for learning how to design and implement wearable-enabled interventions to support arthritis self-management in ways that are respectful of patient autonomy.

Word Count

Limit: 3,800. Current: 3783

DECLARATIONS

Acknowledgements

We thank Charlotte Beck for her important contributions to this project.

Competing Interests

There are no competing interests for any author.

Authors' Contributions

Obtain funding: Li, Backman, Townsend, Leese

Study design and proposal: Li, Backman, Townsend, Nimmon, Leese

Study oversight: Li, Backman, Townsend, Nimmon, Leese

Data analysis: Leese, Geldman, Zhu, Macdonald, Pourrahmat

Data interpretation: Leese, Geldman, Zhu, Macdonald, Pourrahmat, Townsend, Backman, Nimmon, Li

Manuscript review: Leese, Geldman, Zhu, Macdonald, Pourrahmat, Townsend, Backman, Nimmon, Li

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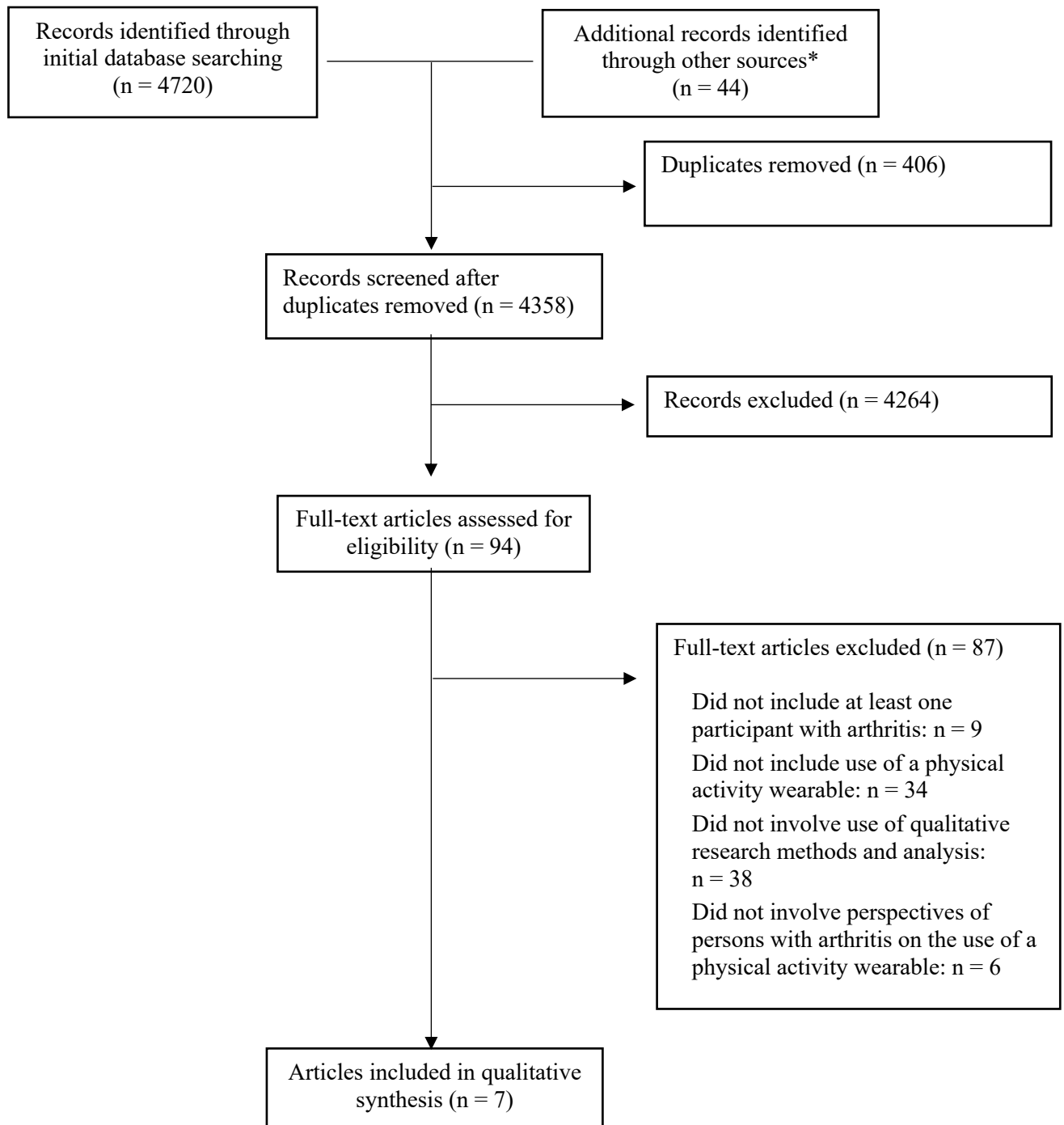
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Figure 1. PRISMA Flow Diagram



*Additional records were identified by inspecting reference lists of eligible articles identified through initial database screening

Table 1. Eligibility Criteria

SAMPLE:	Included at least one participant with any type of arthritis ⁺ .
PHENOMENON OF INTEREST:	Included the use of a wearable* for the purposes of self-monitoring physical activity participation.
DESIGN:	Involved the use of qualitative research methods and analysis.
EVALUATION:	Presented the Sample's (refer to 1) perspectives of the Phenomenon of Interest (refer to 2).
OTHER CHARACTERISTICS:	Published in English

⁺ A participant could have been diagnosed with arthritis through clinical assessment or imaging or could have self-reported a diagnosis of arthritis.

