

# Designing Exergames for Psoriatic Arthritis: *The Spy* and *Zen Forest* Paradigms

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**Abstract**—Psoriatic Arthritis (PsA) is a rheumatic disease that affects the skin and joints, causing stiffness, impaired mobility, and chronic pain. In addition to biological interventions, traditional treatments often include physiotherapy and exercise to improve range of motion and physical function. However, a prevalence of low consistency, high costs, and lack of engagement leads to high drop-out rates, making these interventions ineffective. Exergames, short for exercise games, provide an accessible alternative to complement traditional interventions, which embed therapeutic movements into game mechanics, motivating patients to remain active and consistent in their rehabilitation routines. Here we present the design of two exergames for PsA, namely *The Spy* and *Zen Forest*. Both exergames were co-designed with 29 experts, including PsA patients, clinicians, researchers, and technical stakeholders, ensuring that they align with clinical goals, address patient needs, and support safe and effective physical engagement. In *The Spy*, players act as undercover agents and complete a sequence of physically engaging missions, designed to stimulate dynamic body movement that boost coordination and enhance mobility, balance, strength, and flexibility. In *Zen Forest*, players perform slow and calm stretching routines inspired by Pilates and Yoga exercises, improving their flexibility, relaxation, and body awareness. Both exergames can enable clinicians to monitor patient progress and recommend personalized activity plans, making therapeutic routines more accessible and motivating.

**Index Terms**—Psoriatic Arthritis, Serious Games, Exergames, *The Spy*, *Zen Forest*, Body Tracking

## I. INTRODUCTION

Psoriatic Arthritis (PsA) is an inflammatory musculoskeletal disease that affects both the skin and joints, often leading to pain, joint stiffness, and reduced mobility [1], [2]. Emerging tools, such as Serious Games, allow for more engaging interventions to train patients' mobility, by combining gameplay with clinically validated physical exercises. This complements and improves traditional interventions such as physiotherapy [3]. Exergames (short for exercise games) have been explored in various studies. For instance, Chiu et al. [4] explored MetaQuest's VR exergame *Supernatural VR*<sup>1</sup> with Physical Therapists, and found it offers potential benefits for strength training, mental health, and physical therapy

engagement. However, they noted the absence of biosensors and motion-tracking tools (e.g., heart rate monitors, digital goniometers) limiting its ability to provide real-time physiological data essential for clinical care. Similarly, Juan et al. [5] explored serious games for motor rehabilitation using the Oculus Quest, and compared hand interaction with controller-based input. Their findings revealed a clear user preference for natural hand gestures over physical controllers, suggesting that future developments should focus on integrating pose estimation technologies to alert users in case they are not performing exercises correctly.

This paper explores the design of two full-body exergames to mitigate PsA symptoms, i.e., *The Spy*, and *Zen Forest*, that require players to perform physical challenges and collect achievements. In *The Spy*, previously introduced [6], players assume the role of a secret agent who must complete a series of missions encouraging dynamic movement and coordination. In *Zen Forest*, the players nurture a forest by performing slow and calm stretching routines inspired by Pilates and Yoga exercises. This allows them to improve their flexibility, relaxation, and body awareness while engaged in a game environment where their actions contribute to awaken the surrounding natural environment. The proposed serious games were co-designed with clinicians and patients within the context of iPROLEPSIS (<https://www.iprolepsis.eu/>), a Horizon Europe Project, which addresses the multi-dimensional symptomatology of PsA, including impaired range of motion, stiffness, and fatigue [6]–[8].

The rest of the paper is structured as follows: Section II presents the methodology, Section III presents the proposed design of *The Spy* and *Zen Forest* exergames, Section IV describes the implementation considerations, and Sections V and VI discuss and conclude the article, respectively.

## II. METHODOLOGY

The design of the two proposed exergames followed Tesarolo et al.'s [9] methodology, leveraging user-centred co-creation and an Agile framework to place emphasis on early feedback to iteratively refine game concepts and prototypes.

