

FitFest: Designing a Narrative-driven Exergame to Engage Active Seniors in Physical Activity

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Abstract

Exergaming is a modern approach frequently used to promote physical activity at all ages while playing digital games. Given that physical health deteriorates with age, that older people tend to live sedentary lifestyles and that they get tired faster due to lack of physical stimulation, maintaining a healthy lifestyle and regular exercise routine is important to avoid unintentional injuries. Taking into account interviews and a focus group with seniors and fitness professionals, this paper reports on the design and development of an exergame for seniors to complement their weekly exercise classes. Fit Fest is an exergame for seniors that leverages narrative and sociocultural connections to create an engaging exercise experience.

CCS Concepts

• **Human-centered computing** → **User centered design**; • **Applied computing** → **Consumer health**; • **Social and professional topics** → **Seniors**.

Keywords

Exergames, body tracking, virtual reality

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1 Introduction

Engaging in regular physical activity (PA), leads to an improvement of physical and cognitive capabilities and increased life expectancy [16]. However, the rates of physical inactivity have been rising over time, with 31% of adults worldwide not engaging in PA [32]. Inactivity and unhealthy ways of living can result in the gradual advancement of chronic illnesses and limited mobility, increasing the morbidity, disability, and mortality rates among older adults [16, 29]. Regular physical exercise can successfully enhance mobility in adults over 65, mainly to prevent falls and fall-related injuries [1, 29]. The World Health Organization (WHO) recommends that adults aged 65 years and above should engage in at least 150 to 300 minutes of moderate-intensity aerobic physical exercise per week [1]. These aerobic exercises use large muscle groups in a rhythmic and repetitive flow, focusing on breath and heart rates increasing during these activities [2]. These adults should exercise at least twice to three times a week, 50 minutes per day, to enhance their quality of life [1]. However, there is a low adherence rate to traditional exercise programs among older adults [13].

Thomas et al. [33] interviewed older adults who attend senior gyms; their findings report that motivation for attending is connected to a fear of getting old, physical and psychological wellbeing,

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a sense of purpose and a socially motivating environment. Similarly, Lübcke et al. [23] highlight that while a need to take control of their life/body is a motivator for starting to exercise, the health and social benefits of attending senior gyms are important motivators for frequency. Both studies highlight the importance of trained professionals in connecting seniors to the gym, to their exercise routine and between themselves.

Research in this field has also looked at introducing technology in different settings (e.g., senior gyms, rehabilitation centers, supported living facilities, etc.) to engage seniors in PA. While playing videogames has been widely connected to inactivity and sedentary behaviour, the rise of exergames in recent years is changing this perspective due to its motivating elements [25, 28]. Exergames, which combine PA requirements with digital gaming attributes, have been demonstrated to be as effective or even more beneficial than traditional fitness programs in enhancing older adults' physical and cognitive abilities [17, 27, 31]. These games are designed to provide a more enjoyable and motivating PA session by including entertaining elements [15]. Considering an older population, there is a need for exergames to be designed having in mind the needs and limitation of the end users [19] by engaging not only seniors, but professionals who support them [12]. Therefore, we conducted semi-structured interviews with fitness professionals (who train seniors) and a focus group with seniors who attend senior fitness classes. Our findings call attention to not only the specific needs for conducting these types of classes, but also to the role these classes have as sociocultural connectors. Inspired by the needs of end-users, we designed an exergame for older adults (without disorders/impairments) to complement their current exercise practice. Fit Fest uses a projector-based display and motion tracking hardware to allow for full-body standing exercise; the single player experience engages seniors in sociocultural themes as they progress through a series of minigames. While we plan to evaluate our system with seniors in the future, the current description is useful for researchers interested in designing exergames based on users' needs.