* We define a "wearable" as a worn device that tracks movement through sensors or companion smartphone or computer applications.

Table 2. Sample Characteristics in Included Studies

Author (Year of Publication)	Country	Diagnosis	# of Participan ts	Mean age (range), years	Women	Frequency of use prior to study	Frequency of use during study	Type of wearable(s) used prior to study	Type of wearable(s) used in study
Tierney et al. (2013) (32)	Ireland	RA*	14	Unreported (43.91 – 74.55)	3	Unreported	Continuous across 7 days within the previous six months, with option to remove overnight.	Unreported	Sensewear Pro3Armband; Sensing Health with Intelligence, Modularity, Mobility and Experimental Reusability (SHIMMER) ¹
Papi et al. (2015) (34)	UK	Knee OA*	21	Unreported, (45-65)	19	Unreported.	Unreported	Unreported	None.
Belsi et al. (2016) (35)						Only 9 participants were aware of what a wearable was.			Participants were shown a knee-monitoring prototype in development. ²
Mercer et al. (2016) (33)	Canada	Chronic illness including OA, and RA or other IA*	32 (including 15 OA; 3 RA or IA)	64 (52-84)	23	None. Participants were using wearables for the first time.	30 participants completed testing all wearables over 15 days.	Unreported	A pedometer (Sportline or Mio) was used for 3 days. A Fitbit Zip; Jawbone Up 24 [discontinued]; Misfit Shine [discontinued]; Withings Pulse [discontinued] were next

Author (Year of Publication)	Country	Diagnosis	# of Participan ts	Mean age (range), years	Women	Frequency of use prior to study	Frequency of use during study	Type of wearable(s) used prior to study	Type of wearable(s) used in study
									provided in random order and participants asked to use each for 3 days. Participants were instructed to wear the activity tracker as intended by the manufacturer (eg, Fitbit Zip during waking hours, whereas Jawbone Up 24 during waking and sleeping hours).
Wallis (2019) (31)	Australia	Knee OA (severe)	21	67 (51-84)	9	Unreported	15 participants (71%) completed 70 mins per week for at least 9 weeks of a 12-week moderate intensity walking program, supervised by a physiotherapist	Unreported	Pedometer
Pellegrini (2018) (36)	US	Knee OA	20	64.7 (40-79)	9	Unreported.	Unreported.	Three participants reported	None.

Author (Year of Publication)	Country	Diagnosis	# of Participan ts	Mean age (range), years	Women	Frequency of use prior to study	Frequency of use during study	Type of wearable(s) used prior to study	Type of wearable(s) used in study
								using a wearable, one of whom had used a Fitbit continuously over a period of weeks.	
Leese et al. (2019) (37)	Canada	OA; IA	40 (18 OA; 15 IA; 7 both OA & IA)	59 (23-78)	31	37 provided information about their previous use of wearables. Of those, 11 had used a wearable 1– 2 times per year, 2 used a wearable 1–2 times per month, and 12 used a wearable 1–2 times per week. 12 had no experience with using wearables.	Unreported.	Participants described prior use of a pedometer, a monitor worn on shoe, acceleromete r or Fitbit	None. Participants were shown some examples of wearables before focus group discussion.

* RA = Rheumatoid Arthritis; OA = Osteoarthritis; IA = Inflammatory Arthritis

¹The Sensing Health with Intelligence, Modularity, Mobility and Experimental Reusability (SHIMMER) is a small, light (28-gram), matchbox-shaped 5 cm x 2.5cm x 1.25 cm wireless sensor platform. It is still being developed. It is worn on the dominant thigh and secured using microporous tape and an elasticated bandage. The monitor was turned on by the researcher at application and continuously recorded data throughout the monitoring period.

²The technology, in its prototype form, consisted of a sensor unit, a thin (0.2mm) rectangular (50x10mm) strip of flexible conductive material with two connectors at each end. The connectors were soldered via flexible cables to a small box (35x50x40mm) which contains the circuits to allow sensor unit data capturing and Bluetooth data transmission to a proprietary device application. The sensor unit could be embedded into a pair of leggings and the box positioned in the back pocket, commonly present in commercially available leggings.

Table 3. Theoretical & Methodological Characteristics of Included Studies

Author (Year of Publication)	Authors' Disciplinary Background	Theoretical or Philosophical Perspective	Study Setting	Aim(s) of the Study	Qualitative Methodology/Paradigm	Qualitative data collection methods	Qualitative data analysis methods
Tierney et al. (2013) (32)	Physiotherapy; statistics; clinical therapy; rheumatology	Technology Acceptance	Community	To explore the experiences of home monitoring of health with specific regard to physical activity monitors worn over a seven-day period in people with RA.	Unreported	Focus groups (2 each lasting 40-60mins) located at Mid-Western Regional Hospital held up to 6 months after use of wearable	Thematic analysis
Papi et al. (2015) (34)	Surgery and Cancer	A user-centred technology approach	University	To identify perspective of patients with osteoarthritis, in particular design requirements and mode of use, of wearable technology to support the rehabilitation pathway.	Unreported	Focus groups (4 each lasting 45-60 mins) at Imperial College London	Thematic analysis
Belsi et al. (2016) (35)	Surgery and Cancer	A psycho-social approach	University	To identify the impact the use of wearable technology could have in patients with osteoarthritis in terms of communication with healthcare providers and patients' empowerment to manage their condition.	Framework methodology	Focus groups (4 each lasting 45-60 mins) at Imperial College London	Thematic analysis

