Exploring the Tracking Needs and Practices of Recreational Athletes

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ABSTRACT

Sports are the primary physical activity for over 52 million people in the United States, a vast majority of which are recreational athletes. The general tracking practices and needs of this population has not been studied. In this paper, we explore how recreational athletes use tracking technologies to assess and improve their performance. We conducted interviews with 25 recreational athletes that are runners, soccer, tennis, and basketball players. We found our participants were motivated to improve their play, and engaged in supplementary physical activities like exercise and strength training to improve their sports performance. They used wearables and mobile applications to track general physical activity data. However, they were unable to track sport-specific techniques due to limitations of tracking technologies, and desired better tracking support for the same. Based on our findings, we present design opportunities for future personal informatics tools to better support the needs of recreational athletes.

CCS CONCEPTS

• **Human-centered computing** → Ubiquitous and mobile computing → Ubiquitous and mobile computing systems and tools

KEYWORDS

Personal informatics, activity tracking, recreational sports

INTRODUCTION

Sports is one of the many ways in which users seek to improve and maintain their health and fitness. In the United States alone, sports are the primary physical activity for over 52 million people [14]. The vast majority of these are *recreational athletes*. We define *recreational athletes* as people who frequently play a sport with a goal other than material compensation. These goals could typically include playing sports for fun, to improve their health, or as a way to socialize.

Personal informatics tools like activity trackers and mobile applications are designed to track metrics such as steps, distance and heart rate. These are important in providing users a general sense of their physical activity. They have shown promise in improving people's health [15]. However, they are of limited utility when one wishes to track detailed information on exercises such as sit-ups, push-ups, jumping jacks, etc. Similarly, they fall short in providing tracking support for recreational sports, which are often a combination of multiple techniques and physical activities.

Previous HCI research has designed tracking technologies for individual sports and techniques. These are useful technical contributions for designing and engineering tracking tools. However, they do not inform us about how recreational athletes generally use tracking technologies, and challenges they face. Given their sizable population and the unique nature of sports as a physical activity, studying their needs and practices can offer useful insights for design of personal informatics systems.

We have therefore conducted interviews with 25 recreational athletes across four different sports of running, soccer, tennis and basketball. We chose these sports because they are among the most popular for recreational athletes [19]. Grounded in interview findings, this paper makes following contributions :

1. A better understanding of how recreational athletes engage in supplementary physical activities to improve their sports performance, and their use of general tracking tools and workarounds to track their sport and supplementary physical activities.
2. An analysis of measures recreational athletes desire better tracking support, which we term as "long tail of tracking needs"

3. Design opportunities for future activity tracking systems to better meet the needs of recreational athletes

RELATED WORK

Personal Informatics Tool Adoption and Abandonment

Li et al. [17] defined personal informatics systems as tools that enabled people to collect relevant information about self and helped in insightful reflection. Li and team derived a linear stage-based model of personal informatics systems : preparation, collection, integration, reflection and action. According to them, tracking barriers in initial stages were likely to cascade to successive stages. Thus, an athlete with a wrong or limited tracking tool in the 'preparation' stage would be unable to collect actionable data in later stages. Epstein et al. [8] recommended extensions to the stage-based model by studying how people track physical activity, location and finance. They found that people's tracking motivations could be quite diverse, and depend on their personal goals. Similarly, Rooksby et al [25] also studied how people generally use health and wellness tracking technologies, and found their tracking requirements could be complex. For certain extreme users, termed 'Quantified Selfers', tracking needs could be varied enough for them to design their own custom tracking tools [3]. Other studies have looked into long-term usage of fitness trackers [9], why people tend to abandon tracking [4, 16, 7], and how their wearability can be improved [11, 24]. These studies contribute useful findings and recommendations for designing personal informatics systems. However, they are broad studies and while they have addressed health and wellness, they do not provide an understanding of personal informatics needs within recreational sports.

Recreational Sports and HCI

The HCI community has proposed solutions that increase the visibility of physical activity [5, 6], and encouraged users to be more active through positive social reinforcement [6, 18]. Researchers have also proposed, developed and evaluated tracking systems specific to sports. For example, there have been efforts to track and classify techniques within soccer [26, 13], basketball [20], skateboarding [23], and more [21,1]. Such studies are useful in providing an in-depth understanding of how specific metrics matter in individual sports.

