

Self-Tracking and Management of Physical Activity Fluctuations: An Investigation into *Seasons*

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ABSTRACT

Many active people experience physical activity (PA) frequency fluctuation over the year and need to overcome several perceived barriers to PA to remain active. This paper mainly addresses one of these barriers, Seasonal Variability, and its adherent influencing factors on PA maintenance, which has received limited attention in previous self-tracking studies. We followed a Research through Design approach to explore the influence of the seasons on people's PA fluctuations. We were inspired by professional athletes' seasonal training plan approach, and conceptualized *Seasons*, a PA self-management tool. We used the tool to gather PA maintenance and fluctuation coping strategies from 10 participants. Our results show that experiencing PA fluctuations is commonplace, especially due to weather conditions, as well as unexpected circumstances. Individuals deploy different strategies to overcome these fluctuations. Our findings lead to recommendations for HCI researchers to consider when designing future PA maintenance tools.

CCS CONCEPTS

• **Human-centered computing** → Empirical studies in interaction design; User centered design; Interface design prototyping.

KEYWORDS

Physical activity maintenance, Self-tracking, Physical activity fluctuations, Seasonal variability, Self-management

ACM Reference Format:

Fredrika Åström, Jules Verkade, Thijs de Kleijn, and Armağan Karahanoglu. 2021. Self-Tracking and Management of Physical Activity Fluctuations: An Investigation into *Seasons*. In *CHI Conference on Human Factors in Computing Systems Extended Abstracts (CHI '21 Extended Abstracts)*, May 08–13, 2021, Yokohama, Japan. ACM, New York, NY, USA, 7 pages. <https://doi.org/10.1145/3411763.3451758>

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CHI '21 Extended Abstracts, May 08–13, 2021, Yokohama, Japan

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ACM ISBN 978-1-4503-8095-9/21/05...\$15.00

<https://doi.org/10.1145/3411763.3451758>

Yokohama, Japan. ACM, New York, NY, USA, 7 pages. <https://doi.org/10.1145/3411763.3451758>

1 INTRODUCTION

The modern way of living has led us to a sedentary lifestyle. Remaining physically active has become a challenge for many [27] posing a significant threat to human health [34]. In recent years, a number of tools have been developed to support people in monitoring their daily movement and nudging them to reach their daily activity goals [14]. To some extent, PA maintenance tools have been successful [21]. However, many fail to produce stable long-term Physical Activity (PA) maintenance [10]. The frequency of PA one carries out over the year tends to fluctuate, due to a variety of internal and external factors [27] including *Seasonal Variability* [4, 30, 33]. Seasonal Variability is the natural difference in climate, temperature and daylight hours, especially prevalent in societies living away from the equator [4]. In these societies, individuals often have fewer active days in winter than during summer [4, 8, 9]. A recent study found that summer temperatures result in 10.4 minutes more time spent on PA per day than in the winter [33]. Moreover, periodic or sporadic abandonment of PA may be caused by psychosocial variables, such as low motivation and self-efficacy [3, 24], as well as other perceived personal barriers, including stressful situations [24], a lack of time, motivation or resources [15], all of which should be taken into account for long-term PA maintenance [3]. Thus, to support long term PA maintenance, studying the phenomenon of seasonal PA fluctuation, as well as other reasons for PA abandonment, are of importance.

One way to overcome PA fluctuations and maintain PA is to implement goal-setting [18]. Setting achievable goals can boost an individual's self-efficacy [5, 16], especially in the situations when there is a high risk of relapse [17]. Unmet fitness tracker goals can result in rumination, resulting in reduced motivation and negative consequences on wellbeing [22]. Saksono and colleagues [26] also found that seasonality is one of the barriers to use the fitness app they employed in their study. Despite the evidence, most self-tracking tools do not yet address the influence of seasonal variability and other adherent barriers of PA fluctuations. Therefore, we propose that tools that support PA maintenance should be designed to help people 1) reflect on their experiences with perceived (seasonal) PA barriers, 2) predict those barriers earlier and 3) plan

and implement coping strategies to overcome them. In this paper, our goal is to explore how self-tracking tools could help individuals circumvent significant (re)lapses into sedentary behaviour, by acknowledging and managing seasonal barriers to PA, and implementing realistic goal-setting. Two research questions guided our study: (1) How do barriers to PA, especially seasonal variability and personal circumstances, influence people's PA patterns? and (2) How can a tool be designed to promote PA maintenance, by acknowledging the influence of seasonal variability and personal circumstances?