<sup>1</sup><https://www.meta.com/quest/supernatural/>, accessed: 2025-07-02

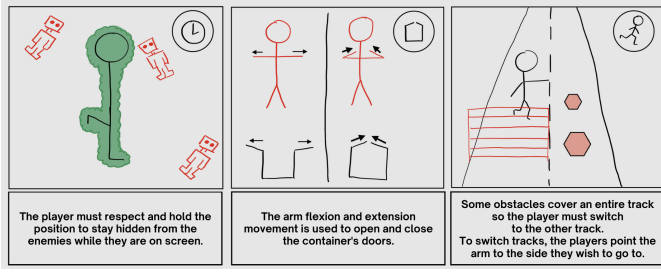


Fig. 1: A storyboard excerpt from the game, *The Spy*, illustrating three player exercises: holding a position, arm flexion and extension, and pointing.

The ideation process began with a collaborative session involving 29 experts, including patients, clinicians, researchers and technical stakeholders, and was guided by the Crazy8s methodology [10]. Here, rapid sketching and discussion generated the concepts for early storyboards, which were later refined in follow-up co-creation sessions. During these sessions, healthcare professionals emphasised the importance of developing full-body exergames focused on strength and aerobic training, as an addition to the other serious games planned, such as those training fine motor skills. This iterative design cycle strengthened both the clinical and entertainment dimensions of the games, leading to the current prototypes for *The Spy* and *Zen Forest*, which will undergo further development and validation through formal clinical trials.

### III. THE PROPOSED EXERGAMES DESIGN

#### A. *The Spy*

*The Spy* is a serious game where players assume the role of a secret agent named Kel, whose main objective is to recover diamonds scattered across a foreign island before they fall into the hands of rogue flying robots. To complete the mission, Kel must move swiftly and collect as many diamonds as possible, all while remaining undetected. Thus, the game combines decision-making tasks with engaging physical activity. Different missions connect to distinct physical challenges. The initial game storyboards (see Fig. 1) were co-designed with patients and health professionals [6].

The ‘spy’ theme served as the main creative reference for the visual concept of the game (see Fig. 2). A blue, cool-toned colour palette and technology-inspired designs elements were explored to reinforce the mission-like atmosphere. A widget-style interface was adopted to modularly organise the screen, which led to five core interface components, i.e., the main gameplay area, the exercise demonstration (recorded by a physical health specialist), a pause option, an exercise progress tracker, and the game score display.

1) *Physical Challenges*: To complete Kel’s quest to gather diamonds while avoiding detection, each gameplay session features a selection of the following physical challenges (see Fig. 3):

- **Balancing Act**: Walk along a narrow path and climb a virtual ladder, practising balance to avoid falling.

- **Diamond Dilemma**: Sort falling diamonds by shape or colour, training quick decisions and lateral movement.
- **Rocket Boost**: Steer a rocket through a star trail, building strength and directional control.
- **Jewel Drop**: Catch falling diamonds in a virtual box, encouraging upper-body coordination and reaction speed.
- **Runway Maneuver**: March in place and dodge obstacles on a track to build agility.
- **Tree Freeze**: Hold creative poses to hide behind trees and avoid robot detection, testing stability and focus.

2) *Rationale for the Challenges*: The in-game physical challenges were structured around three training exercise blocks (mesocycles). Each mesocycle was developed in collaboration with healthcare professionals and exercise/physical activity experts, and has a specific focus, that is, while the first one emphasises foundational movement skills and pattern learning, the subsequent mesocycles aim to increase intensity and introduce greater movement variability. Within each mesocycle, a five-day program is followed. This program features a daily exercise sequence that encompasses four physical challenges (see previous section) for mobility, balance, strength, and flexibility, as well as one aerobic ‘bonus’ exercise. Each selected exercise has a number of sets and a repetition scheme based on either time (in seconds) or count (repetitions or steps), depending on the movement’s nature. Exercise intensity considers the Rate of Perceived Exertion (RPE) scale [11], with levels increasing along mesocycles. In the game context, each mesocycle corresponds to a distinct difficulty level (i.e., easy, medium, and hard). When successfully completing all exercises within a given mesocycle, players can select another level. The duration of each mesocycle may range from one to several weeks, depending on player performance.