Author (Year of Publication)	Authors' Disciplinary Background	Theoretical or Philosophical Perspective	Study Setting	Aim(s) of the Study	Qualitative Methodology/Paradigm	Qualitative data collection methods	Qualitative data analysis methods
Mercer et al. (2016) (33)	Pharmacy, kinesiology, management science	Technology Acceptance	Community	To examine the usability and usefulness of wearable activity trackers for older adults living with chronic illness.	A grounded theory approach	Focus groups	Thematic analysis
Wallis (2019) (31)	Allied Health; Physical Therapy; Rheumatology; Othopaedics; Active Living, Exercise & Sports	Changing Behaviour	Community	To explore the perceptions of people with severe knee osteoarthritis and with increased cardiovascular risk, who participated in a physical activity/walking program from a randomized controlled trial, by gaining insight into their perceived benefits, adherence and their view of the program.	A phenomenological approach	Interviews (each lasting 15 mins on average)	Thematic analysis
Pellegrini (2018) (36)	Preventive Medicine, Exercise Science, General Internal Medicine and Geriatrics	Changing Behaviour	Community	To identify and explore barriers and facilitators to physical activity and healthy eating among total knee arthroplasty patients	Not reported	Interview	Constant comparative analysis
Leese et al. (2019) (37)	Physical Therapy, Rheumatology, Occupational Science, Health Policy	An interpretive, naturalistic approach	Community	To compare and contrast perspectives of patients with arthritis and rehabilitation professionals on starting and sustaining use of physical activity trackers	Constructivist paradigm	Focus groups (9 each lasting approx. 2 hours)	Thematic analysis

Table 4: Selected Illustrative Data*

Analytical Theme 1: Potential to change dynamics in patient-health professional communication

#1) Another interesting finding was patients' belief that enriching their consultations with data from the monitoring device along with their own testimony and description of symptoms would enhance the provision of accurate feedback and management planning; this also appeared to wave any elements of doubt as well as to increase their confidence in the results of the consultation: This in turn seemed to result in communicating better with their clinicians in terms of clarity of the information exchanged but also regarding the quality of advice they would receive. A more patient-centred character of consultations was evident. **(35)** Belsi et al.

#2) With regard to how to use the wearable technology, participants recognized the benefits of using the device as a system for supporting themselves over their rehabilitation course. In particular, they indicated the usefulness of the system... as a new means of communication with health professionals. **(34)** Papi et al.

#3) Many rehabilitation professionals and patients believed physical activity data recorded by physical activity trackers could be used to enhance their communication with each other during clinical visits. **(37)** Leese et al.

#4) This was suggested in many levels, from having more accurate consultations and tailored treatment to better communicating the progress of their health, having greater clarity about their management plan and opening more communication channels with their healthcare provider leading to shared decision-making... Patients felt that being able to monitor their condition could offer accurate data to their healthcare provider in an objective way. **(35)** Belsi et al.

#5) There was agreement among patients and rehabilitation professionals that establishing a "concrete" baseline of patients' activity levels with objective measures from physical activity trackers had potential to make consultations more effective and efficient... Both patients and rehabilitation professionals expected objective measures from physical activity trackers would help rehabilitation professionals in developing treatment plans with their patients. **(37)** Leese et al.

#6) All participants agreed that the information collected would give them more control over their condition and permit their clinicians to be more informed about their problems, thus facilitating individualised treatment planning... The use of wearable technology could offer a novel way to deliver rehabilitation for patients with OA at home while ensuring virtual supervision via aerial data sharing with clinicians. **(34)** Papi et al.

#7) Using the data from the monitoring device as part of their consultations was welcomed by the patients as a positive step in their care: Which in turn made them feel more informed, promoted shared decision-making and moved towards building a partnership with their care provider, rather than following a purely paternalistic model... It was further suggested that having more information and being encouraged to use a monitoring device shifted patients' attitude from a rather reactive approach to their health condition to becoming more proactive. This appeared to also place them in a better place to communicate and negotiate their care with their healthcare provider. **(35)** Belsi et al.

#8) Many patients and rehabilitation professionals indicated they were uncertain how information from physical activity trackers would be integrated into the consultation. Some patients questioned whether clinicians would welcome information from physical activity trackers...

While one patient wondered if clinicians would find the information useful, others doubted it would be realistic for clinicians to make use of the information given perceived time constraints that already exist for clinician visits... Some patients also questioned whether they would feel comfortable to share their physical activity tracker records with their clinicians, with one patient anticipating they might receive a hostile response. Some patients highlighted the quality of their interaction with their clinician would be important in determining whether they felt comfortable or not to share their physical activity tracker records. **(37)** Leese et al.

#9) ...further research will be needed to identify patient preferences in terms of the amount of knowledge and involvement they prefer from a wearable device-supported rehabilitation approach. **(35)** Belsi et al.

#10) It is crucial not just to offer patients their collected data, but also to use those as a platform to provide them with an insight into the progress of their own health and what specifically they could do to improve it. In this way and within the OA rehabilitation context, wearable devices could be used to set rehabilitation targets based on individual needs... **(35)** Belsi et al.

#11) ...these are well-designed in terms of aesthetics and usability, but are mainly designed to track fitness, mostly in healthy people and sports-addicts; these lack the clinical interlink in tracking functional outcomes and lack the understanding of specific clinical population needs. **(34)** Papi et al.