More recently, researchers have conducted qualitative studies with recreational and professional athletes. Havlucu et al. [12] interviewed professional tennis players to better understand their tracking needs. The study revealed that abandonment of tracking tools was high among tennis athletes, and they desired more 'specialized' information. Tholander and Nylander conducted studies with endurance sports' athletes, runners and golfers about their use of wearable sports technology [22, 27]. Their studies revealed that athletes focused on their "feelings" to evaluate their performance. These interviews provided insights about how data from tracking tools should reflect the athlete's assessment of her performance. However, none of the studies inform us of general usage, needs and challenges of recreational athletes with activity tracking tools. This analysis is currently missing, and we wish to fill that gap through our study.

STUDY

We conducted semi-structured interviews with 25 recreational athletes across four sports: running (8 participants), basketball (6), soccer (5), and tennis (5), 1 participant in both soccer and tennis (1). Interviewees were recruited from recreational sports leagues and online sports forums via emails, flyers, and social media postings. 7 participants were female, 18 male, and their ages ranged from 19 to 48 (mean: 30, median: 27).

Interviews were structured into three parts with questions around participants' motivations and goals in playing sports, their past and current usage of tracking tools, challenges with tracking tools, and any wishes they had for future technology to better fit their sports.

Each Interview lasted 25–40 minutes, and took place via Skype, or in person. Participants were compensated with $10 Amazon gift cards for their time. All interviews were audio recorded and transcribed for data analysis. Five researchers conducted an affinity analysis to identify key themes.

RESULTS

In this section, we present our findings from the interviews. We discuss (1) participants' engagement in sports and their usage of tracking tools (2) metrics they desire to track (3) their preferences on wearing tracking devices. Participants' quotes are abbreviated by sport: running (Rx), basketball (Bx), soccer (Sx), and tennis (Tx).

Engagement in Sports and Supplementary Activities

Each of our participants played their sport 2–3 times each week. They had different goals for playing the sport. These included staying fit, gaining exercise, having fun, and enjoying with others. Few participants also enjoyed the competitive aspect of recreational sports. They therefore strove to win more games or better their own performance on a regular basis: "*In that perspective, improvement is being able to run a little bit further than I did the day before. As long as I get a little bit further... For me it is the chase of getting a little bit further. I guess I would say I am a some what competitive with myself*" (R4).

Participants believed their sports performance was a combination of skills and technique needed to play the sport as well as general fitness levels. Thus, apart from engagement in sport matches and games, participants reported practicing certain techniques to perfect it: "*I care about my jump shot the most. I want to improve my accuracy at shooting mid-range shots... I practice that more than anything*" (B3). We noted individual differences among techniques that participants practiced. These were due to their prior experience at the sport and existing skill with techniques.

Participants also reported undertaking activities like cardio exercises, strength training, and healthy eating. They planned

Table 1. Current technologies and tools used for tracking

ID	Sport	Current Tools & Technologies
R1	Running	Fitbit
R2	Running	Garmin, Garmin Connect
R3	Running	Running Fit, Apple Health
R4	Running	Garmin Phoenix 5
R5	Running	Garmin, Garmin Connect, cross training apps
R6	Running	Fitbit, Runkeeper Go, Nike Run
R7	Running	Garmin Forerunner
R8	Running	Couch to 5K
B1	Basketball	*N/A*
B2	Basketball	Google Fit
B3	Basketball	*N/A*
B4	Basketball	Google Maps
B5	Basketball	N/A
B6	Basketball	FitBit
S1	Soccer	Apple watch
S2	Soccer	*N/A*
S3	Soccer	Fitbit
S4	Soccer	Polar, My Fitness Path, Notes
S5	Soccer	Google Maps
T1	Tennis	*N/A*
T2	Tennis	Phone's pedometer, YouTube videos
T3	Tennis	iPhone video camera, Youtube videos
T4	Tennis	Apple Health
T5	Tennis	iPhone video camera, Youtube videos
S6/ T6	Soccer/ Tennis	Fitbit, iPhone video camera

their workout and diet around the sport: "*To play soccer... I actually run during the weekday... for weekend soccer. For both sports (soccer and tennis), I train my legs more than the upper body. I don't do weights much. I try to run regularly... I care about the leg muscles.*" (S6/T6). Participants believed their performance at these supplementary activities was correlated to their overall sports performance, and they were motivated to improve themselves in these activities : "*I use my Apple Watch for practice and stuff... Which I think is directly correlated to my performance because if I look and say, 'well I ran for four miles and it has been 20 min, (so) I ran faster,' that is something specifically toward the running component of soccer*" (S1). Participants mentioned focusing on these aspects of their performance helped them improve in the sport overall, which in turn allowed them to enjoy the sport more: "*One of the ways I have fun is by playing better... Like you know just being a better basketball player.*" (B4).

