


# Perspectives of older adults with chronic disease on the use of wearable technology and video games for physical activity

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## Abstract

**Background:** There is increasing interest in technology to deliver physical rehabilitation and allow clinicians to monitor progress. Examples include wearable activity trackers and active video games (AVGs), where physical activity is required to play the game. However, few studies have explored what may influence the effectiveness of these as technology-based physical activity interventions in older adults with chronic diseases.

**Objective:** This study aimed to explore: 1) perceptions about wearable physical activity trackers; 2) perceptions about using technology to share physical activity information with clinicians; 3) barriers and motivators to playing games, including AVGs for rehabilitation.

**Methods:** Qualitative study based on semi-structured interviews with older adults ( $n = 19$ ) with chronic obstructive pulmonary disease (COPD).

**Results:** Wearable activity trackers were perceived as useful to quantify activity, facilitate goal-setting, visualize long-term improvements and provide reminders. Participants generally wished to share data with their clinicians to gain greater accountability, receive useful feedback and improve the quality of clinical care. Participants were motivated to play games (including AVGs) by seeking fun, social interaction and health benefits. Some felt that AVGs were of no benefit or were too difficult. Competition was both a motivator and a barrier.

**Conclusions:** The findings of the present study seek to inform the design of technology to encourage physical activity in older adults with chronic diseases.

## Keywords

Aged, video games, fitness trackers, chronic obstructive lung disease

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## Introduction

### *Evolution of technology in the delivery of rehabilitation for chronic disease*

Physical activity and exercise are key components of physical rehabilitation for chronic diseases in older adults.<sup>1,2</sup> Increasingly, physical therapy rehabilitation of older adults with chronic diseases is being mediated by various forms of technology such as computers, tablets, mobile phones and wearables. A field known

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as mobile health (mHealth) involves the use of mobile phones and other mobile devices, such as wearable activity trackers, for health services,<sup>3</sup> such as providing and supporting patient rehabilitation and self-management. For instance, wearable activity trackers and activity monitoring apps (applications) can provide constructive feedback and encouragement regarding a user's recorded physical activity,<sup>4,5</sup> which may promote physical activity across a variety of chronic diseases.<sup>6,7</sup> Data from mobile or wearable devices can also be accessed by healthcare professionals to monitor and support their patients remotely, enabling supervised interventions with greater ease and lower cost than in-person supervision.<sup>8</sup>

The importance of feedback from experts is stressed in theoretical models of human behavior that are widely accepted and commonly used in health psychology, such as Social Cognitive Theory (SCT).<sup>9,10</sup> SCT postulates that perceived self-efficacy and outcome expectations are two major constructs that influence behavior, and that these two constructs can be strengthened or weakened by various sources of information or feedback.<sup>11</sup> Accordingly, instruction and feedback from trusted others such as healthcare professionals can improve self-efficacy and increase outcome expectations, thereby enhancing motivation to act.<sup>11,12</sup> Through the data collected through the use of wearable activity trackers, healthcare professionals can model the behaviors of monitoring and provide persuasive feedback, facilitating self-monitoring and self-regulation within rehabilitation programs. Emerging evidence indicates that receiving feedback remotely from a coach/instructor in home-based physical rehabilitation can have similar effectiveness to supervised onsite exercising.<sup>13</sup> People with chronic disease have demonstrated interest in the prospect of sharing data from wearables with healthcare professionals.<sup>14</sup> Other studies have indicated that older adults had little to no concerns about being monitored in this way,<sup>15,16</sup> which bears special relevance due to chronic diseases being more prevalent among older adults.

### *The integration of games in rehabilitation for older adults with chronic disease*

The use of health technology like wearables, with their ability to monitor patient activity, provides an opportunity to transfer rehabilitation into the home for patients with chronic disease. However, older adults may perceive wearable activity trackers as being too complex, more appropriate for younger people or of questionable value to them.<sup>14,17</sup> Therefore, it has been recommended that wearable activity trackers and other mHealth interventions are developed with input from

older adults and address the specific barriers to uptake faced by older adults with chronic diseases.<sup>18,19</sup>

Engagement with health technology may be enhanced by gamification – incorporating features of games into non-game contexts,<sup>20</sup> such as rehabilitation exercises, or incorporating rehabilitation exercises within the context of a game. Active video games (AVGs), where exercise or physical activity is required to play the game, have been demonstrated as an alternative and enjoyable form of delivering physical exercise in a range of chronic diseases that affect older adults, such as neurological conditions,<sup>21</sup> cardiac conditions<sup>22,23</sup> and geriatric rehabilitation.<sup>24–26</sup> However, there is limited and contradictory data on long-term adherence to interventions involving AVGs in older adults with chronic diseases, with most studies examining the short-term effects of these interventions.<sup>27,28</sup> Additionally, as with wearable interventions, many reviews into games for older adults<sup>29</sup> and older adults with chronic diseases<sup>30–32</sup> have concluded that game design should take account of user perspectives in order to improve motivation and adherence. Despite this, the perspectives of older adults with chronic diseases have not been thoroughly explored, making it difficult to determine what may influence the effectiveness of wearable activity trackers or AVGs in encouraging physical activity in this population.