#12) ...although both patients and rehabilitation professionals commonly envisioned sharing records from physical activity trackers had potential benefit to improve their consultations, many were also uncertain about how this potential could be realized in practice. **(37)** Leese et al.

#13) ...the emotional wellbeing of some less active patients (e.g., due to flare-ups) may be negatively affected if a clinician was not involved in setting realistic goals with the patient... Further research is warranted to evaluate the clinician's role in supporting theory-based interventions that involve physical activity trackers as safe self-management support. **(37)** Leese et al.

Analytical Theme 2: Wearable-enabled self-awareness – a benefit or downside?

#14) Overwhelmingly, participants felt that having their health monitored in the home was a positive thing and were 'delighted' by it... People also liked the fact that they were more in control of their condition and its management [...] Some individuals also reported that wearing of the monitors in the home made them more conscious about increasing their activity levels. **(32)** Tierney et al.

#15) The greatest advantage to wearable activity trackers is that they help participants become more aware of their activity levels. **(33)** Mercer et al.

#16) Many patients felt walking with physiotherapy supervision and using a pedometer was motivational, encouraging and improved their confidence and distracted them from their knee. **(31)** Wallis

#17) Other common facilitators to physical activity mentioned by pre-operative patients were monitoring and awareness of activity levels... some reported using some type of wearable device such as a Fitbit or smartwatch which monitoring activity. **(36)** Pellegrini

#18) ...already active patients experience their use of physical activity trackers as a “nice reinforcement” of their motivation, providing incentive to push themselves a bit further and reach a physical activity goal they had set. **(37)** Leese et al.

#19) Patients also expressed the view that the use of monitoring devices would benefit them, as having access to their day-to-day progress would make them feel more empowered to take control over their condition and manage it more effectively... having the power to make informed choices about their health was associated with improvements in their quality of life, as they felt they would now also be in control, rather than just following professional guidance... being encouraged to use a monitoring device shifted patients’ attitude from a rather reactive approach to their health condition to becoming more proactive... And this information had the potential to reinforce their ability to take control over their situation. **(35)** Belsi et al.

#20) With regard to how to use the wearable technology, participants recognised the benefits of using the device as a system for supporting themselves over their rehabilitation course... All participants agreed that the information collected would give them more control over their condition. **(34)** Papi et al.

#21) Other users reported the reassurance of being provided with details of their levels of physical activity, providing assurance that they were progressing well. **(32)** Tierney et al.

#22) Even if participants thought they were active, they either wondered or worried that they were not as active as they should be. **(33)** Mercer et al.

#23) People expressed that learning more about their own physical activity levels had motivated them to keep working at increasing them... Many reported learning about their physical activity levels served as a motivation to continue to work to improve their physical activity levels, and also served to negate ‘excuse making’. **(32)** Tierney et al.

#24) Self-awareness translated into motivation when it made activity a game or competition for some participants. For participants, the “goal” of 10,000 steps seemed to matter less than being aware of how much, or how little activity they got, compared with where they wanted to be. **(33)** Mercer et al.

#25) If a person is driven to improve his/her health that influences his/her intentions, it leads to potential openness for adoption. However, this growing motivation does not necessarily translate into increased physical activity. **(33)** Mercer et al.

#26) ...participants perceived the use of technology as an incentive to adhere to rehabilitation regimes. **(34)** Papi et al.

#27) Patients suggested that it would help them engage more in behavioural change or sticking to a new health regime and thus help them reach the desired health outcome. **(35)** Belsi et al.

#28) From patients’ perspectives, physical activity trackers would be ineffective in bolstering motivation if patients were not already motivated to be active, but were a nice addition for those who were already active and wanted to “do a little bit more”... It is to caution

against any expectation that using physical activity trackers would increase physical activity levels among patients with arthritis regardless of their level of readiness for physical activity. **(37)** Leese et al.

#29) Others found that they were happy with the results... Conversely, others felt that, although they would have liked to increase their activity levels, this might not have been possible. **(32)** Tierney et al.

Analytical Theme 3: Designing a wearable for everyday life

#30) All patients expressed a positive attitude towards wearing our wearable technology, although different views emerged on how long they would be willing to wear it. **(34)** Papi et al.

#31) Our findings suggest overall positive and welcoming views in terms of promoting self-management... with the adoption of wearable technology for OA management. **(35)** Belsi et al.

#32) Flexibility in the choice of clothing was another important issue highlighted in patients' views, as they would prefer to have a choice in what they wear, rather than having to put on a specific clothing item just because the sensor would be attached to it... It was raised that specific clothing could be identified as 'patient clothing', thus bringing in concerns of being 'labelled as patients'. Identity intrusion seemed to be an important demotivator... Patients, hence, suggested paying attention on the design to avoid the stereotype of a medical item but without looking '*too out of the ordinary*'... it should remain "silent" so as to not "draw attention to yourself in anyway"... The main determinants for acceptance of a wearable system were identified in its appearance and the comfort in wearing it. Design requirements were discussed in detail. Among these, patients expressed the necessity for a wearable system to be small, stable, lightweight, and discrete to enable them to wear their usual outfit with no constraints and no identity intrusion... Our findings suggest the need for... a sensor that could also allow unobtrusive monitoring in everyday environments. **(34)** Papi et al.