To answer our research questions, we followed a *Research through Design* (RtD) approach [35]. The first research question was partially addressed by PA maintenance literature. This knowledge informed the design process of a PA maintenance tool, *Seasons*, which we employed to fully address both questions. We designed the features of *Seasons* based on knowledge from existing PA maintenance literature, and articulated ways for individuals to employ PA management tools to manage PA fluctuation. Our design was inspired by sports training periodization approach [7] where athletes implement preparation, performance and recovery periods to optimize performance [20, 28]. By conceptualizing such a tool, we purposefully refrained from using existing commercial products, to reduce their influence on research and design process [13]. In the following sections, we explain the theory-based features of *Seasons*. Subsequently, we describe the participant study we conducted with 10 motivated individuals, to extrapolate how such tools can help people tackle the challenges of seasonal PA fluctuations.

2 DESIGNING SEASONS: MAINTAINING PA THROUGH SEASONAL GOALS

In the design of *Seasons*, we adopted athletes' seasonal planning approach, in which training frequency and intensity are strategically planned over the year. The tool establishes three seasons: *Prepare*, *Perform* and *Recover*. For each season, users can set realistic goals that are considerate of their (seasonal) circumstances and capacities (Figure 1.6) and is considerate of past experiences (Figure 1.2). In the *Prepare* season, the user can build their goals towards the performance season. In the *Performance* season, the user can set goals that pushes their capabilities to a higher level. In the *Recovery* season, the user can set goals that help them remain active, while still providing a slightly lowered tempo and space for recovery. The user can choose to implement these seasons in accordance with their preference. For instance, the user is free to apply *Prepare* during spring, *Perform* during summer and fall, and *Recover* during winter, or simply adapt the plans to what fits them the best. We know from the literature that setting too ambitious goals can be counterproductive for PA maintenance [24]. This may lead to disappointment [2, 26], and abandonment of PA habits, or the tool itself [2, 23, 26]. Therefore, *Seasons* aims to help the user prevent sporadic or periodic PA abandonment caused by unrealistically high expectations. Instead, the user can plan their seasonal goals to build towards a long-term goal, hopefully reducing the occurrence of relapse into sedentary behaviour. It should be noted that the tool we describe aims to guide people who are intrinsically motivated to continue their PA behaviour, through active management of PA fluctuation. We designed the tool at a conceptual level to allow user input for further development and deployment.

Allowing users to update the goals they set is another key aspect of the *Seasons* tool. This feature may be critical when dealing with stressful periods, or unforeseen life circumstances. In the design of the tool, we wished to highlight that PA fluctuation, due to seasonal variability or other life circumstances, is commonplace and manageable, if actively tracked and regulated. To support self-monitoring of PA, the tool would retrieve PA data from multiple sources (e.g. smartphone, smartwatches) and display it in the *Activity Overview* (Figure 1.3). The default setting shows the collected data compared to the seasonal goal and average, but that can be adjusted to other temporal periods (e.g. week, month, year).

The key features of the *Seasons* tool are founded in learnings from behaviour maintenance literature. Specifically, the Transtheoretical Model of Behaviour Change (TTM) served as inspiration, which elucidates three behaviour change processes relevant to the maintenance phase of behaviour change [25]. These are Counterconditioning (i.e. substituting problem behaviour by healthy behaviour), Contingency Management (i.e. planning for unforeseen circumstances), and Stimulus Control (i.e. managing cues for (un)healthy habits) [25]. Counterconditioning and stimulus control are addressed in the Onboarding phase (i.e. when the user sets up their account) (Figure 1.1 and 1.2). Here, the user is encouraged to identify factors that have contributed to them veering off-track from their PA habits in the past, such as seasonal variability or personal circumstances (Figure 1.2). Based on these factors, the user implements contingency management by creating coping strategies to manage these potential contingencies. The users' self-determined coping strategies are stored and can later retrieved through the built-in *I'm Slipping* feature (Figure 1.5). Furthermore, literature shows that helping people remain intrinsically motivated to carry out PA can be essential for long-term PA maintenance, for example by experiencing positive emotions during PA [32]. Hence, in the onboarding phase, the user is asked to list which PA forms they find the most enjoyable (Figure 1.1), to elicit reflection on the joy that can be derived from PA.