### *Technology and games in older adults with COPD*

A prevalent chronic disease which requires physical rehabilitation for older adults is chronic obstructive pulmonary disease (COPD). COPD is an incurable multi-system disease that causes respiratory symptoms such as shortness of breath, chronic cough, decreased exercise capacity, and early mortality.<sup>33</sup> COPD is particularly prevalent in older adults, with a prevalence of 7.5% of Australians (around 1 in 13) aged 40 years or older and 29.2% (around 1 in 3) of Australians aged 75 years or older.<sup>34</sup> Formal physical exercise programs like pulmonary rehabilitation are strongly recommended for people with COPD,<sup>35,36</sup> as they can reduce shortness of breath and improve exercise capacity and health-related quality of life.<sup>37</sup> Despite these known benefits, pulmonary rehabilitation for people with COPD has low adherence and completion rates.<sup>38–40</sup> This can be attributed to difficulties such as travel time, inconvenient timing of programs, and low motivation among people with COPD.<sup>41–43</sup>

Wearable activity trackers have been shown to be effective in increasing physical activity levels in people with COPD, but some trials have indicated that adherence wanes substantially after several months.<sup>44–46</sup> For wearable activity trackers to be widely adopted in routine care for people with

COPD, there first must be convincing evidence that an intervention based on these devices can provide more than a short-lived benefit. However, it remains unclear how to best design a wearable activity tracker intervention to optimize adherence and physical activity benefits.<sup>47</sup> Receiving feedback from clinicians may be of importance in this regard, as recent research indicates that some older adults with COPD have a desire to share data from wearable activity trackers with clinicians.<sup>48</sup> Likewise, recommendations have been made to incorporate clinical supervision into AVGs for people with respiratory conditions<sup>32</sup> and physical activity data from either wearable activity trackers or AVGs could facilitate a form of remote supervision. However, research exploring the perspectives of people with COPD on sharing physical activity data with health-care professionals is only now emerging.<sup>48</sup> It is therefore important to more fully explore how older adults with COPD feel about wearable activity trackers in general, as well as the specific aspect of sharing physical activity data with clinicians.

A small number of pilot or feasibility trials have investigated using AVGs as a method of increasing adherence to exercise and improving physical activity in people with COPD,<sup>49–52</sup> but all of these studies used commercially available games designed for healthy children and young adults. Though preliminary evidence suggests these games are enjoyed by people with COPD<sup>50</sup> as well as healthy older adults<sup>53,54</sup> the games were not designed for the unique challenges that may be experienced by people with chronic respiratory diseases.<sup>32</sup> As a result, they may be too physically demanding, be inadequately paced or have other characteristics that are suboptimal for older adults with COPD. This highlights the need for research into needs and preferences of older adults with chronic respiratory diseases with respect to the use of technologies, such as wearable activity trackers and AVGs, to support their physical rehabilitation.

Consequently, the current study aimed to understand perceptions, needs and self-reported behavior of older adults with COPD with respect to wearable activity trackers and games for encouraging physical activity. The objective of this study was to answer the following research questions:

1. How do older adults with COPD feel about using wearable activity trackers?
2. How do older adults with COPD feel about sharing physical activity information via technology devices with clinicians?
3. What are the main barriers and motivators to the adoption of games (including AVGs) by older adults with COPD?

## Methods

### Procedure

An exploratory qualitative approach using semi-structured interviews was utilized. Interviews were chosen over focus groups as interviews allowed participants to more openly and honestly express individual opinions and experiences, especially with respect to difficulties they face with maintaining exercise or using technology.

Convenience sampling was used to recruit older adults with COPD to the study. Participants were recruited by advertising at a number of pulmonary support groups in and around Brisbane, a major capital city in Australia. Inclusion criteria included, a diagnosis of COPD and previous experience with a formal exercise program for their COPD (e.g. pulmonary rehabilitation). In order to source a participant group representative of those likely to participate in future interventions involving AVGs as a form of physical rehabilitation, exclusion criteria were: inability to exercise without supplemental oxygen; inability to understand written or spoken English; inability to independently mobilise; inability to perform exercise due to medical instability or physical conditions; and inability to read text displayed on computers or mobile phones due to insufficient visual acuity. Recruitment continued until data saturation was reached (where additional interviews would be unlikely to uncover any new themes).

The semi-structured interviews consisted of questions which defined the areas to be explored in the interview, but also provided opportunities or prompts for the interviewer or interviewee to discuss responses in more detail. The areas covered in the interview were, usage of technology (i.e. computers, tablets, and mobile phones including smart phones); perspectives on games in general, perspectives on AVGs, perspectives on wearable activity trackers and opinions on sharing physical activity data with other people or clinicians. As the research was exploratory in nature, interview questions were largely open-ended and targeted towards gleaning unbiased understandings of health technology and gamification perceptions and behaviors in the target population. A pilot interview was conducted on a sub set of the target population and was refined by qualitative research experts for the main study (final version of interview guide available as online Appendix 1).

Interviews were conducted face-to-face or via telephone, lasting approximately 45 min by a single investigator (JS). Each interview was recorded and transcribed verbatim.

