

Towards developing an e-coach to support arthritis patients in maintaining a physically active lifestyle

Ankit Gupta
School of Interactive Arts and
Technology
Simon Fraser University
Canada
aga53@sfu.ca

Tim Heng
School of Interactive Arts and
Technology
Simon Fraser University
Canada
bheng@sfu.ca

Chris Shaw
School of Interactive Arts and
Technology
Simon Fraser University
Canada
shaw@sfu.ca

Linda Li
Department of Physical Therapy
University of British Columbia
Canada
lli@arthritisresearch.ca

Lynne Feehan
Department of Physical Therapy
University of British Columbia
Canada
lfeehan@arthritisresearch.ca

ABSTRACT

Arthritis reduces mobility and functional independence due to inflammation and stiffness in joints. A physically active lifestyle consisting of moderate-to-vigorous physical activity (MVPA) and non-sedentary hours helps in improving pain and mobility in arthritis patients. Physiotherapists recommend an appropriate amount of physical activity to patients so that the patients can maintain a physically active lifestyle without further hurting the joints. However, meeting the goals set by a physiotherapist becomes hard when the patient experiences a flare in the symptoms. When the symptoms flare, clinicians can help the patients in adjusting their goals. However, a meeting with a physiotherapist is not always possible. E-coaching solutions provide an opportunity to provide immediate feedback to the patients. Receiving immediate feedback is useful for patients in performing an adequate amount of physical activity without hurting the joints. We developed and studied a web application to support the clinician-guided physical activity among arthritis patients. In this paper, we discuss the implications of the study for future automated e-coaching solutions designed to support physical activity among arthritis patients.

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. Copyrights for components of this work owned by others than the author(s) must be honored. Abstracting with credit is permitted. To copy otherwise, or republish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee. Request permissions from permissions@acm.org.
PervasiveHealth '18, May 21–24, 2018, New York, NY, USA

© 2018 Copyright held by the owner/author(s). Publication rights licensed to the Association for Computing Machinery.

ACM ISBN 978-1-4503-6450-8/18/05...\$15.00

<https://doi.org/10.1145/3240925.3240954>

CCS CONCEPTS

• **Applied computing** → **Consumer health; Health care information systems; Health informatics;** • **Human-centered computing** → *Information visualization;*

KEYWORDS

e-coaching, arthritis, self-management, wearable sensors

ACM Reference Format:

Ankit Gupta, Tim Heng, Chris Shaw, Linda Li, and Lynne Feehan. 2018. Towards developing an e-coach to support arthritis patients in maintaining a physically active lifestyle. In *PervasiveHealth '18: 12th EAI International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth '18)*, May 21–24, 2018, New York, NY, USA. ACM, New York, NY, USA, 4 pages. <https://doi.org/10.1145/3240925.3240954>

1 INTRODUCTION

Arthritis is a common term used to describe a variety of conditions such as Osteoarthritis and Rheumatoid Arthritis which cause inflammation in joints and other body parts. The inflammation in the joints reduces mobility and functional independence. Physical activity has been shown to improve pain and mobility among arthritis patients [4, 6, 7, 9]. Additionally, a sedentary lifestyle increases the risk of cardiovascular diseases [1, 5, 8]. Despite the benefits of MVPA and the risks associated with sedentary lifestyle, 57% of Canadians with arthritis remain inactive during leisure time¹.

We developed a web application called FitViz to help the clinicians in guiding patients based on objective measures of physical activity and inactivity. Further, it helps the patients in self-managing their physical activity behaviour by showing visualizations of their progress towards daily physical

¹2011 Canadian Community Health Survey database (retrieved September 10, 2017)

activity goals. We conducted a pilot study with ten knee Osteoarthritis and ten Rheumatoid arthritis patients. We have discussed the system and the study in detail elsewhere [2]. In this paper, we provide a quick overview of the system and discuss the need, challenges, and opportunities to develop an e-coach to support the self-management of physical activity better.