If the user anticipates slipping from the original PA plan, the *I'm Slipping* feature can be activated (Figure 1.5). Here, the user can retrieve their coping strategies if the cause of the lapse has already been predicted. The user can then choose whether to follow or update the coping strategies described, or to update their goals. If the user is experiencing a new type of PA barrier, a new coping strategy can be created and saved. Thus, the *I'm Slipping* feature serves as a bridge between daily PA and the relapse prevention plans established during the *onboarding* phase. Through these features, *Seasons* aims to help the user achieve a realistic, mindful, and compassionate way of managing lapses, that hinges on the user's agency to avoid descending into a full relapse. Lastly, the tool has integrated social features, such as connecting with friends, or individuals that enjoy the same activities.

3 PARTICIPANT STUDY

We invited acquaintances via email to partake in our participant study, they were screened on basis of their PA levels. In the email we included an online form, to collect information about demographics and PA levels of potential participants. The PA levels were determined by asking the participants to answer a question to grade how often they are active based on a scale from literature (doing

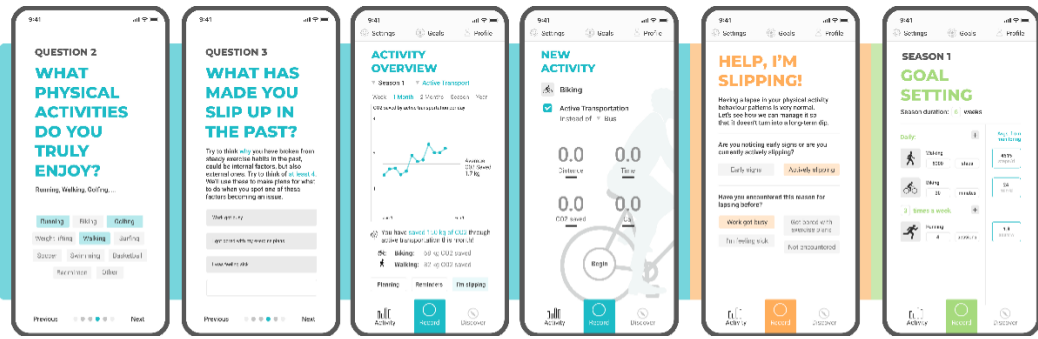


Figure 1: (1-6): Selection of screenshots from *Seasons* prototype with colour-coding of Prepare (blue), Perform (orange) and Recover (green) phases.

PA for at least 20 minutes, 3 or 5 times a week) [29]. The ones who declared to be at least moderately active at the time of our study were invited to partake in an online discussion session to explore active individuals' experiences with PA fluctuations, the coping strategies they deploy, and how the features implemented in *Seasons* could potentially support their PA maintenance. Hosting the participant study online was a necessary safety measure to take during the global COVID-19 outbreak. Each session consisted of 2-3 participants and was guided by one researcher and two observing researchers. The study ended when we arrived at saturation in the responses. In the end, 10 participants were recruited using purposeful sampling [11]. Of the participants, four identified as male, and six identified as female, of ages between 20-39, with a median of 23. All invitees lived in regions where climate exhibits substantial variability.