#### B. *Zen Forest*

*Zen Forest* invites players into a calm, nature-inspired world, where they explore a mystical forest in search of balance and harmony. Each gameplay unfolds as a three-stage journey through the forest: it begins with a warm-up where the environment slowly reveals itself through serene natural elements; then, during the main stage, players interact with the forest by triggering soothing animations and sounds (such as chiming flowers and falling leaves) that respond naturally to their yoga-inspired movements; and finally, the gameplay concludes with a cool-down phase where the forest visibly blossoms and grows. The initial game storyboards (see Fig. 4) were also co-designed with patients and healthcare professionals [6].

The visual theme embraces soft, earthy tones that complement the peaceful atmosphere (see Fig. 5). The interface retains the widget-style design from *The Spy*, featuring intuitive guidance, posture demonstrations, progress tracking, and ambient soundscapes that support the player’s journey toward balance and well-being.

The game features intuitive audio cues that guide players through each movement, ensuring continuous participation, even when their poses prevent them from viewing the screen.

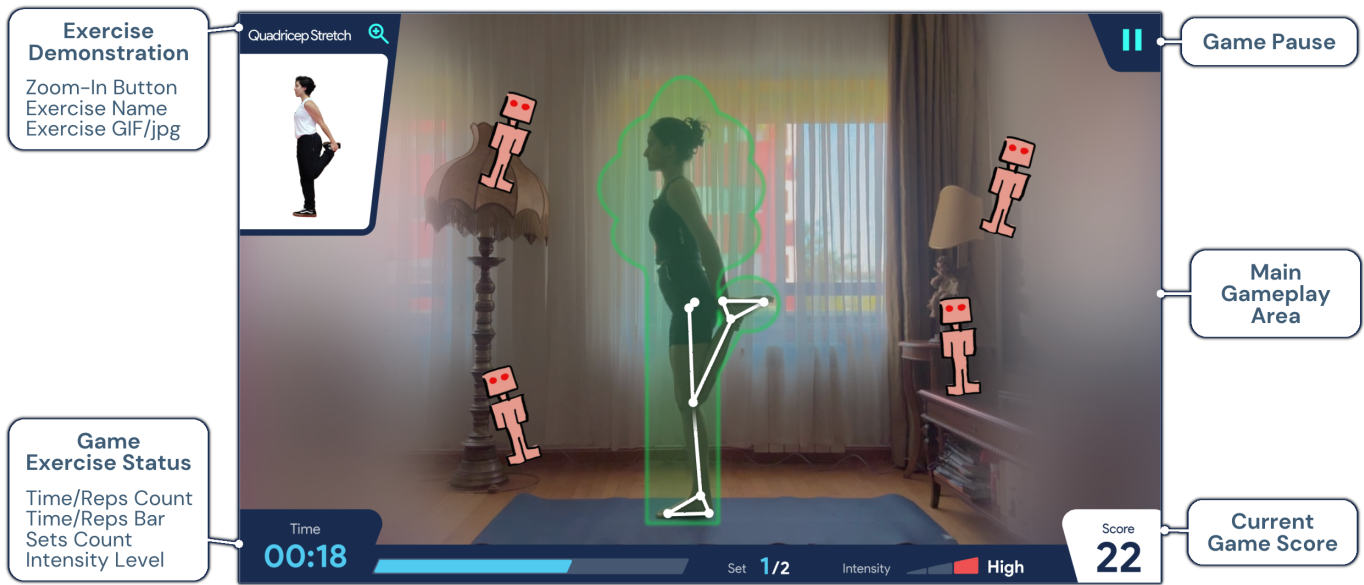


Fig. 2: A user interface layout for *The Spy*, depicting a player performing a knee bend. The interface includes an exercise demonstration in the top-left corner, a game status display, a pause button, the main gameplay area, and the current score.