#33) The participants expressed positivity with health monitoring in the home... The majority of people did not find the monitors to be obtrusive or feel that they were an imposition in their lives... It was also felt that home monitoring in this way allowed people to live normally and unaffected, which was considered a positive aspect... the physical activity monitors we used were perceived as unobtrusive with regard to the 'routine dimension' of obtrusiveness. There appeared to be no interference with daily activities, and no acquisition of new rituals was necessary as a result of the wearing of the monitors. **(32)** Tierney et al.

#34) Overall, participants generally enjoyed trying out the wearable activity trackers. **(33)** Mercer et al.

#35) Waterproof design decreases worry about the fragility of the device if it is forgotten, and accidentally damaged by doing dishes or the laundry, and also allows older adults to use it in the water-based activities that are commonly recommended by health care providers as part of a low-impact way to increase physical activity. **(33)** Mercer et al.

#36) Changes were also suggested with regard to the location of the SHIMMER and although this was not mentioned as a problem, it was an area in which users wished to apply change. This could indicate that the location might indeed have proved problematic and might have been related to the 'physical dimension' of obtrusiveness or perhaps to embarrassment or stigma, which are both aspects of the 'self-concept dimension' of obtrusiveness. **(32)** Tierney et al.

* Note that data presented are authors' interpretations from results/findings, discussion and conclusion sections of included articles.

Supplementary File I. Search Strategy using Cooke et. al's SPIDER tool for Medline via OVID

Search terms include a mix of database-controlled keywords, including MESH headings, and non-controlled keywords. Where appropriate, terms are truncated to broaden the search. Pilot searches were conducted to determine suitable search combinations, and preliminary searches identified several articles from which keywords were selected. Search terms were grouped according to whether they related to “Sample”, “Phenomenon of Interest”, “Design”, “Evaluation”, or “Research Type”, and combined with Boolean operators.

S	<p>exp Arthritis/ OR osteoarthriti* or rheumatoid arthritis or gout or lupus or arthriti* or psoriatic* or ankylosing spondylitis or scleroderma or Sjogren syndrome</p> <p>AND</p> <p>Exp Patients/ OR patient* OR service user* or service-user* or consumer* or client* or user*</p>
P and I	<p>Monitoring, Physiologic/ OR Actigraphy/ OR Monitoring, Ambulatory/ OR fitbit* or Nike+ or yamax* or omron* or garmin* or wearable device* or activity tracker* or step counter* or activity monitor* or wearable* or fitness tracker* or pedometer* or accelerometer* or wearable system* or monitoring* or wearable technolog*</p> <p>AND</p> <p>Exp Exercise/ OR Exp Activities of Daily Living/ OR Exp Leisure Activities/ OR Exp Physical Fitness/ OR Exp Recreation/ OR stair climbing/ OR Exp running/ OR swimming/ OR Exp sedentary lifestyle/ or exp disease management/</p> <p>OR physical activ* OR physically active OR management OR managing OR self-management OR self-managing OR self care OR self-care</p>
D	<p>Exp Interview/ OR Qualitative interview* OR interview* OR case stud* OR constant comparison* OR conversation analysis OR descriptive stud* OR discourse analysis OR ethnograph* OR exploratory stud* OR feminis* OR hermeneutic* OR narrative* OR narrative analysis OR naturalistic stud* OR participant observation* OR phenomenology OR qualitative method* OR qualitative research OR interpretive phenomenological analysis</p>

E	Exp Community Participation/ OR Exp Attitude/ OR Exp Attitude to health/ OR Satisf* OR value* OR perspective* OR view* OR experience* OR opinion* OR belie* OR perce* OR feel* OR know* OR understand* OR need* OR issue*
R	Exp Qualitative Research/

Supplementary File II. Data Extraction Form

DATA EXTRACTION FORM	
Record #: Click here to enter text.	Year of Publication: Click here to enter text.
Author(s): Click here to enter text.	
Study Funder:	
SAMPLE CHARACTERISTICS:	
Total number of participants:	Eligibility criteria:
Number of participants with arthritis:	
Age range (median):	
Sex:	
Ethnicity:	Type(s) of arthritis:
Disease duration:	
Disease activity:	
Marital status:	Level of physical activity on entering study:
Level of education:	
Employment status:	Describe usage of a wearable on entry to and/or during the study:
Annual household income:	
DESIGN DETAILS	
Study location:	Aim(s) of the study:
Qualitative Methodology/Paradigm:	
Study setting:	
Methods of recruitment:	
Type of wearable(s) involved:	

Qualitative data collection methods:	Qualitative data analysis methods:
AUTHOR INFORMATION	
Authors' disciplinary backgrounds:	Authors' personal experience:
FINDINGS	
All qualitative findings (in authors' words) relevant to research question (stated on page 1) in Results/Findings section:	All quotes from participants with arthritis to support qualitative findings relevant to research question (stated on page 1) in Results/Findings section¹:
Points in discussion relevant to research question (stated on page 1):	Strengths & limitations:
Conclusion/Implications:	
Articles identified in bibliography for further screening:	

¹ If quotes from participants with arthritis are indistinguishable from quotes from participants without arthritis, please make a note in this box and include quotes from all participants with or without arthritis.