2 THE FITVIZ APP

Physical activity for arthritis patients

A physiotherapist guiding an arthritis patient recommends the patient to perform a minimum amount of MVPA every day and to keep non-sedentary throughout the day. A session of MVPA occurs when a patient performs physical activity with a recommended minimum intensity for a minimum recommended duration. As over-exercise can be detrimental to the patient's health, the physiotherapist also recommends a maximum intensity and duration of any MVPA session. The physiotherapist also recommends that the patient moves every hour for a minimum duration. An hour where the patient walks for the minimum recommended minutes is referred to as a non-sedentary hour. The physiotherapist suggests daily goals for the total number of MVPA minutes and non-sedentary hours.

The recommendations for the physical activity of a patient are referred to as a physical activity plan. A physical activity plan consists of minimum and maximum parameters, and daily goals. FitViz allows a physiotherapist to set a plan for a patient by moving sliders and observing the effect of different parameters on completion of daily goals (Figure 1).

Visualization

To use the FitViz app a patient wears a Fitbit device on the wrist every day. The device gathers the exercise intensity, which the FitViz app gathers the physical activity data of a patient using the Fitbit Web API². FitViz uses the data from the Fitbit device and the physical activity plan to extract sessions of MVPA and non-sedentary hours. The MVPA sessions and non-sedentary hours are visualized using a bar-chart-like visualization, as shown in Figure 2. The visualization shows detail about the MVPA sessions over the day. These MVPA sessions are further marked if the patient exceeds the maximum recommended intensity or duration. Finally, the visualization visualizes progress towards daily goals. Additionally, a user can look at the physical activity over a longer period using a calendar visualization³.

A patient can share her data with one or more clinicians. A clinician can look at the daily and calendar visualizations of a patient. Also, the clinician can move the sliders of the

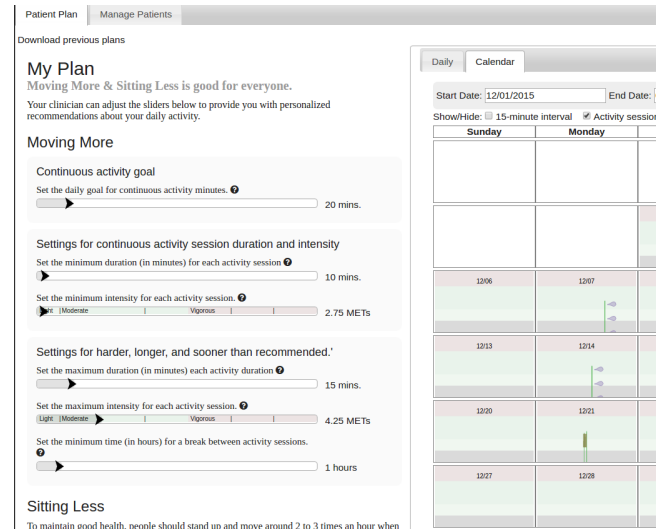


Figure 1: A physiotherapist adjust the physical activity plan by adjusting the sliders. When moving the sliders the visualization updates to reflect the effect of the parameters on MVPA and non-sedentary hours(c.f. [2])

physical activity plan to see how different values of the plan parameters affect MVPA and non-sedentary achievement.

3 THE PILOT STUDY

We conducted a pilot study for which we recruited 10 knee OA patients, 10 RA patients, and seven physiotherapists who coached the patients with respect to their physical activity. Every patient-participant was assigned a physiotherapist-participant with whom the patient had biweekly phone calls. During the phone calls, the physiotherapist looked at the physical activity of a participant over multiple days. When required, the physiotherapist adjusted the physical activity plan to match the ability of the patient.