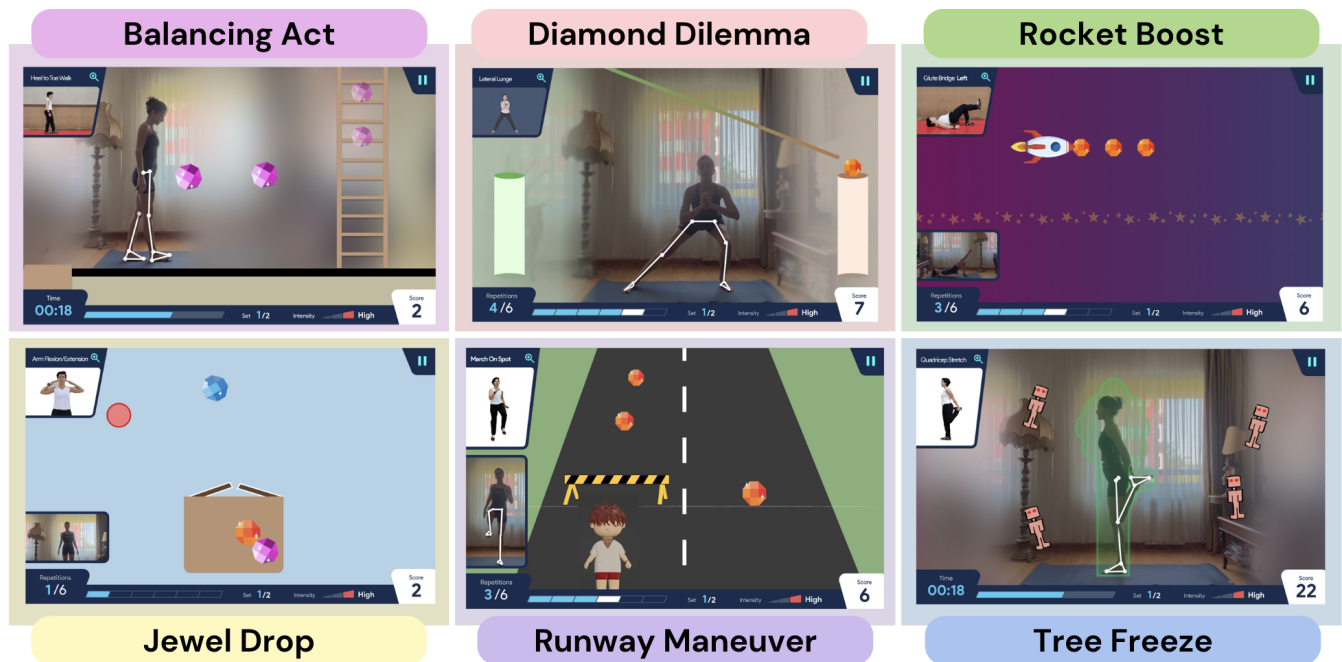


Fig. 3: Prototypes of six flow-based interactions in the *The Spy* game: Balancing Act, Diamond Dilemma, Rocket Boost, Jewel Drop, Runway Maneuver, and Tree Freeze.

1) *Zen Forest Interactions*: During the main Yoga sequence, players engage in a series of interactive moments with the virtual forest environment (see Fig. 6):

- **Forest Spirits**: Gentle animals land on the player's shoulder during balancing poses, reinforcing focus.
- **Wind Whispers**: Spine twists trigger synchronized wind currents with breath-paced audio cues.
- **Bell Flowers**: Side bends activate chiming bell-shaped flowers hanging from above, guiding smooth stretches.
- **Sun Beams**: Upward-opening poses reveal sunlight beams breaking through the forest trees.
- **Falling Leaves**: Forward bends cause gentle leaf falls, encouraging calm transitions.
- **Forest Totems**: Grounding poses build stacked ancient

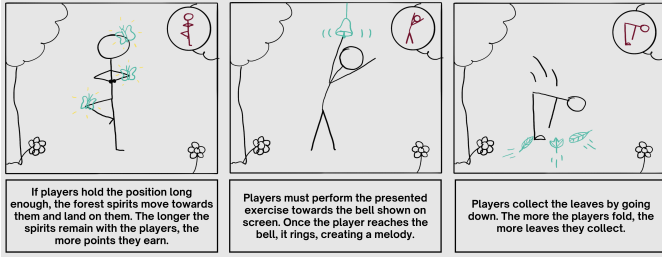


Fig. 4: A storyboard from *Zen Forest*, showing three key exercises: steady pose, reaching, and bending.