Supplementary File III: Summary of Articles Assessed, based on McMaster Critical Review Form*

	Tierney (2013) (32)	Papi (2015) (34)	Belsi (2016) (35)	Mercer (2016) (33)	Wallis (2019) (31)	Pellegrini (2018) (36)	Leese (2019) (37)
STUDY PURPOSE							
Was the purpose and/or research question stated clearly?	✓	✓	✓	✓	✓	✓	✓
LITERATURE							
Was relevant background literature reviewed?	✓	✓	✓	✓	✓	✓	✓
SAMPLING							
Was the process of purposeful selection described?	X	✓	✓	✓	✓	✓	✓
Was sampling done until redundancy in data was reached?	NR	✓	✓	✓	NR	✓	✓
Was informed consent obtained?	✓	✓	✓	NR	✓	✓	✓
DATA COLLECTION							
Clear and complete description of site	X	✓	✓	X	X	X	✓
Clear and complete description of participants	✓	✓	✓	✓	✓	✓	✓
Role of researcher and relationship with participants	X	X	✓	X	✓	X	X
Identification of assumptions and biases of researcher	X	X	X	✓	✓	X	X
Procedural rigour was used in data collection	✓	NR	NR	NR	NR	✓	NR
DATA ANALYSIS							
Data analyses were inductive	X	NR	NR	✓	NR	NR	✓
Findings were consistent with and reflective of data	✓	✓	✓	✓	✓	✓	✓
Decision trail developed	✓	NR	NR	NR	NR	NR	✓
Process of analyzing the data was described adequately	✓	✓	✓	✓	✓	✓	✓

	Tierney (2013) (32)	Papi (2015) (34)	Belsi (2016) (35)	Mercer (2016) (33)	Wallis (2019) (31)	Pellegrini (2018) (36)	Leese (2019) (37)
Did a meaningful picture of the phenomenon under study emerge?	X	X	X	X	X	X	✓
OVERALL RIGOUR							
Was there evidence of the four components of trustworthiness?	✓	✓	✓	✓	✓	✓	✓
Credibility	✓	✓	✓	✓	✓	✓	✓
Transferability	X	✓	✓	✓	✓	✓	✓
Dependability	X	X	X	X	✓	✓	✓
Confirmability							
CONCLUSIONS & IMPLICATIONS							
Conclusions were appropriate given the study findings	✓	✓	✓	✓	✓	✓	✓
Findings contributed to theory development and future practice/research	✓	✓	✓	✓	✓	✓	✓

Notes: *Only key questions on left-hand side of the McMaster Critical Review Form have been reported, without questions regarding study design as these are addressed in Table 4. ✓ refers to criteria met within study and X refers to criteria not met.

Abbreviation: NR, not reported.

Supplementary File IV: CERQual Qualitative Evidence Profile

Review Finding	Studies Contributing to the Review Finding	Assessment of Methodological Limitations	Assessment of Coherence	Assessment of Adequacy	Assessment of Relevance	Overall CERQual Assessment of Confidence
Theme 1: Potential to change dynamics in patient-health professional communication						
1	34, 35, 37	Moderate concern.	Serious concern.	Serious concern.	Moderate concern.	Low confidence.
2	37	No or very minor concerns.	Minor concern.	Serious concern.	Moderate concern.	Low confidence.
Theme 2: Wearable-enabled self-awareness: a benefit or downside?						
1	31, 32, 33, 34, 35, 36, 37	Moderate concern.	Minor concern.	Serious concern.	Moderate concern.	Low confidence.
2	32, 33, 34, 35, 36, 37	No or very minor concern.	Minor concern.	Serious concern.	Moderate concern.	Low confidence.
Theme 3: Designing a wearable for everyday life						
1	34, 35	Moderate concern.	No to minor concern.	Serious concern.	Moderate concern.	Low confidence.
2	32, 33	Moderate concern.	Moderate concern.	Serious concern.	Moderate concern.	Low confidence.

Theme 1; Review Finding 1

Some participants expect that communication with health professionals could possibly be enhanced if they were to share their wearable data as part of their self-management in future. While some believed that this could support “more patient-centered character of consultations”, “shared decision-making” and building a partnership “rather than following a purely paternalistic model” during a clinical consultation, one participant expected that they would receive a negative response from their health professional if they were to share wearable data with them in future.

Assessment of Methodological Limitations

None of the studies addressed the researchers’ assumptions or biases. In 2 studies (34, 35), it was not clear whether analyses were inductive, and there was a lack of discussion regarding confirmability of the data.

The evidence supporting the review finding was assessed as having moderate concerns mainly because researchers’ possible biases could have an impact on participants’ opinions reported.

Assessment of Coherence

The finding reflects the complexity and variation of the data and is mostly well supported by details in the underlying studies. There are gaps however in the evidence presented in the primary studies for the interpretation in this finding. For example, a patient-centered consultation, shared decision-making or a building a partnership is not clearly described in the evidence presented.

We considered the review finding to be of serious concern mainly because it was hard to tell if the data really supported the interpretative claim that was vaguely described in the underlying evidence.

Assessment of Adequacy

Three studies contributed to this finding and the data that the finding was based on were relatively superficial. Based on an overall assessment of the richness of the data and quantity of the data, we concluded that we had serious concern about data adequacy.

Assessment of Relevance

Much of the underlying data were of indirect relevance to the review question because many participants across the primary studies did not have first-hand experience of using a wearable in their everyday lives to self-monitor physical activity participation.

Overall CERQual Assessment of Confidence

Low confidence

Explanation of Judgement

This finding was graded as low confidence because of moderate concerns regarding methodological limitations and relevance, and serious concern regarding coherence and adequacy.

Theme 1; Review Finding 2

Some participants expected that the quality of their relationship with a health professional could play a role in whether they would feel comfortable sharing wearable data as part of their usual everyday self-management in future.