2 Literature Review

Introducing game technology in gym settings offers a socially engaging, active and innovative training experience. For example, *Exergame Fitness* provides interactive floor and wall games, dance, step games, strength and cardio workouts for organizations and health centers [6]; *Exergame4D* provides competitive group exercise sessions in a supervised room with interactive floor projections, offering immediate performance feedback and focusing on cardio, weight training, or both [5]. Gaming elements have also been incorporated in the context of rehabilitation as it is an effective strategy for improving patient exercising motivation [20, 34]. For example, the *NeuroRehabLab AHA* (Augmented Human Assistance) project combines familiar mechanics and traditional Portuguese elements through a mobile Robotic Assistance Platform with Augmented Reality (AR) and serious games to enhance senior fitness [3]; the Sinai Residences in Boca Raton provide MultiBall exergames designed to improve senior's motor coordination, balance, agility, and cognitive abilities through interactive screen-based ball games [18].

Combining narratives with exergames can create new possibilities for players' connection to the character(s), adherence, motivation, and behaviour during gameplay [22]. *RingFit Adventure*, a narrative-based exergame, uses two external devices, a Ring-Con, and a leg band, with Nintendo Switch controllers to precisely monitor movements [9]. In this exergame, players level up by using exercise-based attacks to defeat enemies, earning experience points and ingredients for the character's energy-recovering milkshakes [9].

Past exergames have taken advantage of eXtended Reality (XR) technology to create immersive scenarios for play. Using four walls to project different perspectives of a game scenario at 90-degree offsets, provides the players with an immersive Cave experience, allowing the exploration of different mechanics and movements, without compromising physical movement [14]. For example, *Exercube* adopts a training concept that gives participants a variety of six games focused on various forms of exercise with an enjoyable workout experience, while enhancing their physical and mental capabilities [4]. Using Virtual Reality (VR) technology to gamify PA can induce positive emotions in players [30]. *Supernatural* and *FitXR HIIT Studio* are great examples of this approach. In *Supernatural*, the player exercises in stunning 360-degree landscapes, striking targets in boxing or rhythm-based workouts, with intensity tailored to their capacities from low, medium, and high intensity [8]. *FitXR* comprises seven games that focus on various body workout strategies, including boxing, combat, and dance, to mention a few [7]. Karaosmanoglu et al.'s [19] systematic review of eXtended Reality (XR) exergames not only summarized the current landscape as a taxonomy to describe these games, but also highlights research concerns and directions. Among other findings, they advise considering sociocultural contexts and interactions when designing exergames.

3 Methodology

To better understand our target audience's needs and sociocultural contexts, we engaged with professionals and older adults involved in physical exercise classes. As such, we conducted qualitative data collection methods like semi-structured interviews and focus group. All procedures implemented in this study were approved by the Ethics Committee of the University of Madeira. Participants were recruited through convenience sampling and by direct contact with institutions. Each participant received an informed consent form, explaining the context of the study and their rights as participants. All interviews were audio recorded and transcribed.

To identify and understand the exercise variations across institutions, we interviewed a fitness gym professional who works with senior clients, two professionals who teach fitness classes in a Senior University (a community center for seniors with an educational component) and seven seniors who frequent fitness classes in a community center. This required different methods and questionnaire (see table 1). Given the small number of professionals, we conducted semi-structured interviews with the professionals. Given our desire to understand the influence of social factors, we conducted a focus group with the older adults, as focus groups are ideal because they facilitate group interaction and easier self-expression [11, 26].

Table 1: Research Details

Establishment	N°. participants	Method	Identity Code
Fitness Gym	1	Semi-structured interview	P1
Senior University	2	Semi-structured interview	P2, P3
Community Center	7	Focus Group	FG1-7

In the semi-structured interviews, we aimed to explore: 1) population (demographics, health, lifestyle, and engagement); 2) professional's experience (qualifications and challenges); 3) motivation and benefits (factors, scenarios, social, cognitive and physical benefits, and participant withdrawal); 4) plan structure (challenges, and objective progression); 5) class structure (introduction of new exercises, group dynamics, preferred exercises, and exercise variation); 6) physical assessment (parameters, health conditions, and medical reports); 7) games (mechanics, familiarity, PA stimulation, and interaction considerations); and 8) technologies and equipment. In the focus group, we aimed to explore: 1) seniors' experience (adherence, health, routines); 2) motivation and benefits; 3) games (preferences, single or multi-player); 4) technology preferences; 5) visuals (appearance, elements); and 6) narratives (interests, and perspective). We supported the seniors in understanding the technologies in exergames during the focus group by using simple language and YouTube videos. We also included pictures for seniors to identify and recognize the accessories they use most frequently during exercise classes.