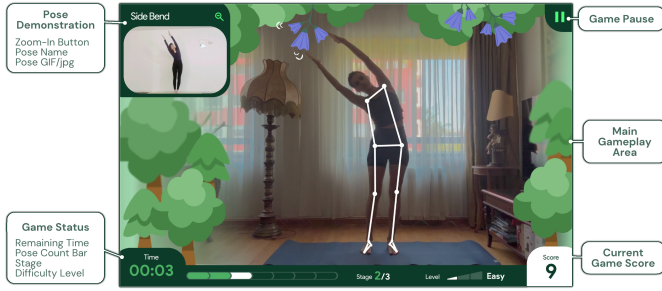


Fig. 5: A user interface layout for *Zen Forest*, depicting a player performing a side bend. The interface includes a pose demonstration, a game status display, a pause button, the main gameplay area, and the current score.

forest stones symbolizing strength and endurance.

2) *Rationale for the Zen Forest Interactions*: The game offers a progressive sequence developed in collaboration with a yoga specialist, including three distinct levels: beginner, intermediate, and advanced. Each level includes four guided flow sequences (lasting approximately 5 to 8 minutes), composed of specific Yoga postures. During gameplay, one sequence is selected internally by the game, following a consistent three-stage format: a) an initial diaphragmatic (deep belly) breathing phase; b) a main flow phase performing the selected yoga poses; and c) a final relaxation phase in *Savasana* (corpse pose) for deep rest and recovery. The beginner level focuses on gentle mobility, relaxation, and body awareness, with poster holds of 30–45 seconds. As players progress to intermediate and advanced levels, sequences become more physically challenging, with longer posture durations (up to 1 minute), increased flow complexity, and stronger focus on breath control and muscular engagement. Similar to the mesocycle progression in *The Spy*, this structure allows for gradual progression, accommodating different player abilities while promoting body-mind integration through movement and breath.

#### IV. IMPLEMENTATION CONSIDERATIONS

The game suite is developed for mobile devices (smartphone and/or tablet). To enable full-body interaction, the proposed exergames may apply MediaPipe, a Google open-source framework developed for real-time pose estimation

[12]. MediaPipe uses the device’s camera to track key body landmarks such as joints, limbs, and posture, making it an accessible and cost-effective solution for home-based rehabilitation. The MediaPipe has proved its accuracy and reliability in different environments, similar to our proposal [13], [14], making it a strong candidate to enable pose estimation in the proposed games. For instance, Latreche et al. [13] present the use of MediaPipe to determine range of motion in motor rehabilitation, comparing a (remote) web-based tool with two traditional *in-loco* instruments: goniometer and angle ruler. Results with 50 volunteers were satisfactory, as the MediaPipe approach fared as well as the traditional approaches, proving its accuracy and reliability. The web-based tool was even deployed in a patient case study, also with satisfactory results. Simoes et al. [14] present another use of the MediaPipe library, this time integrating it in a framework to identify different poses in real-time, thus helping people perform different physical therapy exercises. The angles of different joints are calculated and then a classifier is used to evaluate if they reflect a given pose. This approach directly aligns with our proposal, thus also proves the applicability of MediaPipe to aid implementation of the described exergames.

The games will be developed using the Unity<sup>2</sup> engine, thus the MediaPipe Unity Plugin<sup>3</sup> can be used. This plugin enables real-time full-body tracking using smartphone or tablet cameras, allowing developers to translate physical poses into interactive game inputs. As conveyed before, this data can help infer joint angles and detect specific movement patterns such as squats, arm raises, or stretches. Once identified, these movements can be mapped to in-game actions, making gameplay responsive and immersive. To ensure correct pose estimation, the games should inform players about an adequate distance and position of the mobile device in a calibration phase, to ensure that all applicable joints are visible and tractable throughout the game session. As experimentally verified on some devices, a full-body frame can be achieved by placing the mobile device at a distance of about a meter from the player, which should be manageable even by patients with limited mobility. If the player falls out of the frame, the game should warn about this undesirable event with sound and/or a visual prompt.