The study lasted 4 weeks and the patients and the physiotherapists had two bi-weekly phone calls where the plan was adjusted if needed. At the end of the study, we asked the patients to share their experiences with the app and the conversations with the therapist using a semi-structured interview. In this paper, we focus on the patient-physiotherapist interaction (for different themes that emerged during the analysis of patient interviews refer to [2]). In the next section, we will discuss the implications of our findings for e-coaching solutions for supporting physical activity among arthritis patients.

²Fitbit web API (<https://dev.fitbit.com/build/reference/web-api/>)

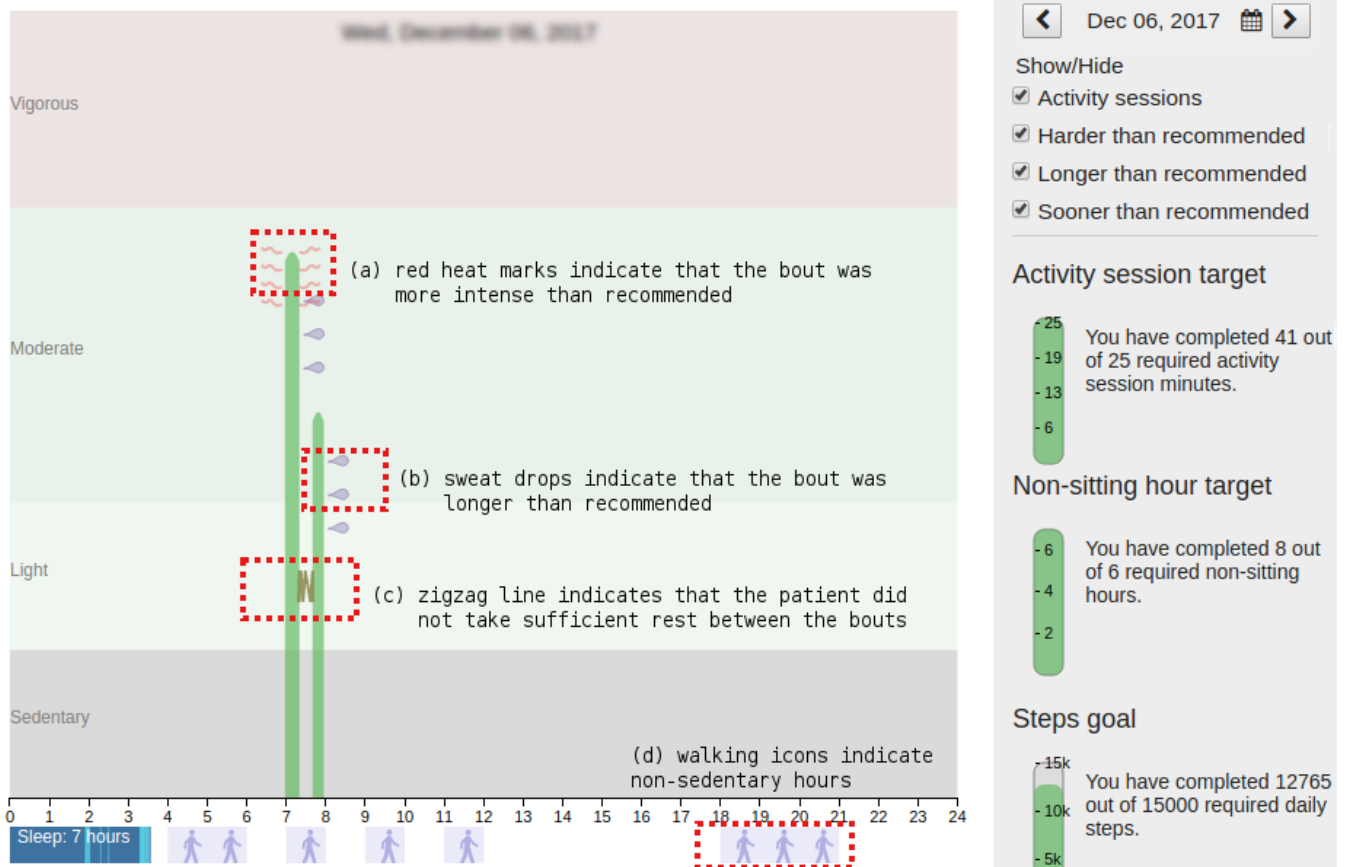


Figure 2: The daily visualization shows the MVPA as green bars, the non-sedentary hours as walking icons below the x-axis, and the daily progress towards goals. (c.f. [2])