After each interview, a brief demographic survey was conducted to record participant's age, sex, ethnicity and employment status. Technological confidence was assessed on a 0–10 numerical rating scale, with 0 being not at all confident and 10 being perfectly confident with technology. Disease severity was assessed using the Medical Research Council (MRC) dyspnoea scale<sup>55</sup> and the physical functioning domain questions (question 7–10) of the Clinical COPD Questionnaire (CCQ).<sup>56</sup>

### Data analysis

Interviews were audio recorded and transcribed by the interviewer (JS). The interview transcripts were analysed using content analysis due to the exploratory nature of the study.<sup>57</sup> Qualitative data analysis used the software *NVivo*, version 11 (QSR International, Melbourne, VIC, Australia). Specific statements were coded and organized into themes, theme clusters and categories. The data was then interpreted to describe the key underlying themes and uncover patterns or relationships between themes.

Double coding (coding by two authors – JS, AM) was performed for two randomly selected transcripts to ensure acceptable reliability of the coding protocol. Any discrepancies were discussed until consensus was reached. Participants were provided a lay summary of the findings and were provided contact details of the research team for feedback if required.

### Ethical considerations

Both The University of Queensland Business Economics and Law Faculty, Low and Negligible Risk Ethics sub-committee and the Royal Brisbane and Women's Hospital Human Research Ethics Committee approved this study. All participants provided written consent (for face-to-face interviews) or verbal consent (for telephone interviews) prior to data collection and were reminded they could withdraw their participation at any stage of the research.

## Results

### Participant overview and technology use

The characteristics of the participant sample are shown in Table 1 and the ensuing discussion overviews their perceptions of various technology. Online Appendix 2 presents the code categories, their total frequency of appearance in the interviews and the number of participants mentioning that each category.

**Use of technology.** Participants reported using a range of technology, such as desktop or laptop computers ( $n = 13$ ); smart TVs ( $n = 3$ ); tablet computers ( $n = 9$ );

**Table 1.** Participant characteristics.

Characteristic	
Gender, $n$ (%)	
Female	11 (58)
Age (years), mean (SD)	
	70 (6)
MRC breathlessness scale, $n$ (%)	
MRC grade 1	5 (26)
MRC grade 2	7 (37)
MRC grade 3	5 (26)
MRC grade 4	2 (11)
MRC grade 5	0 (0)
Confidence with technology (0–10 scale), mean (SD)	
	5 (3)
Employment status, $n$ (%)	
Retired	17 (90)
Employed	1 (5)
Unemployed	1 (5)
Race or ethnicity, $n$ (%)	
White	11 (58)
Prefer not to say	8 (42)

smartphones ( $n = 14$ ); and smartwatches or wearable activity trackers ( $n = 3$ ). Screen size was one of the main reasons for choosing tablets over smartphones and laptops or desktops over tablet devices.

*Because it's a bigger screen. And it's more comfortable. No, I'd always use the laptop.* – P11, female, age 74

Communication with family and friends was by far the main reason given for using technology, primarily through phone calls, text messages and emails. Many participants also used social media as a platform for communication with younger family members; some reported being reluctant to engage with social media.

*I'm really an emailer. And, you know, phone and text. Not a lot else in a way, really.* – P7, Female, age 70

*I don't like social media. I got on it in 2011, when we had the last major lot of floods in Brisbane. [...] I really*

*don't like it for me, but I use it as a way of just staying in touch with, you know, what the boys are doing and some other people that I know. But I don't make a posting on it myself, ever. – P6, male, age 68*

*My missus set up a Facebook page for me, but I've never used it. [...] I've been thinking I should get in and redo it, because...my family...we don't sort of stay in touch very well. Apparently I miss out on a lot by not having Facebook. Because they post all this stuff on Facebook, so I'm thinking I should get on Facebook. – P10, male, age 62*

A variety of other reasons for using technology were given, including online shopping, gaming, working and researching health information.

**Challenges of technology.** Many participants felt using technology was a challenge for older people like themselves, and shared stories of how they needed help with technology from younger people (usually younger family members).

*Oh yeah, I think probably too, coming into it at mid-70s almost, I have a problem remembering all the different processes. There's...if I push this, that will happen, then I have to push that to get this. Whereas obviously as you would know my grandkids, the little ones, they know exactly what to push – P3, female, age 76*

Even those participants who did not find technology to be especially challenging felt like they were unusual compared to their peers.

*I'm not doing too bad for my age. A lot of guys my age don't even know...I've got a buddy, he doesn't even know how to start up a phone. – P15, male, age 67*

A lack of education or instruction on the use of various technology was a significant issue among participants. Because they hadn't grown up with technology, many participants assumed they would require explicit education on how to use technology. Similarly, participants felt their education on technology was now outdated, or they'd had forgotten how to use technology.

*I remember sitting in front of a computer when we first got it and I thought, how do I turn it on? Because nobody told me. So I can remember I got the manual out and I found out how to switch this on. And they were the old computers. And I think those days...technology in computers is so advanced now. That I've forgotten. Remember have to put in discs and I don't know. Too hard. – P2, female, age 76*

In part because of this lack of current knowledge around modern technology, some participants mentioned that they were uncomfortable with exploring technology. One participant even mentioned that modern technology is designed with trial-and-error in mind, but they didn't feel as confident as younger generations with this process as it conflicted with how older technology was used.