Usage of Tracking Tools and Technologies

Most participants were tracking certain aspects of their performance. Participants reported using a combination of tools and information resources to track and improve the activities related to their sport. These included wearables, health and fitness mobile applications, repurposing mobile applications not intended for health and fitness, information resources like blogs, forums, YouTube videos. None of the participants playing soccer, tennis and basketball used devices tailored to their sport. Instead, participants used more general-tracking devices from brands like Garmin, FitBit, Apple Watch to track the activities they undertook, as shown in Table 1.

All runners in the study used either wearables or mobile applications. Runners reported they were largely satisfied with the data collected by the technology but expressed concern about the accuracy of the data. Participants of other sports also used wearable devices (e.g., FitBit, Polar, Apple Watch) and mobile applications (e.g., MyFitnessPath, Google Fit) indirectly for their sport. They tracked physical activity data such as distance, steps and speed during their sprint drills, practice sessions and friendly matches. They acknowledged the inaccuracy of data but unlike runners did not view it as a big disadvantage. We believe this difference in response could be because most existing trackers track measures such as the number of steps taken, heart rate, or the distance ran. This data is more directly related to running and can be easily incorporated by runners in performance improvement, but not so much by other athletes. However, participants of other sports, who used a wearable, did mention they desired better recognition of the sport they were engaged in. One participant said his activity tracker would occasionally characterize the sport as 'exercise' or 'running' instead of recognizing it as 'sport', and vice versa: "*There is probably some algorithm to detect sports... But sometimes it fails. If I am running very quickly in short periods, it is tracked as 'sport' by FitBit... like soccer*" (S6/T6). Another soccer participant who used an older FitBit said he had no option of selecting his sport within the FitBit mobile app. His data during matches was therefore collected as 'running' activity. Participants felt this mischaracterization impacted the data on calories burned, steps taken, and time of activity. We therefore found a difference between how well existing fitness trackers supported the goals of runners relative to how they supported the goals of other athletes.

As stated earlier, athletes repurposed applications not meant for health and fitness for tracking data. For example, a basketball and a soccer athlete reported using Google Maps to measure the distance of their running routes. Another participant said he

used 'Notes', the note-taking application on iPhone to note down the details of his workout i.e. exercises carried out, number of repetitions, etc. Recording this information helped him to plan his workout better. Similarly, tennis players used mobile cameras to record their forms and postures during the game and assess their technique: "*Casually I sometimes put my phone down… I hit a couple serves and see where I am. I look at the speed… I look at my form during serve.*" (T4). Given that these applications were being used as workarounds, there were various issues that participants faced. For example, one tennis participant mentioned that that he faced difficulty in analyzing his form and posture because of video angles: "*I usually set the phone against the wall and it's like a little bit different each time, it's always facing up so even if I'm hitting exactly the same way it would be always different.*" (T5). Participants also struggled to find someone to record their video. Another example was when participants tried to emulate videos they had watched on YouTube. Without feedback, it was difficult for them to identify tweaks that would perfect their technique.

Lastly, participants reported relying on self-reflection and referred to their feelings after the game (e.g., feeling of competency, strength) and to the memory of mentally tracked measures (e.g., number of shots, passes). This was especially true for the four participants who were not using any tracking tools at the time of our study. They felt that none of the existing technologies could track such qualitative measures or accurately track their sport techniques: "*I've never seen anyone who's using a gadget for tennis, except the Fitbit thing but that's only for pedometer or heart rate for fitness. It does not help me for tennis.*" (T3). This is in agreement with previous research that found athletes are likely to refer to their feelings to gauge their performance [27].

Desired Metrics and Categories

We inquired our participants about measures they wanted to to track to improve their performance further. This revealed a variety of unmet tracking desires amongst the participants. We refer to this this as a 'long tail' of desired metrics. This is because of individual differences in tracking desires among participants of same sport as well as across sports. We recorded 70 unique measures, as shown in table 2. These were categorized into four groups: 1) sports-specific or technique, 2) physical status, 3) outcome, and 4) social support.