Assessment of Methodological Limitations

The role of the researcher and relationship with participants, or the researchers' assumptions or biases were not addressed in the study. Using procedural rigour in data collection strategies was also not addressed in the study.

The evidence supporting the review finding was assessed as having no or very minor concerns because these methodological limitations were not seen to affect participants' stated opinions.

Assessment of Coherence

We considered the review finding was of minor concern mainly because the underlying study did not explore in detail what the participants meant when they expressed this opinion.

Assessment of Adequacy

One study contributed to this finding and the data that the finding was based on were relatively thin. Based on an overall assessment of the richness of the data and quantity of the data, we concluded that we had serious concern about data adequacy.

Assessment of Relevance

Some of the underlying data were of indirect relevance to the review question because 15% of participants did not have first-hand experience of using a wearable in their everyday lives to self-monitor physical activity participation.

We therefore had moderate concern about the relevance of the finding.

Overall CERQual Assessment of Confidence

Low confidence

Explanation of Judgement

This finding was graded as low confidence because of moderate concerns regarding relevance, and serious concern regarding adequacy.

Theme 2; Review Finding 1

Participants with and without experience of using wearable technology often described benefits of their use of a wearable. These benefits included becoming more aware of activity levels and more in control of arthritis management, improved confidence, distraction from symptoms, and feeling reassured. Some participants who used wearables during research participation experienced negative feelings (e.g., guilt) as they became more aware of their physical activity levels.

Assessment of Methodological Limitations

5 of the primary studies (32, 34, 35, 36, 37) did not address researchers' assumptions or biases and 5 studies (31, 32, 34, 35, 36) did not make it clear whether analyses were inductive.

The evidence supporting the review finding was assessed as having moderate concerns mainly because researchers' possible biases could have an impact on participants' experiences reported.

Assessment of Coherence

The finding reflects the variation of the data and is well supported by details in the underlying studies. The studies did not often, however, explore the downsides of using a wearable in detail. We therefore assessed the finding as having minor concern.

Assessment of Adequacy

Seven studies contributed to this finding and the data that the finding was based on were relatively thin. Based on an overall assessment of the richness of the data and quantity of the data, we concluded that we had serious concern about data adequacy.

Assessment of Relevance

Three studies (34, 35, 37) were of indirect relevance to the review question because many participants across these studies did not have first-hand experience of using a wearable in their everyday lives to self-monitor physical activity participation. Another three studies (31, 32, 33) were of indirect relevance to the review question because participants used the wearable within the context of research participation.

Two primary studies in the underlying evidence were of partial relevance to the review question. In the first (33), only 18 participants (56%) were living with arthritis. Remaining participants lived with other forms of chronic illness, including hypertension, hyperlipidemia, diabetes and osteoporosis, or they had a significant family history of cardiovascular disease or diabetes or a parental history of hip fracture. In the second (36), only data from 3 participants (15%) were reported indicating they had used a wearable in their everyday lives.

Overall CERQual Assessment of Confidence

Low confidence

Explanation of Judgement

This finding was graded as low confidence because of moderate concerns regarding methodological limitations and relevance, and serious concern regarding adequacy.

Theme 2; Review Finding 2

Participants had contrasting perspectives on whether heightened self-awareness of physical activity levels could motivate them to be more active. While some were motivated to increase activity levels during their research participation or their everyday self-management, others discovered it was not possible to increase their activity levels due to circumstances out of their control. Some participants also expressed an opinion that wearables would be ineffective at prompting increased physical activity among persons who were not already motivated to make a change.

Assessment of Methodological Limitations

5 of the primary studies (32, 34, 35, 36, 37) did not address researchers' assumptions or biases. 4 studies (32, 34, 35, 36) did not make it clear whether analyses were inductive and lacked discussion regarding confirmability.

The evidence supporting the review finding was assessed as having no or very minor concerns because the methodological limitations were not seen to affect participants' experiences reported.

Assessment of Coherence

The finding reflects the variation of the data and is well supported by details in the underlying studies. The studies did not often, however, explore in detail conditions in which participants were not motivated to be more active by wearable-enabled self-awareness. We therefore assessed the finding as having minor concern.

Assessment of Adequacy

Six studies contributed to this finding and the data that the finding was based on were relatively thin. Based on an overall assessment of the richness of the data and quantity of the data, we concluded that we had serious concern about data adequacy.

Assessment of Relevance

Three studies (34, 35, 37) were of indirect relevance to the review question because many participants across these studies did not have first-hand experience of using a wearable in their everyday lives to self-monitor physical activity participation.

Another two studies (32, 33) were of indirect relevance to the review question because participants used the wearable within the context of research participation.

Two primary studies in the underlying evidence were of partial relevance to the review question. In the first (33), only 18 participants (56%) were living with arthritis. Remaining participants lived with other forms of chronic illness, including hypertension, hyperlipidemia, diabetes and osteoporosis, or they had a significant family history of cardiovascular disease or diabetes or a parental history of hip fracture. In the second (36), only data from 3 participants (15%) were reported indicating they had used a wearable in their own everyday lives.

Overall CERQual Assessment of Confidence

Low confidence

Explanation of Judgement

This finding was graded as low confidence because of moderate concerns regarding relevance, and serious concern regarding adequacy.

Theme 3; Review Finding 1

Participants with OA who had been shown a wearable prototype, but did not use it, typically felt positively about the possibility of using wearable technology in their everyday self-management in future. They expected they would prefer a discreet design, which would prevent them looking too out of the ordinary or labelled as patients if they were to use a wearable in their everyday self-management in future.