*I'm an age group when whole floors of the city building were given to a computer. [...] Back then it was a case of 'You don't press enter until you make sure everything is right'. So I find it really hard how everyone, and even little kids, just go away and bash away everything, and you can pick it up. [...] I was initially trained, you don't go further until you make sure it's right. Well now every bit of technology I pick up, it doesn't matter, you'll be able to recover it, just keep going. So that's the big thing I've got to fight with it. – P18, male, age 59*

Despite these barriers, many participants stressed that technology was an essential part of their current life.

*I could not do without my computer nowadays, particularly for emails. – P1, female, age 66*

### **Wearable activity trackers**

To address the first aim of this study, participants were asked how they would feel wearing an activity tracking device to assist in their physical rehabilitation.

Participants were generally positive about wearable activity trackers. Though few were currently using wrist-worn activity trackers, some mentioned considering purchasing one and others had experience with older hip-worn or pocket pedometers. Responses regarding the value of wearable activity trackers generally fell into four main categories: quantifying physical activity; visualizing improvement over time; enabling clear goal-setting and achievement; providing reminders to be active.

**Wanting to quantify.** The promise of using wearable activity trackers to quantify the level of physical activity was perceived as the main value of wearable activity trackers. Participants sought a true reflection of how much physical activity they were doing, as many worried their perceptions of their own physical activity could be inaccurate. Some participants reported experiencing this realization when they had used activity trackers in the past.

*You might walk for 40 minutes but you can actually do nothing in that 40 minutes. And unless you measure it with a pedometer that puts a number basically on what you're doing.* – P10, male, age 62

*You just flip it on and go for a walk. And you think, 'Oh, is that all the steps I've done? Feel like I've done a thousand.'* – P16, female, age 73

**Helping to see long-term improvement.** Participants also thought wearable activity trackers could help them to better see the improvements they were making in their level of physical activity. These improvements could take place slowly over several months and may not be perceptible without an objective measure of activity.

*When I first got it [Fitbit], I was doing about 3000 paces a day. Well, now my average is 4700. And that's only within the twelve-month period.* – P18, male, age 59

*I'd benefit, because then I can see how much I'm doing and how far I'm going. And each day, or every couple of days, it should be a bit further and further.* – P4, female, age 74

**Allowing for clearer goal-setting.** Similarly, several participants expressed a desire to use a wearable fitness tracker to allow them to set specific and measurable goals for their physical activity, and to better determine whether they were achieving these goals.

*I do want to clarify it a little bit more, and put it into more of a goal-setting and goal achievement type structure. And that's where, yeah, a bit of technology would help, like the Fitbit.* – P7, female, age 70

*It was a motivator. One of my wife's friends said, 'I'll get it for [P18], because it gives him a target, he'll have to beat it.' Which I did. I'll not go to bed until I've done the four-thousand paces a day. And, yeah, I'm trying to get the average up to five thousand.* – P18, male, age 59

**Reminders to be active.** Additionally, participants who had experience with wearable activity trackers mentioned the benefits of receiving reminders from the device to be more active, or to avoid long periods of inactivity.

*This [Apple Watch] here, if I sit for an hour it'll go 'tap tap tap' on my wrist and say 'get up'. [...] It reminds me what I'm doing, you know, that's probably the best.* – P5, male, age 70

*I've got [a Fitbit] on, yes. It was given to me by my daughter-in-law. And I use that if you're sitting...before we've finished our conversation, it'll be asking me to take it for a stroll. It sends a little message if you're still for an hour, like if you've been sitting, it will just remind you to get up and move. [...] So that's how I use that anyway. And yes, I'm quite happy with it really.* – P14, female, age 66

**Concerns around social features.** However, some participants felt that the wearable fitness trackers had some downsides, primarily due to concerns around social features. For instance, some participants felt the competitive challenges in some fitness tracking apps encouraged walking in the short-term but undermined the enjoyment of the walking itself.

*I just found the challenging annoying. I said 'Stop challenging me because it's just...it's annoying me. I'm not enjoying my physical activity as much'. It certainly made me more active, I have to say. I have to admit that. Because I pushed myself to do more steps, but at the same time for me it took a bit of the enjoyment away. [...] I wouldn't keep it up, if somebody kept pushing me to do it, I just wouldn't keep that up.* – P14, female, age 66

Overall, even participants who expressed a dislike for wearable activity trackers nonetheless saw the value that these devices could provide for better seeing changes over time and making for clearer-goal setting.

*I can see it being a benefit, because it gives me a yard stick to work to, you know what I mean? When I come home, I'd have a look at it, I'd write it in the calendar or I'd have a book I keep. So I know that I'm progressing or I'm not. So that [Fitbit] thing, even though I don't particularly like them, I can see where that would be a benefit to me. I can write down how much I did on Monday and how much I did on Tuesday. And it gives me something to work against.* – P17, male, age 73

### Sharing data with clinicians via technology

**Perceived benefits of sharing data with clinicians.** In order to address the second aim of this study, participants were asked their opinion on sharing physical activity data via technology with clinicians. Participants were generally, but not entirely, positive about this idea. Many participants mentioned how they would value the additional feedback that clinicians with access to individual physical activity data could provide.