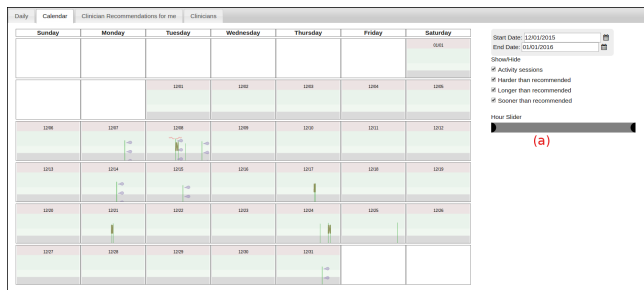


Figure 3: The calendar visualization allows the user to look at daily visualizations of multiple days at a time. (c.f. [2])

4 CHALLENGES AND OPPORTUNITIES

E-coaching as an educational tool

We identified two instances where an e-coach will be useful as a tool for educating the patients. First, an e-coach is suitable for informing the patients their physical activity is not

identified as an MVPA. Second, an e-coach can help the patients in developing strategies to meet their daily goals. The identification of MVPA sessions follows a strict definition. Even the slightest change can unqualify a physical activity session as an MVPA session. For instance, the sessions cannot have more than one-minute of lower-than-minimum intensity continuously. This strict definition is a source of frustration, especially for new users, as the patient might not see a “green bar” even though she expects one after an exercise session. This is an opportunity to educate the patient about the importance of not taking breaks and the importance of continuously maintaining a minimum intensity throughout the session.

A patient can perform two 10 minute sessions to meet a daily goal of 20 MVPA minutes. We found that this was not obvious for certain patients. An e-coach can present the patients with strategies to meet daily goals by observing the patient’s everyday activities.

E-coaching for immediate feedback and adjusting goals

As discussed earlier, arthritis patients often experience a sudden flare in the pain and stiffness of the joints. When a flare occurs, getting immediate feedback from an expert is important. However, the increased pain and the need for an appointment with a physiotherapist makes receiving immediate feedback an impossibility. An e-coach can fill this gap. When experiencing a flare, the patient can fill a pain questionnaire. The e-coach can use the pain scores and the physical activity of the patient to adjust the goals. The e-coach can even be personalized for a patient by training it with the physical activity data of a patient. Further, a real-time e-coach can guide the patients when they are performing the MVPA.

How to develop an e-coach in setting a parametric physical activity plan?

For the pilot study, we did not allow the patients to change their physical activity goals. The rationale behind this restriction is to prevent the patients from setting unrealistic goals, which can lead to over-exercise, and subsequently increased pain and immobility. The goals for the patients were set by the physiotherapist, after consultation with the patient. There is evidence that people who set their own goals are more adherent to the goals [3]. An e-coach will be useful in allowing the patient to self-set realistic goals.

However, a challenge, in this case, is that the physical activity plan consists of several parameters which are set by the physiotherapist based on her experience. For developing e-coaches which recommend plans consisting of multiple parameters, further research is needed to understand how the physiotherapists make their decisions when setting a plan. One possible solution might be for the e-coach to suggest various plans and provide the user with an opportunity to choose one.

5 CONCLUSION

Physical activity is an important aspect of successful management of arthritis. Patients with arthritis have lower physical ability and often experience sudden flare in their symptoms. Further, patients with arthritis are required to maintain their physical activity within a range. These differences have led us to develop FitViz, which provides the patients and clinicians an opportunity to collaboratively set a physical activity plan.