Assessment of Methodological Limitations

The researchers' assumptions or biases were not addressed in the primary studies. They also did not report procedural rigour in data collection strategies or make clear whether analyses were inductive.

The evidence supporting the review finding was assessed as having moderate concerns mainly because researchers' possible biases could have an impact on participants' opinions reported.

Assessment of Coherence

The finding reflects the variation of the data and is well supported by details in the underlying studies. We therefore assessed the finding as having no to very minor concerns.

Assessment of Adequacy

Two studies contributed to this finding and the data that the finding was based on were relatively thin. Based on an overall assessment of the richness of the data and quantity of the data, we concluded that we had serious concern about data adequacy.

Assessment of Relevance

The underlying data were of indirect relevance to the review question because participants did not have first-hand experience of using a wearable in their everyday lives to self-monitor physical activity participation.

We therefore had moderate concern about the relevance of the finding.

Overall CERQual Assessment of Confidence

Low confidence

Explanation of Judgement

This finding was graded as low confidence because of moderate concerns regarding methodological limitations and relevance, and serious concern regarding adequacy.

Theme 3; Review Finding 2

Participants with OA or IA who used multiple wearables during their research participation generally felt positively about their experiences of incorporating wearable technology in their everyday lives, continuing to live normally and unaffected. Of these participants, some who used a wearable under development suggested that developers change the design so persons with arthritis would not need to wear the device on their thigh (secured using microporous tape and an elasticated bandage) if they were to use it in future. It was speculated that reasons for this may have been related to embarrassment or stigma that the participants may have experienced in their own everyday environments.

Assessment of Methodological Limitations

Neither primary study shared a complete description of the site of data collection or made clear the relationship of the researchers with participants. Both lacked discussion regarding confirmability.

The evidence supporting the review finding was assessed as having moderate concerns mainly because researchers' possible biases could have an impact on participants' experiences reported.

Assessment of Coherence

The finding is well supported by details in the underlying studies. We explored other possible experiences and found some disaffirming data, for example that a participant less familiar with mobile technology expressed that a lack of an instruction manual "almost did me in". There is also an absence of data presented in the primary study to fully support an interpretation that participants may have experienced embarrassment or stigma while using a wearable in their own environments.

Given the 'outlier' data and the insufficient evidence, we assessed the finding as having serious concern.

Assessment of Adequacy

Two studies contributed to this finding and the data that the finding was based on were relatively thin. Based on an overall assessment of the richness of the data and quantity of the data, we concluded that we had serious concern about data adequacy.

Assessment of Relevance

One primary study (33) in the underlying evidence is of partial relevance to the review question because only 18 participants (56%) were living with arthritis. Remaining participants lived with other forms of chronic illness, including hypertension, hyperlipidemia, diabetes and osteoporosis, or they had a significant family history of cardiovascular disease or diabetes or a parental history of hip fracture.

Both primary studies are of indirect relevance to the review question because participants used the wearable within the context of research participation.

We therefore had moderate concern about the relevance of the finding.

Overall CERQual Assessment of Confidence

Low confidence

Explanation of Judgement

This finding was graded as low confidence because of moderate concerns regarding methodological limitations, coherence and relevance, and serious concern regarding adequacy.

Supplementary File V: Overview of initial codes, descriptive themes and analytic themes

Examples of Initial Codes	Descriptive themes (n = 14)	Analytical themes (n = 3)
Communicating better with clinicians	Informing clinicians with objective evidence	Potential to change dynamics in patient-health professional communication
Gaining quality advice	Improving shared decision-making with health professionals	
Increasing confidence in consultation	Moving towards partnership with health professionals	
Gaining clarity		
Improving accuracy of consultations	Informing/ tailoring clinician recommendations	
Enhancing communication during clinical visits	Feeling uncertain of health professionals' response to changes	
Enhancing shared decision-making with clinicians		
Opening more communication channels with health professionals		
Informing clinicians		
Having objective evidence		
Tailoring treatment		
Negotiating care		
Moving towards building partnership		
Becoming more proactive		
Questioning health professionals' interest in wearable data		

Examples of Initial Codes	Descriptive themes (n = 14)	Analytical themes (n = 3)
<p>Encouraging clinician supervision/support</p> <p>Seeking measures of knee function</p>		
Taking control of condition/management	Taking control	Wearable-enabled self-awareness – a benefit or downside?
Feeling more empowered	Becoming more proactive	
Feeling more informed to make choices	Becoming more aware of activity levels	
Becoming more proactive	Experiencing negative emotions	
Facilitating physical activity	Being unable to be physically active	
Becoming more aware of physical activity levels		
Improving confidence		
Being reassured of progress		
Prompting negative emotions		
Facilitating behavioral change		
Having motivation driven by self-awareness		
Being unable to be physically active		
Having a nice reinforcement		

Examples of Initial Codes	Descriptive themes (n = 14)	Analytical themes (n = 3)
Feeling positively about use of wearable	Enjoying use	Designing a wearable for everyday life
Practical issues impacting daily life	Seeking unobtrusive monitoring in everyday environments	
Being obtrusive	Feeling ill-equipped to use	
Worrying about fragility of device	Seeking changes in appearance/ comfort & design	
Seeking waterproof design		
Seeking discrete wearability		
Having concerns of being ‘labelled as patient’		
Avoiding identity intrusion		
Potential embarrassment or stigma		