*Somebody looking over your shoulder, who probably knows a damn sight more about it than what you do. To say 'Well, hey you're not doing anywhere near enough', or, you know, 'You're doing well', or 'You're overdoing it'. – P10, male, age 62*

Similarly, several participants felt that physical activity data could assist the clinician to improve the quality of clinical care they, and others, receive.

*I guess if it was your therapist or your doctor or whatever, you know, that's more data for them on which to be able to shape whatever advice it is that they going to give you. So I can't see anything other than a benefit in that. – P6, male, age 68*

Some participants also expressed a desire to use the data from wearable activity trackers to prove how active they really were to a clinician who may not trust self-reported physical activity. Other participants expressed that the physical activity they report to a doctor may not be accurate, and they'd feel more accountable if they had to provide objective proof of their physical activity to their clinicians.

*Well they know I'm exercising. I'm not saying that I'm walking down to [the park], they probably think 'Oh yeah...', you know. At least if I have the watch and go to my doctor they know I am exercising. – P19, female, age 82*

*I am quite likely to cheat and lie, if I could. But if I can't get away with it, it would really be very good. I'd like to have a big brother looking over the shoulder at me and saying, 'Hey, come on, you're not doing what you said you're supposed to do or we told you to do'. – P11, female, age 74*

**Concerns about sharing data with clinicians.** However, several participants expressed a concern that clinicians would not be interested in detailed physical activity data. One participant commented that certain clinicians (e.g. physiotherapists conducting a pulmonary rehabilitation class) already have a good enough idea of their patient's physical activity levels due to regular face-to-face contact with patients while they are being physically active.

*I don't think they'd be that interested in it. I think it's all, more for my benefit. Knowing that I'm doing it. And I'm the one that's going to get the benefit out of it. [...] I have them here [at pulmonary rehabilitation] and they know what I'm like, so I don't think they'd be interested*

*in finding that out, because they can see me doing things. – P4, female, age 74*

## Use of games

In order to address the third aim of this study, participants were first asked their perceptions of playing games (such as board games, card games, video games and sports). Additionally, they were asked specifically about their experiences of and views on AVGs (such as games for the Xbox Kinect or Nintendo Wii consoles, and mobile games like *Pokemon Go*).

Participants reported various barriers and motivators for participating in various forms of games, which could be broadly categorized into 'self-focused' and 'socially-focused'. This categorization follows the sub-theme categorization employed by Kosteli, Heneghan<sup>58</sup> in their research on motivators and barriers for physical activity in people with COPD.

### Socially-focused barriers and motivators

**Fear of failure and embarrassment.** The difficulty of some games dissuaded many participants from playing these games, especially those with a social component. Some participants wanted to practise alone before playing with other people.

*My husband used to like [Mario Kart] [...] I'm not very good at it. I crashed all the time [...] It affected my motivation. Absolutely. Because I think, 'Mmm, I'm not very good at it'. I'd really like to be able to do it, you know. I'm probably more likely to try something by myself. Maybe I just need to, sort of, feel more comfortable doing something before I, you know, play with other people. – P14, female, age 66*

**Having fun with other people, especially family members.** In spite of this, the fun experienced when playing games with other people was considered a major socially-focused motivating factor for playing games among participants in this study. This enjoyment appeared closely associated with being able to play games as a way of spending quality time with family.

*I play a lot of games with my grandchildren [...] We play Beggar My Neighbour, and Uno, [...] and I really enjoy that. We love playing games together. – P11, female, age 74*

*Sometimes they can be really fun. When we have the family over [...], we have a Wii game [...] You can have a lot of fun doing things like that. And that's all movement and exercise too. – P14, female, age 66*

Many participants reported being encouraged to play AVGs by family members, and that this added to the enjoyment of the game.

*Without the interaction of the kids, to me, that sort of game. . .eh, does nothing for me. But with the interaction of the kids, I enjoy it. – P5, male, age 70*

**Not having anyone to play with.** However, many participants reported that not having anyone to play with constituted a barrier to playing games socially. Some participants mentioned that distance and changing life circumstances had separated them from the friends and family with whom they used to play games.

*Yeah, the granddaughters have a sleepover, we play Uno. And I teach them the oldies. And we have another game we play. But see, they're all grown up now, so you don't. – P16, female, age 73*

*Some of the games you can't play on your own, you need somebody to play with. – P13, female, age 71*

**Competition is a double-edged sword.** Competition in games was also a barrier to playing games, with many participants expressing how the possibility of losing decreased the appeal of playing competitive games. For some participants, this was related to feeling different from other people who didn't have chronic diseases or were at a different stage of disease, making comparison with others seem unfair.

*I wouldn't like to run in last. You know, in a competition, second-last, maybe third or fourth. But if I had to win it, I'd most certainly do my utmost to try. – P8, male, age 59*

*I think it's the whole competitive thing about games that does not particularly appeal to me. Because somebody's got to win and somebody's got to lose. – P3, female, age 76*

*I'm just not into, you know, comparing myself to other people, because. . .like I know we're all different, and I'm not interested much. [ . . . ] I don't want to be in constant competition, you know. – P14, female, age 66*

One the other hand, several participants expressed how much they enjoyed the competitive aspect of many social games, and how this increased their motivation to play these games. For some participants, this was

driven by a fear of social embarrassment in the event that they did poorly in front of others.