Before joining the online discussion sessions, each participant was asked to prepare themselves by carrying out a *Sensitizing Exercise*. This exercise introduced the topic of PA maintenance, prompting participants to take the time to think about their personal experiences with PA maintenance over the year, and potential fluctuations. We prepared online workspaces (boards) using Miro.com [19] and asked participants to create a visual mapping of their PA over the last year, using the tool's built-in functionalities (e.g. drawing, adding photos and text, etc.). Next, in the online discussion session, four exercises were carried out. Similar to the sensitizing exercise, we used Miro boards to facilitate exercises. The first exercise was a warm-up exercise to get to know the participants. We asked them to create a collage of a virtual avatar representing themselves and their PA interests. The second exercise was built upon the results of the sensitizing exercise and aimed at understanding the individual's experiences with PA fluctuation over the year. The participants were asked to present and discuss their PA patterns over the last year, as well as what might have been causes for any fluctuations. The third exercise explored how the participants manage PA barriers and the strategies they used to overcome them. For the fourth exercise, we introduced the visualizations of the *Seasons* prototype. We allowed them to complete exercises within the tool, which help the user create plans for overcoming barriers to PA. Lastly, we explained the features of the tool and asked participants to reflect on their circumstances, and if such a tool could help them manage seasonal PA fluctuations, and how it could be improved.

These questions were designed to evaluate the ideas that arose in our first synthesis of known PA maintenance research, and to evaluate, and prompt new ideas for, the *Seasons* concept.

In total, we conducted four online discussion sessions. All sessions were recorded upon the explicit approval of the participants, and anonymized. The collected data were transcribed into text documents and thematically analysed to identify themes in the participants' stories [31]. All researchers who participated in the online discussion sessions, worked on the thematic analysis simultaneously. The data was inductively analyzed and any misalignment between the researchers were resolved through discussion to arrive at consistent and meaningful themes, presented in the following section.

4 RESULTS

In the following lines, we describe our findings in two main sections: two reasons for PA fluctuations and four PA fluctuation coping strategies. Based on our analysis, two themes were derived as common reasons for PA fluctuations: being (1) Seasonal Variability and (2) Internal and External Barriers to PA. Furthermore, four themes were identified as belonging to PA fluctuation coping strategies: (1) Goal-Setting and Adaptation, (2) Maintaining and Regaining Motivation, (3) Planning, and (4) Support Seeking.

4.1 Reasons for PA fluctuations

Our results showed that all participants ($n=10$) experienced a fluctuating PA pattern over the year, to varying degrees. Although the participants experienced different barriers to be active, all had moments of lower PA frequency at different moments over the year. We clustered the identified reasons for PA fluctuation into two overarching categories through the thematic analysis: Seasonal Variability, and Internal and External Barriers to PA.

4.1.1 Seasonal Variability. One of the most prevalent reasons mentioned for PA fluctuation was seasonal climate changes ($n=8$). Several participants stated that remaining active during the fall and winter months is more challenging than the warmer months ($n=6$), finding the darkness and cold weather to pose barriers to their PA routines. For instance, P6 stated that "Spring and summer are my high exercise time. When it gets dark, I'm not motivated anymore". On the other hand, some participants avoided PA during

the warmer summer months (n=2), finding the warmth to be too uncomfortable to exercise in. Additionally, numerous participants mentioned that their annual rhythm of working and taking time off, associated with the seasons, also influenced their PA frequency. P8 stated that “During the holiday, it’s generally quite common to lose the [PA] habit. You are doing something else from your regular schedule. It is really hard to have a habit when you have random things going around. Especially if you are somewhere else.” Expectedly, these findings are aligned with the previous research showing that PA frequency varies over the year [e.g. 4], and depending on the working and holiday periods associated with the seasons [26], suggesting that the seasonal goal-setting in the *Seasons* tool may be of high relevance to motivated users.

4.1.2 Internal and External Barriers to PA. All participants had experienced internal or external barriers, temporarily preventing them from being active, during the year. We understand internal barriers as psychological or emotional barriers to conduct PA (e.g. lack of motivation), and external barriers as independent of the individual’s influence (e.g. closed facilities). We found that many barriers carry characteristics of both and can therefore be challenging to separate.

Recurring internal barriers mentioned by the participants were low motivation or energy (n=9), feeling stressed (n=7), and procrastination (n=4). These barriers were occasionally coupled with minor experiences of turbulence in interpersonal relationships, or changing habits due to disrupted schedules. For instance, P6 stated: “I think it [PA abandonment] all came together with winter beginning, it gets dark. [I was having] some issues with my housemates that really dragged me down and took a lot of energy away, so now I don’t find myself very motivated to work out.”