The category of 'technique' includes skills specific to the sport. We discovered that technique information, despite being the most desired, was least supported by tracking tools. Most of these measures were mentioned by non-runners: "*I would like to know how fast my shots are or my racquet speed . . . I think they are critical to track especially in a serve, (because) speed trumps all. I think speed is my primary focus.*" (T5). Participants in these sports felt less supported by existing tracking technologies.

The second most popular categories were 'physical status' and 'outcome'. We defined the former as a category involving data on physiological state of athletes. Participants across all sports saw these metrics as tied to their performance and wanted further statistics like respiratory rate, blood pressure, muscles' output, etc. The category of "outcome" included measures on game statistics like wins, losses, and individual scores. Participants playing tennis, basketball, and soccer mentioned they mentally tracked the outcome related measures. Reflecting upon these numbers allowed them to conclude if they had improved or not: "*You kind of keep the mental record for yourself like 'Oh, I made that many points in that game, that was good.'*" (B5). However, participants mentioned that counting in their heads was tedious and erroneous, and they wished for a tool that could compile and present this data.

"Social support" characterizes data that can be utilized to improve team performances. Only one participant stated she wished to track "team connectedness": "*I would like to see the data on how feeling connected to the team can actually relate to the outcomes of the game. You feel socially responsible for the team can affect the outcome like it is the team endeavor vs. single person's endeavor that can change the outcomes because I do think that after years of playing soccer that is a huge component that if you feel like a cohesive team the outcome is usually significantly better.*" (S1). Other participants mentioned they did not explicitly try to track metrics as a team. There were multiple reasons for this. Few participants of basketball and soccer stated that in recreational sports team members changed often. In addition, team members did not share the same goals. While few team members enjoyed playing competitively and winning more matches, others just wanted to have fun. This made it difficult for them to track performances collectively and develop a strategy. However, participants mentioned keeping a mental track of their teammates' and opponents' performances during a match. This helped them make decisions such as whom to pass the ball, how to change their play, etc. We therefore see this metric worthy of future exploration.

Need for Appropriate Device Placement

Participants elaborated upon disadvantages because of placement limitations of tracking tools. Participants who owned wearables had to wear it on the wrist, while those who used mobile applications had to carry their mobile phones in their pockets. This posed problems to tracking various activities, especially tracking data during a game or match. For example, soccer and basketball athletes mentioned that sports' rules didn't allow them to wear anything on their wrists, arms or ears. These posed risk of injury to others. Further, carrying a mobile phone during a match hindered sprinting and running for participants of all sports. Therefore, participants, refrained from tracking data in matches, and mostly used it for practice matches and supplementary activities.

Further inquiry revealed that athletes preferred to wear trackers at unobtrusive locations so that it would not get in the way of active play. Thus, runners and tennis players preferred wrists, basketball players preferred ankles, and soccer players preferred chests. Participants acknowledged that while wearing it on body parts not used in the sport may affect data quality, they would prefer a "less accurate" tracker over "an accurate but obtrusive" device: "*It would be more accurate on the leg, but then it would get in the way… so maybe not on the leg.*" (S3). We also found individual differences in participants' preferences. For example, one runner wanted to wear the tracker on his wrist to

check statistics while running. Another runner wanted to wear the tracker on his ankle to avoid being distracted with data mid-run. Athletes therefore valued customization for conveniently tracking sports and related activities.

Table 2. Desirable metrics by type (70). The numbers in parentheses are the number of participants who asked for a given metric for their sport.

Type	Metrics
Technique	How hard the ball was hit (5), Movement (direction, area) (5), Ball spin (3), Ball location (3), Ball speed (3), Live pace performance (3), Shot attempts (1), Angle of shot (1), Person defending (1), Shooting accuracy (1), Distance from the hoop (1), Ball release time (1), Whether shot was contested (1), Vertical jump distance (1), Potential moves/poses to make (1), Ball height (1), Serve trend/tendency (1), Overall presence on the floor affecting the score of the game (1), Steps per time period (1), Rebounds (1), Assists (1)
Physical Status	Respiratory rate (3), Cardio performance (3), Speed during the play (3), Body change (muscles output) (2), Blood pressure (2), Metabolism rate (1), Postures (1), Sprints (1), Calories burning (1), Strengths & weaknesses (1)
Outcome	Progress (4), Agility (2), Distance (2), How many points you gave up (2), Goals you made (2), Game history (2)
Team	Team connectedness (1)

DESIGN OPPORTUNITIES

Based on the results, we identify two major design opportunities for personal informatics systems to better support recreational athletes.