*I like competitive. . .yeah, I find that if you go out and just play golf, but if you play in a competition, it's the competitiveness that makes you try harder. – P2, female, age 76*

*I want to be a contest. I don't like it if you're not contesting something. You don't have to win but you do have to not embarrass yourself. – P11, female, age 74*

### Self-focused barriers and motivators

**A fun way to pass the time.** In addition to the social enjoyment of games, enjoyment was also identified as a motivating factor for single-player games. Some participants stressed that this intrinsic enjoyment was personal and distinct from the competitive or social aspects of games.

*If I'm going to play a game, I want to do it for the enjoyment I get and the fun that it is. I don't think that it has anything to do with anybody else or ranking me in any way. I don't think that would be helpful to me as a person. – P3, female, age 76*

Many participants mentioned how games were useful to help pass the time, which motivated them to play these games when waiting or to avoid feeling bored. For some participants, this was related to the desire to keep busy or to keep the mind active, perhaps for cognitive benefits (discussed below).

*While I'm waiting [at] the doctor, I usually sit there and play solitaire if they've got no magazines to read. [ . . . ] If there's nothing else to do, I'll play solitaire. – P10, male, age 62*

**Games being too difficult or risky.** The difficulty of AVGs was they were perceived as requiring physical actions that were too difficult for their age or disease state. Some participants felt unable to perform these actions, or expressed concern that the attempt could be dangerous.

*When the grandkids were here they were doing some exercises. . .some exercise things on the. . .on the TV and I thought, 'Oh, don't think I could be doing that'. [ . . . ] I have to be very careful what I'm doing because of my osteoporosis. Don't want to start breaking bones otherwise I'm really badly off. – P13, female, age 71*



**Not having the required equipment.** Some participants reported being unfamiliar with or unable to regularly play AVGs because they did not possess or have access to the game consoles required for many AVGs.

*No, we don't have an Xbox, we don't have any of this machinery stuff. The grandkids have that. I'll have to ask them.* – P13, female, age 71

*We haven't got a game and I wouldn't go out and buy [a Nintendo] Wii to try it out.* – P2, female, age 76

**Games as a form of beneficial exercise, or not.** When considering the application of AVGs as a form of physical activity, participants were motivated to play AVGs specifically as a type of exercise that could benefit health.

*Oh, I just think they [AVGs] would be more fun and you'd be moving more. Would be better for your health, I would imagine* – P15, male, age 67

Some participants perceived AVGs as primarily as a form of exercise rather than entertainment, and therefore saw the entertaining game-like aspects as potentially unnecessary. By assuming the game as primarily a form of exercise, some participants desired the games to be structured and to provide accurate measures of progress, like other forms of exercise.

*If there is something, some instruction with movement, to assist my breathing, yes, I would be open to a program like that. It would have to be clear. It would have to not have too much periphery that is unnecessary. It doesn't have to try to motivate, to entertain me as such, because it's not for entertainment* – P7, female, age 70

*You want to be able to see if you're improving. You want it to say if the exercise to improve the number of times you do something improves your ability to lift a weight. I'd like it to be measurable. If it was a game, it wouldn't matter. But if it was an 'exercise game', I'd like it to be measurable.* – P18, male, age 59

However, other participants did not think that AVGs were necessary or could not see a reason to use them rather than other types of physical activity such as walking, which were perceived as being more realistic, as well as being cheaper and having additional benefits, such as fresh air.

*It's also a case of... 'Hmm, why are we doing this?' in a way. There could be that question, because you're just*

*standing there and it's all make-believe.* – P1, female, age 66

*[Nintendo] Wii, is like, it's a simulation, yeah? I think I'd rather go outside and play on a tennis court. I don't know, I haven't played it. But I don't think it would have the same impact as you would out and hearing a ball hit a tennis racket. You can go out into a field and do that exercise and it's free. And it's fresh air.* – P2, female, age 76

**Games as a form of mental stimulation.** Even games that did not entail physical activity were still perceived to have health benefits, specifically cognitive health benefits. Many participants mentioned the mentally stimulating effect of playing video games or the perception that certain games were a form of mental exercise. Some suggested they believe the mental stimulation provided by games and puzzles can prevent cognitive decline.

*Well, Candy Crush is one of them, and I do Words with Friends in various shapes and forms with people overseas, my friends. So yeah. I keep my brain active.* – P12, female, age 68

*Well I think it does help your brain not to start forgetting everything. I think it keeps the brain more active when you do crosswords and things like that.* – P13, female, age 71

## Discussion

The current study aimed to understand perceptions, needs and self-reported behaviors of people with COPD with respect to wearable activity trackers, sharing data with clinicians and games for encouraging physical activity. This is the first qualitative study to investigate the nuanced perceptions of older adults with COPD and their use of various technologies to assist with their physical rehabilitation.