Participants also pointed out how the external circumstances they find themselves in can severely drain their motivation to plan and perform PA. External barriers to PA that were identified included injuries (n=4), limited time due to busy schedules (n=4) and limited access to facilities (n=8). Moreover, a common example of the influence of extraordinary circumstances was the COVID-19 pandemic and associated social distancing regulations and uncertainties. As P7 stated, “Different circumstances take you out. Not that you don’t feel like it, but that you don’t feel like it because something else is draining your energy. COVID-19 is not helping”.

4.2 PA Fluctuation Coping Strategies

Through our participant study, it became clear that essentially all participants had experienced PA setbacks at certain points and had to adopt strategies to overcome sedentary behaviour. We identified four overarching PA fluctuation coping strategies addressed by various participants: (1) goal-setting and adaptation (2) regaining and maintaining motivation, (3) planning and (4) support seeking.

4.2.1 Goal-Setting and Adaptation. We observed a variety of approaches and attitudes towards goal-setting among the participants. For instance, for some participants, establishing clear goals was paramount. As P1 explained: “[Goal-setting] helps me a lot. [PA] needs to be for something, like getting back from an injury or working towards the competition. [. . .] You need to create a momentum again, that’s what keeps you going”. Furthermore, some

participants described that many existing tools do insufficiently incorporate adaptive goal-setting and expect the individual to perform at a static or increasing level, regardless of the circumstances: “Normally apps expect you to act like a robot - like you should stick to [your plan] even if you are struggling. [Seasons] feels more human” (P3). This supports the *I’m Slipping* feature, and adaptive goal-setting incorporated in *Seasons*. However, it should be noted that not all participants implement goal-setting to remain active. For example, P4 indicated how performance goals could be counterproductive: “I usually don’t set any goals, because I tend to get demotivated when I cannot reach the goal”. This suggests that realistic goal-setting could be of relevance to PA maintenance tools.

4.2.2 Maintaining and Regaining Motivation. The participants of our study were intrinsically motivated to be physically active. Their motivation commonly stemmed from the enjoyment they derived from an activity, how it made them feel after an activity, or from learning a new skill. Additionally, extrinsic motivation, such as becoming more attractive to others or gaining discounts from stores, were mentioned by some participants as drivers to PA. For P5, disappointment in themselves helped with regaining motivation: “If I stopped for a while and need to get back [to exercising]; I tell myself I look fat. I need something negative to go and exercise.” Similar notions are made by a few other participants, explaining that feeling generally unhealthy drives them to perform PA to nullify this feeling. This behaviour might be effective in the short term, but could be considered unsustainable in the long term. PA tools like *Seasons* could therefore strive to help individuals be compassionate to their circumstances, while managing their PA fluctuations. Several participants also mentioned that fluctuating motivation played a role in their fluctuating PA patterns. These findings indicate that PA management tools like *Seasons* should consider supporting both intrinsic and extrinsic forms of motivation, to manage PA fluctuation.

4.2.3 Planning. All participants used planning strategies to remain active. As mentioned by P6: “Using a fitness plan that gives a clear structure will help. Start with a 2K run, then gradually build up the intensity of the exercise. I think that’s way more effective [than not having a gradual plan] and will result in you engaging in the exercise a lot longer.” Scheduling time for PA appeared to be an effective strategy to increase the likelihood of working out, by holding the individual accountable if they do not perform the planned activity. P8 noted that during the COVID-19 pandemic restrictions, making a reservation to go to the gym at a certain time made it easier to follow through with their plans: “The gyms require you to reserve; if you reserve a spot, it’s a lower threshold to exercise, and it makes me feel bad if I don’t go anyways”. Notably, one of the participants implemented annual performance planning with different phases of performance, preparation, and recovery throughout the year. They placed higher performance periods around competition seasons and implemented periods of recovery afterwards. As P1 explained it: “For me, it’s normal to have a year with rest and recovery, but this is not usually known. If I’m not in the competition season, my exercises look different.” The participants acknowledged the value of seasonal PA planning in *Seasons*, and found it to be a novel addition to PA tools.