The exergames may also record a set of performance and biomechanical metrics during each session, some related with user engagement and others with clinical evaluation. Performance-related data include the game score and level achieved, while session information captures its duration. In terms of movement and biomechanics, the system may track average joint angles, average movement speed, and a detailed joint array containing 3D coordinates for each tracked joint. All these data will be stored in a MongoDB database, using OAuth via Keycloak for the app authentication. Consent will be needed from each participant to cover data collection,

<sup>2</sup><https://unity.com/>, accessed: 2025-09-11

<sup>3</sup><https://github.com/homuler/MediaPipeUnityPlugin/wiki/Getting-Started>, accessed: 2025-07-11





Fig. 6: Prototypes of six flow-based interactions in the *Zen Forest* game: Forest Spirits, Bell Flowers, Falling Leaves, Sun Beams, Wind Whisperers, and Forest Totems.

storage, and processing. The games should be deployed in mobile distribution platforms, such as the Google Play Store<sup>4</sup>, as an integrated part of the iPROLEPSIS Game Suite app.

## V. DISCUSSION

Exergames have increasingly been proposed as complementary treatments for a variety of health conditions, with previous studies revealing their potential to complement conventional therapy, while being highly engaging/motivating [15], [16]. Even so, the same studies also suggest a high discrepancy in the results, which means more studies are needed to validate exergames as therapeutic tools. Several areas for improvement remain, which we take into account in the development of the *The Spy* and *Zen Forest* exergames, designed to promote physical activity/exercise in individuals with PsA.

Firstly, Ruth et al. [17] highlighted key challenges such as cost, adherence, and the need for customization. Using Media Pipe allows game creation without specialized equipment, making these interventions cost competitive with traditional rehabilitation programs [18]. Furthermore, full-body tracking enables the collection of detailed movement data that can be used to monitor patient progress over time, adapt exercise plans based on performance metrics, detect asymmetries or movement limitations, encourage adherence through gamified feedback, and provide personalized recommendations. Adherence can be improved by designing engaging storylines [19] and appropriate difficulty levels and progression systems, eventually leveraged by Dynamic Difficulty Adjustment [17].

This is also part of our future work and an area we intend to refine further. Customisation is essential, particularly in healthcare applications. In this regard, co-designing games with patients and clinicians ensures that exercise intensity and gameplay mechanics are tailored to individual needs and therapeutic goals. The exergames *The Spy* and *Zen Forest* are currently under development and will be integrated into a formal clinical trial to evaluate their therapeutic effectiveness for patients with PsA.

## VI. CONCLUSION AND FUTURE WORK

This work outlined the conceptual and design framework of two full-body exergames, *The Spy* and *Zen Forest*, designed to promote physical activity/exercise in individuals with PsA. In *The Spy*, players act as undercover agents and complete a sequence of physically engaging missions, designed to stimulate dynamic body movement that boost coordination and enhance mobility, balance, strength, and flexibility. In *Zen Forest*, players perform slow and calm stretching routines inspired by Pilates and Yoga exercises, improving their flexibility, relaxation, and body awareness. By translating conventional physiotherapeutic exercises into interactive, gamified environments, these exergames aim to improve adherence, engagement, and physical function. The incorporation of real-time body tracking not only enhances gameplay immersion, but also offers novel data sources for quantitatively capturing user movement data, laying the groundwork for objective, longitudinal monitoring of therapeutic progress.

Future work will involve clinical evaluation of both exergames through iterative preliminary usability studies, con-

<sup>4</sup><https://play.google.com/store/games?hl=en&pli=1>, accessed: 2025-09-10

ducted across four European clinical centers over a three-month period. This will assess therapeutic efficacy, functional outcomes (e.g., joint mobility, pain levels), and behavioral metrics such as engagement and adherence. Additionally, the data captured via motion tracking will be analyzed to determine their validity as digital biomarkers to monitor the PsA progression and the response to rehabilitation, thereby contributing to the growing field of digital health interventions for chronic rheumatic conditions. Moreover, the proposed serious games are developed in the context of the iPROLEPSIS Horizon Europe project, which also aims to construct game-informed clinical dashboards for PsA monitoring, that can be used to recommend game sessions. Post-validation, subsequent development will integrate data-driven metrics and monitoring capabilities into the dashboards, supporting clinicians in tracking therapeutic outcomes and recommending personalized exergame interventions for PsA.

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