The present study identified difficulties with technology among older adults with COPD that included feeling too old for technology, having a lack of technological education, and not feeling confident with technology. Other studies of healthy older adults or older adults with chronic illnesses other than COPD have found similar themes, such as lack of technological knowledge,<sup>59</sup> not feeling comfortable or confident with technology<sup>60,61</sup> and feeling too old.<sup>62,63</sup> Therefore, the results of the present study imply that providing older adults with COPD with adequate instructions and facilitating their confidence to experiment are key

facilitators to them learning to use new technologies, which is in accordance with recommendations for promoting technology use among healthy older adults.<sup>64</sup>

When considering the use of technology to assist with physical activity, participants perceived wearable activity trackers as useful for providing reminders to move and for quantifying activity, allowing for clearer goal-setting and helping to see long-term improvement. In other studies, healthy older adults have also mentioned the benefits of wearable activity trackers for quantifying how much physical activity they are doing, as well as the motivational benefits of using these devices to provide reminders and for goal-setting.<sup>15,16,65</sup> Some participants in the present study expressed concern about the competitive aspects of wearable activity tracking apps, something that has also been identified as a barrier to wearable use in other studies of healthy older adults and older adults with chronic diseases other than COPD.<sup>66,67</sup> Some other studies have also indicated that healthy older adults with experience with wearable activity trackers express concern about the accuracy of the data,<sup>68</sup> but this was not found in the present study, likely because most participants did not have much experience with wearable activity trackers.

Participants were generally quite open to sharing data from wearable devices with clinicians, motivated by the opportunity for greater feedback, improving the quality of care, and providing a sense of accountability. While prior research of older adults with various other chronic diseases have also indicated an interest in sharing data from wearable activity trackers with clinicians,<sup>14,17,69,70</sup> in contrast to the present study these previous studies in older adults did not explore the motivations for and barriers to sharing data with clinicians. The results of the present study suggest that older adults with COPD are motivated to share health data with clinicians and seek to gain better feedback and aid in interpreting data. Further, participants in the present study did express concerns that clinicians may not have the time or the desire to look at their physical activity data. Privacy was not identified as a concern in the present study, despite it being a key issue for some users in other studies.<sup>71,72</sup> There is some evidence that suggests that older adults are not particularly concerned about the privacy implications of sharing physical activity data, though this could be because they are not as aware of the risks.<sup>16</sup>

With respect to both playing games in general and playing AVGs specifically, older adults with COPD in the present study were motivated by fun, social interaction and health benefits. Health benefits were especially relevant as a motivator for using AVGs as a form of physical activity, though not all older adults saw AVGs as superior to other forms of physical activity.

Also, older adults expressed concerns about excessive difficulty with respect to games in general, although the physical movements of AVGs appeared to magnify these concerns. Competition in games was controversial: considered a motivating factor by some participants and a barrier by others. Previous studies that have explored the motivators and perceptions to AVGs in older adults with chronic diseases have been limited to trials or demonstrations of one specific AVG.<sup>73–75</sup> Results from these studies may not apply outside of the specific context of that one AVG, in contrast to the present study which explored these motivators and perceptions with respect to both games and AVGs in general. However, despite this difference in context, many of the themes uncovered in the present study reflect those found in previous research. For example, the disagreement around competition has also been reported previously by people with COPD in the context of a prototype digital coaching intervention.<sup>73</sup> Likewise, research with older adults with heart failure trialling a single AVG at home identified motivators that included enjoyment of the AVG, the AVG being better when played with others and providing health benefits as well as barriers of the AVG being uninteresting or inappropriately challenging.<sup>74</sup> Finally, another study, which demonstrated a video clip of an AVG to older adults on anticoagulation therapy, also uncovered themes of having previous positive experiences playing AVGs with family and preferring to play with others, as well as the barriers of having no need or desire to play AVGs, or feeling like AVGs are too difficult or too risky.<sup>75</sup> The concordance between present research on games and AVGs as a whole and previous research might suggest that these single AVGs that have been previously studied do not differ substantially from most other games in their overall game design. Additionally, research suggests that when older adults without chronic diseases are given the opportunity to design games for themselves, they prioritise games that foster social interactions and provide a benefit, such as improved knowledge about a topic of interest.<sup>76</sup> Therefore, the findings of the present study, together with existing research, indicate that older adults with COPD or other chronic diseases consider AVGs as being generally able to provide health benefits while also being enjoyable, especially when played with others. However, some older adults with chronic diseases may be concerned about AVGs being too difficult or too competitive, while others may not see an advantage to AVGs over other forms of physical activity.

Overall, the findings of the present study with people with COPD supports what little research exists concerning how older adults with chronic diseases feel about wearable activity trackers, sharing data with clinicians and the use of AVGs. The present findings

extend the results of previous research of wearables and games into the specific context of COPD. Additionally, the findings of previous research into specific examples of AVGs are broadened into the context of games and AVGs in general.