Furthermore, the participants had varying preferences for how, or if, they would like to be reminded to carry out PA. Based on this, our findings suggest that when using notifications to remind the user to conduct PA, these should be easily adjustable to suit the user's preferences, as a one-size-fits-all approach could be counter-productive.

4.2.4 Support Seeking. Many participants identified support structures they implemented to overcome barriers to PA. In our thematic analysis, we categorized these support structures into two main themes: social support and expert support. Making plans together with friends or peers to exercise increased the likelihood of the participants maintaining active, through social support as well as being held accountable by someone. A number of participants also stated that they benefited from expert support to overcome the barriers for PA. This type of support was provided by coaches who professionally made training schedules, or physiotherapists who helped them overcome injuries. As P1 stated: "The physiotherapist was the main contributor [for my recovery]. They do some tests and adjust [the schedule] accordingly to the progress of recovery. I still have a lot of advantage from what I learned during the recovery phase".

During the evaluation of the tool, the participants identified an opportunity in combining the social features of *Seasons* (being able to join into teams with their friends) as an opportunity to be combined with the seasonal goal-setting features, to improve the performance and planning of their sports associations. This is an interesting point of improvement for *Seasons*, and similar tools. Additionally, several participants mentioned that self-management tools like *Seasons* could support the user by (gently) nudging them to be active, if a pattern of inactivity in the user's PA is detected. Moreover, the idea to provide the users with customized PA schedules, or expert advice, when adapting to new circumstances could also be an interesting focus for the *Seasons* tool to adopt. Such features were not yet considered in the *Seasons* concept but might prove valuable in further iterations.

5 DISCUSSION

Our findings illustrate the complexity of PA maintenance, the influence of seasonal variability and other barriers to PA on successful PA maintenance, and the strategies individuals deploy to overcome these challenges. In our study, we found that all participants experience PA fluctuation to varying degrees over the year. The influence of seasonal variability on active individuals was evident in the participants' PA levels and stories. Concurring with previous research, most participants experienced a decrease in PA during the colder and darker parts of the year [8, 9]. Furthermore, the special circumstances caused by the COVID-19 pandemic also posed challenges for individuals to remain active. Thus, our results demonstrate that even active and motivated people experience PA fluctuation and adapt their PA plans to overcome such temporary obstacles. Our findings are in line with previous research demonstrating how seasonal variability [4, 6, 12], as well as internal and external circumstances [27] can pose challenges for individuals striving to remain active. We propose that future PA maintenance tools should be designed for a more human experience, and should prompt the user to evaluate their experiences with PA fluctuations and help

them plan how to overcome foreseeable challenges, by formulating personal coping strategies. These strategies should then remain accessible to the user, similar to the *I'm Slipping* feature of *Seasons*. This recommendation is aligned with the suggestions made in the TTM, promoting contingency management, counterconditioning and stimulus control as means to promote PA maintenance [25].

Adaptive goals may yield better exercise and performance results in goal achievement [1]. Our results indicate a similar direction, being that adaptive goal-setting should be considered as a feature in PA tools as they encourage self-compassion and continuous reflection on PA fluctuation, and thereby better support PA maintenance. This may be especially relevant for stressful moments, challenging weather conditions, or unexpected life circumstances, where people may need to adjust their goals to remain active. We found that the concept of realistic and seasonal goal-setting is well-acknowledged amongst our participants, and recognized as a novel feature amongst PA maintenance tools. Consequently, we propose that tools similar to *Seasons* should allow goal adaptation based on seasonal and personal circumstances, encouraging self-reflection and management of anticipated PA fluctuations. Allowing adaptable goal-setting is therefore a promising feature for the development of future PA maintenance tools.