As arthritis patients can experience unexpected flares, it is not possible for patients to get immediate feedback from their physiotherapists. An e-coach can be developed to provide patients with constant support and planning of their

physical activity. In this paper, we showed some of the opportunities and challenges that we identified as a result of a pilot study of the FitViz. An e-coach can help the patients in increasing awareness about the physical activity requirements, developing strategies to meet the goals, and supporting the goal-setting of physical activity plan for arthritis patients.

The pilot study was conducted to test the feasibility of using FitViz to support self-management and facilitate patient-clinician communication. The results show that our approach is feasible. We are currently conducting a randomized clinical trial to test FitViz on a larger scale. There are further design opportunities that need to be explored with respect to FitViz. These include adding features to increase engagement using approaches such as gamification and social interaction with “similar others”. We plan to explore these opportunities, in addition to e-coaches in our future work.

REFERENCES

- [1] Sally A. M. Fenton, Jet J. C. S. Veldhuijzen van Zanten, George D. Kitas, Joan L. Duda, Peter C. Rouse, Chen-an Yu, and George S. Metsios. 2017. Sedentary behaviour is associated with increased long-term cardiovascular risk in patients with rheumatoid arthritis independently of moderate-to-vigorous physical activity. *BMC Musculoskeletal Disorders* 18, 1 (2017), 131. <https://doi.org/10.1186/s12891-017-1473-9>
- [2] Ankit Gupta, Tim Heng, Chris Shaw, Linda Li, and Lynne Feehan. 2018. Designing pervasive technology for physical activity self-management in arthritis patients. In *12th EAI International Conference on Pervasive Computing Technologies for Health-care (PervasiveHealth'18)*.
- [3] Edwin A. Locke. 1996. Motivation through conscious goal setting. *Applied and Preventive Psychology* 5, 2 (1996), 117–124. [https://doi.org/10.1016/S0962-1849\(96\)80005-9](https://doi.org/10.1016/S0962-1849(96)80005-9) arXiv:reviewed
- [4] M A Minor, J E Hewett, R R Webel, S K Anderson, and D R Kay. 1989. Efficacy of physical conditioning exercise in patients with rheumatoid arthritis and osteoarthritis. *Arthritis and rheumatism* 32, 11 (nov 1989), 1396–405. <http://www.ncbi.nlm.nih.gov/pubmed/2818656>
- [5] Neville Owen, Phillip B. Sparling, Geneviève N. Healy, David W. Dunstan, and Charles E. Matthews. 2010. Sedentary Behavior: Emerging Evidence for a New Health Risk. *Mayo Clinic Proceedings* 85, 12 (2010), 1138–1141. <https://doi.org/10.4065/mcp.2010.0444>
- [6] Guy Plasqui. 2008. The role of physical activity in rheumatoid arthritis. *Physiology & behavior* 94, 2 (may 2008), 270–5. <https://doi.org/10.1016/j.physbeh.2007.12.012>
- [7] Christina H Stenström and Marian A Minor. 2003. Evidence for the benefit of aerobic and strengthening exercise in rheumatoid arthritis. *Arthritis and rheumatism* 49, 3 (jun 2003), 428–34. <https://doi.org/10.1002/art.11051>
- [8] A A Thorp, N Owen, M Neuhaus, and D W Dunstan. 2011. Sedentary behaviors and subsequent health outcomes in adults a systematic review of longitudinal studies, 1996-2011. *Am J Prev Med* 41, 2 (2011), 207–215. <https://doi.org/10.1016/j.amepre.2011.05.004>
- [9] C H van den Ende, F C Breedveld, S le Cessie, B A Dijkmans, A W de Mug, and J M Hazes. 2000. Effect of intensive exercise on patients with active rheumatoid arthritis: a randomised clinical trial. *Annals of the rheumatic diseases* 59, 8 (aug 2000), 615–21. <https://doi.org/10.1136/ard.59.8.615>