### *Theoretical implications*

A key focus of this study was to explore the perceptions of older adults in adopting games as a form of physical rehabilitation supported by technology, with a view to informing the design of game-based technology interventions. It has been argued that complex health interventions should be designed with reference to general theories of human behavior.<sup>77</sup> The motivators and barriers associated with games reported by participants in this study can be interpreted within the framework of social-cognitive theory (SCT), a model of human behavior which is widely used in healthcare contexts.<sup>9,10</sup> SCT highlights the importance that the constructs of perceived self-efficacy and outcome expectations have in forming goals and behavior, and how these two constructs are impacted by knowledge and socio-structural barriers or facilitators.<sup>11</sup> In addition to its use in healthcare, SCT has been used in technology research exploring computer use among older adults<sup>78</sup> and to explain video game consumption behavior.<sup>79</sup> The results of the qualitative inquiry confirms the existence of both social and personal barriers and motivators for the adoption and use of games by people in this population with COPD. This offers support for a previous study by Kosteli, Heneghan<sup>58</sup> who adopted SCT as a framework to interpret the barriers and motivators to physical activity in people with COPD, and identified both personal and social barriers and enablers. These results underscore the importance of both personal and social factors in any intervention aimed at improving physical activity.

Participants in this study reported a desire to play games to gain physical or mental health benefits or enjoyment, and less motivation to play AVGs when they saw no purpose to doing so or feared negative consequences (such as injury). This accords with SCT, which states that people are motivated to perform an action based upon what benefits they expect will be the outcome of that action. Perceived self-efficacy, according to SCT, refers to people's beliefs in their ability to achieve an action and has a large influence on whether they attempt that action. Consistent with SCT, some participants in our study reported not wanting to play games they considered too difficult. Finally, SCT also outlines the importance of socio-structural facilitators and barriers and their impact on behavior. It is likely that the social encouragement received when playing with others and the feedback given by a game,

both of which were identified in the present study, can act as facilitators and increase self-efficacy.<sup>80</sup> On the other hand, those who reported not having access to the equipment required to play AVGs would be reporting what could be classified as a structural barrier according to SCT.

The results of this study concerning wearable activity trackers and sharing data with clinicians could also be interpreted through the lens of SCT. Wanting to use wearable activity trackers to monitor one's own physical activity could strengthen self-efficacy perceptions or act as a socio-structural facilitator of physical activity, something that has been hypothesized in research in young adults.<sup>81</sup> Similarly, the use of wearables to provide reminders would be also be a socio-structural facilitator, while sharing data with clinicians to facilitate improved clinical care or receive their clinician's approval (or avoid their disapproval) are likely outcome expectancies under the SCT framework. Wanting to share data with a clinician to receive the clinician's interpretation of the data may indicate that participants want to improve their self-efficacy by having a clinician provide persuasive feedback (such as encouragement) or modelling for them how to interpret the data.

Taken together, the results of this study indicate relevance of SCT when examining the use of games, wearable activity trackers and sharing data with clinicians in the context of physical rehabilitation in older adults. SCT has been previously incorporated into a framework for the design of serious games<sup>82</sup> and a motivation model for AVGs,<sup>83</sup> though not necessarily as the sole theoretical basis for these frameworks and models. There is need for research that employs SCT to guide the development of game-based interventions that also incorporate wearable activity trackers and sharing data with clinicians.

### *Clinical research implications*

The results of this study provide key insights for future research concerning how best to design technology and AVGs to encourage physical activity in people with COPD. AVG interventions designed for people with COPD should place an emphasis on the health benefits and enjoyment, should be able to be played with other people, and should use equipment that people with COPD already have, or are familiar with (e.g. smartphones, tablets). Competition was considered both a motivating factor and a barrier, suggesting competitions in games should be optional. Furthermore, wearable activity trackers are generally viewed positively and incorporating these devices into AVG interventions may be beneficial. Additionally, concerns about clinician's interest in health data indicate the need to

include clinician perspectives in the design of any intervention which may involve patients sharing health data with clinicians. Finally, technology needs to be accompanied by clear instructions for use.

The present research also has some relevance to clinicians wishing to use of wearable activity trackers to provide motivation or remote monitoring of their patients. Given the finding that some people with COPD desire to share health information from these wearables with their clinicians, it is critical that clinicians be able to interpret data from wearable activity trackers and integrate this data into patient care. Digital health training and digital literacy are key facilitators of adopting health technology, such as wearable activity trackers, among clinicians involved in COPD.<sup>84</sup> Therefore, clinicians may benefit from education or professional development training specific to the use of technologies to ensure clinicians are aware of the strengths and limitations of these devices and can competently integrate data from these technologies into clinical decision-making.<sup>85</sup>

### Quality of the evidence

The qualitative design of this interview research allowed participants to express their opinions with minimal external bias and enabled an in-depth exploration of these opinions and beliefs. In addition, use of multiple coders, achievement of data saturation and an inductive process of content analysis provide further strength to the findings of the present study. However, the participants did not provide feedback on the findings. In addition, the participants are limited to people of Caucasian ethnicity living in south-east Queensland, Australia, so the results of this study may not generalise to people with COPD in other countries or of other ethnicities. Finally, although it was emphasised that participants did not need to be confident or proficient with technology or video games, there may have been self-selection bias where participants who were more interested in the use of technology in their healthcare were more likely to volunteer to participate.

### Conclusions

This study has provided valuable insights into the opinions that older adults with COPD have in regard to the use of wearable activity trackers, sharing data with clinicians and the use of games for physical activity. This information will be useful to guide the future optimization or development of health technology, such as AVGs to encourage physical activity in older adults with chronic disease.

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