Our study also revealed the important role of scheduling PA, as well as implementing supportive structures, to remain active. Firstly, by scheduling activities, individuals feel as if they are being held accountable if they do not show up. This highlights an area of improvement for *Seasons*, which did not have an integrated scheduling functionality at the time of this research. Secondly, implementing supportive structures from experts or friends helped many active individuals in our study to remain active when facing an obstacle. This reinforces the social features integrated in *Seasons*, where users can create teams with their friends. In our participant study, an idea to combine the seasonal goal-setting functionality and the team functionality surfaced. This way, teams, associations, or groups of friends can plan periods of preparation, performance, and recovery over the year. This was identified as a promising idea for the continued development of *Seasons*, or similar tools. Furthermore, integrating direct contact with experts to help users overcome significant obstacles to PA such as injury could also be of relevance, based on the participants' stories and experiences.

It is commonly understood that motivation plays an important role in PA maintenance [3, 24]. This observation is also supported by the findings in our study. PA maintenance tools could therefore play a role in fostering intrinsic motivation and be appropriate for helping people remain motivated. The *Seasons* tool approaches this by encouraging the user to partake in activities they enjoy. On the other hand, some participants in our study made suggestions for extrinsic motivational elements (e.g. rewards or discounts) to be integrated into the design of a PA tool. Nonetheless, these elements should be examined on the grounds of relevance, as well as their ethical implications, before being applied to PA maintenance. Thus, further research is encouraged, to study when implementing intrinsic or extrinsic motivation is appropriate.

We manifest that the concept of periodization in sports training [7], in other words, the application of annual exercise performance planning, could be of value to a non-athletes. We believe that HCI research can be inspired to adopt the idea of different performance

seasons deployed in professional sports. Furthermore, by taking seasonal variability into account, a PA management tool could help people identify their personal experiences with PA fluctuations, set structured and realistic goals to overcome PA obstacles, and prepare coping strategies for circumstances that may arise. This could prove a novel addition to PA management tools. Such tools can be suitable especially when PA fluctuations are observed due to uncontrollable factors such as injury, changing seasons, low motivation, or societal challenges such as pandemics or environmental disasters.

We find seasonal PA plans and adaptive PA goals to be promising strategies for future PA maintenance tools. However, these require further and long-term participant studies. We believe that the main contribution of this paper is the idea of incorporating an understanding of the common human experience of PA fluctuation and seasonal variability [4] into the design of a PA maintenance tool. This tool leverages knowledge from the scientific community about PA maintenance processes, as well as knowledge often reserved to professional athletes in how to strategically plan PA activities over the year. In doing so, we hope that designers and researchers can find inspiration for similar projects and continue investigating the role of PA fluctuation, seasonal variability and adaptive goal-setting in the world of PA maintenance tools. By designing tools that are compassionate to the human experience, we hope to support people in maintaining a more stable and intentional level of PA, reducing involuntary and sporadic PA fluctuation.

6 CONCLUSION

This paper investigated people's experiences with PA fluctuation and seasonal variability and adherent internal and external barriers to PA, the strategies they employ to remain physically active, and how these strategies can be integrated into PA management tools. Based on our literature findings, we designed a PA maintenance tool, *Seasons*. With this tool, we explored the possibility of dividing the year into three exercising seasons to optimize PA during different circumstances, inspired by the insights into professional athletes' annual training periodization. Through our participant study, we found that people feel discouraged when they could not maintain a static PA level over the year, resulting in negative self-talk, and temporary lapses into sedentary behaviour. Our findings suggest that existing tracking tools insufficiently identify the barriers that individuals face to remain physically active and do not acknowledge the common occurrence of PA fluctuation. By encouraging a compassionate approach to managing unpredictable circumstances in an individual's life, *Seasons* recognizes the influence of external and internal factors on PA maintenance, such as seasonal variability, motivation, injuries, busy work schedules, or a global health crisis such as the COVID-19 outbreak in 2020.

We think that our results can be used in the future studies in two ways: (1) to design and implement self-tracking and self-management tools that address seasonal fluctuations and barriers to PA, and (2) to provide insights for investigations into the effect of these tools in managing these fluctuations in longitudinal studies. We encourage the HCI researchers to explore the effects of adaptable and seasonal goal-setting in self-tracking tools on people's PA fluctuations.

ACKNOWLEDGMENTS

We thank Jitske Hedeman for her input in the early stages of this work.

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