4 Results

4.1 Semi-structured Interviews with Professionals

Through the semi-structured interviews performed with professionals, we were able to pinpoint specific details about older adults that should be considered (e.g., motivations, digital tools they interacted with regularly, exercise programs, and recommendations for working with this target population). Seniors attend these classes mainly for health-related reasons, such as staying active, leaving the house, and socializing. To reinforce their motivation, gatherings are organized on important events (e.g. during Christmas holidays). Regarding the methods used by professionals in the classes, both environments have confirmed that the exercises should be tailored to accommodate the individuals' capacities, considering each person follows a different routine and, therefore, has varying levels of mobility. According to P1, *"What we do is plan a standard class, which everyone can follow, and then we create some progressions of some exercises or regressions of some exercises."* Therefore, professionals typically offer three difficulty levels: easy, standard, and advanced. For fitness classes in the Senior University, according to P2 and P3, each session lasts 45 to 50 minutes, is held twice a week, and includes a 10 to 20-minute warm-up session, 20 to 30 minutes of cardio and strength, and a 10-minute relaxation. The primary goals are to improve strength, mobility, and motor coordination in senior participants. Frequently used materials include weights, chairs, elastic bands, and balls. These exercises are important because *"The objective of classes for seniors is always to make their day-to-day life*

more comfortable." (P1). As P1 has stated, in the gym setting, they take extra effort to replicate real-world actions and movements in their classes (e.g., picking up groceries or a grandchild). Since most older adults have orthopedic conditions, we should avoid intense exercises, such as jumping, when creating an exercise program for them. However, they dislike the thought of them being incapable of doing the exercises. Therefore, it is crucial to motivate them to improve by progressively increasing the physical complexity of the exercises. Interviewees also stressed the need to use simple, familiar language and clear communication to accommodate the cognitive limitations of older adults. Finally, P2 added that older songs from the seniors' youth that they enjoy are typically played in class to motivate them. These songs have a beat range of 128 to 145 beats per minute (BPM).

4.2 Focus Group with Seniors

Regarding the focus group, participants reported that they attend these programs two to three times per week. While participating in the activities, they usually adjust the execution of the exercises according to their capacities because they *"(...) used to do it in 2 minutes and now do it in 10"* (FG1). Outside the classes, they try to be physically active by doing other activities, such as walking for 30 to 60 minutes. The characteristics of narratives the seniors find more appealing are stories similar to real-life events, along with familiar cultural elements, given they expressed their enthusiasm for this theme and shared some of their personal experiences with traditional customs *"I took the grapes from my backyard, threw them into a bucket, stepped on them and drank the wine!"* (FG2). While showcasing videos of the different exergames mentioned in a previous section of this document, the projection on the wall and/or the floor was the preferable choice for a digital and interactive experience amongst the group interviewed. Overall, their high regard for these classes and agreement that exergames are beneficial for those *"who do not or can not leave the house"* (FG3), contributes to the impression that they would prefer to stay in traditional classes. Considering this, their thoughts on the use of technology in these sessions are primarily focused on blending in regular exercise programs or covering for traditional class absences during the Christmas season, for instance.

5 FitFest Design & Development

Considering the findings from the qualitative methods and existing literature on exergames for seniors, we designed and developed Fit Fest, an exergame leveraging sociocultural narratives to create an engaging, effective, and enjoyable physical exercise environment. Interviewees expressed their preference for "familiar concepts" from daily life, which could be portrayed in visual elements, a storyline, or an overall concept. Given the social importance of



Figure 1: Wine Fest minigames in Fit Fest

holidays and festivities for seniors, we pursue this idea by incorporating traditional festivities from Madeira Island into the gameplay. As a result, this single-player exergame was named Fit Fest because of the combination of fitness with festivities.