Tracking Support for Multiple Activities

Our interviews revealed that recreational athletes engaged in supplementary physical activities like cardio workout, strength training, and technique practice to improve their overall sports performance. They often used activity trackers to monitor exercise related activities. This helped them assess their improvement at these activities. However, they desired more tracking support for technique information. They were unable to collect data from existing tools about techniques they were trying to improve. This was especially true for participants engaging in soccer, tennis and basketball. We therefore recommend that activity trackers should be enhanced to track multiple activities. Our recommendation builds on Choe et al's [3] finding regarding Quantified Selfers' practices, who often designed custom tools because it was difficult for them to track and explore data using a single tool. Similar to Quantified Selfers, recreational athletes have multiple tracking needs, and they are currently unable to track these fully due to limitations of activity trackers. This leads them to devise workarounds. Our recommendation is also in agreement with industrial analysis of wearables [10], which suggest that wearables currently collect data that is too generic. To further the adoption of wearables among recreational athletes, they need to have capabilities to capture more complex and tailored data, without forgoing the general data they capture and utilize currently.

Enable Combining Data with Multiple Sensors. Most wearables are designed with limited number of sensors, and can track select metrics. It is not possible for a single sensor to track many of the metrics that athletes want to track in conjunction. Bearing these in mind, we recommend that devices, sensors, and applications should be designed to exist as part of a larger, uniform tracking system. Thus, designers should consider how a new sensor or wearable can extend the capabilities of other, perhaps even, older sensors, and make the overall system more versatile and "holistic." Such a system would be better suited to meet athletes' tracking requirements even as their sports goals change with time and experience.

Provide Placement Options For Tracking Technologies. Previous work has shown that most wearables are designed to be worn on wrists [2]. However our interviews showed that recreational athletes did not always wish to wear the tracking technology on their wrists. This need was driven by sports rules, other physical activities they undertook, and personal preferences. To adequately support athletes in tracking multiple activities, these preferences and reasons need to be taken into account. We recommend that activity trackers should have multiple placement options. Designers should examine sports rules when designing wearables, as athletes may not be permitted to wear trackers at certain body locations lest players are injured. It should be possible to place the wearable at an unobtrusive position during active play. For example, during a soccer or basketball game, athletes should have an option to wear the tracker on their chest or ankles respectively. But during exercises or running, the same tracker should have the option to be worn at more convenient locations such as wrists or arms. This would allow the user to access data quickly. Lastly, having more than one placement option would also cater to individuals' preferences identified in our study. Our finding and recommendation builds on previous HCI research to improve wearability of activity trackers [11, 24].

Allow Self-Defined Goals

Our study demonstrates that recreational athletes were motivated to improve their performance. Getting better allowed them to enjoy their sport more. They therefore tracked measures that mattered to them, and desired tracking support for other related metrics. We found individual differences in the desirable metrics of athletes. Even athletes playing the same sport had different goals for their improvement, and this drove different tracking requirements. Given this variety in athletes' needs, we suggest that personal informatics systems should enable athletes

to define and articulate their own goals. Depending on the goal stated, the technologies should provide suggestions to athletes about how they can best track measures related to their goals. These suggestions could include the various activities the athlete should undertake, and their execution on the field. This builds on Choe et al's [3] suggestion that technologies should initially suggest the measures one should track. It should also consolidate information resources that would serve the athlete in practicing and training for their sport. This is because recreational athletes refer to online information resources to better themselves. This will greatly reduce the burden on recreational athletes to collect data, implement changes, and reflect upon their sports performance.

LIMITATIONS AND FUTURE WORK

We recognize that our participant pool is skewed with regard to gender. Despite our best attempts to recruit more female athletes, our participant population was male-dominant. This may be a consequence of the population sampled across the four sports. Thus, the findings may not fully represent challenges and needs of female recreational athletes. In future studies, we wish to address this, and have more balanced gender participation.

Based on our findings, we want to co-design personal informatics systems with recreational athletes. We want to understand how athletes set their goals, and use tracking tools to meet their goals. This would allow us to evaluate the tracking tools, and further refine our findings and design opportunities.

CONCLUSION

Recreational athletes are motivated to improve their play because it enables them to enjoy their sport more. Tracking technology can help them to improve their performance. Currently, there are still many unmet tracking needs for recreational athletes, particularly for sports besides running. Specifically, technique data is not well supported by existing tools. Based on our interviews, we identified design opportunities for future personal informatics tools to better support these needs.

ACKNOWLEDGEMENT

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