Aesthetics and functional game design decisions were adopted following the feedback from the qualitative methods. Considering the insights from the focus group session regarding technology preferences, we used a projection on the wall with the support of three HTC Vive trackers and two wands to track key joints of the gamer's body (hips and feet + hands) [10]; due to safety concerns concerned with VR systems, using a projection is beneficial for seniors as it allows more mobility and avoids issues with balance when playing in immersive setups that limit senses. We chose a 2.5D design which includes 3D scenarios and 2D sprites within the overall 2.5D game design. The introduction of 2D animations enhances the scenarios' dynamics, while the 3D environments enable the player to move forward and laterally. The exergame was built using the Unity game engine.

To prevent Fit Fest from becoming a typical workout program, we wanted to incorporate storytelling to establish a connection between the players and the character's stories and experiences. The player follows a main character, a local 65-year-old resident who wants to rediscover youth and escape the monotonous daily routine by engaging with PA and experiencing new things. For that, the character creates a bucket list of four local cultural events. Each festivity is composed of five minigames chronologically attached to the festivities' events. For example, the Wine Fest minigames (see fig. 1) follows a wine-making process, requiring players to follow a session plan to progress through the mini games. Minigames for the other three local cultural events are similarly themed to the topic of the festivities.

The session plan, validated by a physical fitness expert and aligned with the structure of senior gym classes, lasts 45 to 50 minutes and includes a warm-up, followed by cardio and strength exercises, ending with a cool-down phase. We gamified the exercise sets to replicate real-world movements, similarly to what P1 claimed to employ in gym classes, integrated with the narrative (e.g., seniors must squat to place grapes in a basket). To allow replayability, we made the elements and obstacles appear randomly during gameplay. To stimulate seniors' memory, we included mechanics to engage their cognitive abilities, such as catching specific items, as well as puzzles of each mini-game poster.

Finally, to address the seniors' need for clear instructions, highlighted by the interviewees, we included a mandatory tutorial before each minigame, simulating the exercise and ensuring understanding of correct posture. Similarly to the approach used by professionals

in their classes, Fit Fest recognizes the different capabilities of senior players and provides three difficulty levels (easy, standard, and hard) to tailor exercises to individual mobility and progression.

6 Discussion

Previous research suggests that exergames improve the players' physical health and raise motivation to practice PA [21]. In designing Fit Fest, we focused on creating a user-friendly experience by applying research findings on the user experience and motivation. Participants preferred familiar cultural concepts and emphasized the importance of social interaction in staying active. Additionally, adapting the exercises to individual capabilities and using a simple, intuitive interface are essential for seniors.

Fit Fest was designed to complement our users' weekly classes (or replace them when instructors are not available), as they highlighted the value of these sessions during interviews and focus groups. This method allows the exergame to be more accessible for independent use at community centers with minimal reliance on external assistance (e.g., instructors, who are already overburdened). While we recognize the importance of social interaction, we prioritized single-player gameplay due to the intricacies of tracking multiple bodies.

Several design elements were particularly difficult to incorporate. Firstly, Karaosmanoglu et al. [19] describe several ways in which to adapt task in exergames which was also reported by professionals who highlighted the importance of adapting exercises to seniors' abilities. Given the exploratory nature of this prototype and the complexity of designing adaptations for diverse users, we implemented a subjective-rating based adaptation (three difficulty levels) that is chosen by the player. This approach is a simpler adaptation for our setup (e.g., no physiological instruments needed, no support staff, no desire to force player to overexert themselves); yet further testing is needed to determine if the difficulty of each level is appropriate for the target population. Secondly, tasks in minigames are often monotonous due to repetitive movements over an extended period; we try to overcome this by incorporating different task types (as described by Karaosmanoglu et al. [19] and random game events (e.g., obstacles) to keep the player engaged.

7 Future Work & Conclusion

We designed Fit Fest, a full-body exergame for seniors that combines physical and cognitive engagement with a narrative about cultural festivities. Through our qualitative analysis and following Maedche et al. [24] approach, we mapped the problem space by considering the needs and challenges seniors might face when interacting with exergames. Similar to previous research [23, 33], our findings reveal the importance of accessibility, social interaction

and sociocultural settings have in seniors' motivation to exercise. Because of this, the single-player design reveals potential reduced engagement, which can be enhanced by the surrounding environment and integrating motivational features. We will evaluate the prototype with seniors in the context of the community centers not only to incorporate gameplay feedback but also to understand how this type of exergame can be deployed in real-life settings.

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