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**LAURA CAMPOS
GUSTAVO DE
MATOS**

**AN INTERACTIVE PRODUCT TO
ENHANCE ELDERLY PEOPLE'S
SELF-ESTEEM**

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ENHANCING THE ELDERLY'S SELF-ESTEEM THROUGH AN INTERACTIVE PRODUCT

Dissertação apresentada ao IADE - Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia, para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Design do Produto e do Espaço realizada sob a orientação científica da Doutora Hande Ayanoglu, professora auxiliar do IADE - Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia e do Doutor Rodrigo Hernández-Ramírez, professor auxiliar do IADE - Faculdade de Design, Tecnologia e Comunicação da Universidade Europeia.

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palavras-chave

Produto interativo, idoso, auto-estima, atividade física,
Estímulo cognitivo, ux

resumo

Esta dissertação explora o envelhecimento e o envelhecimento ativo, investigando os vários fatores influenciadores da auto-estima, e a dimensão dos efeitos

de *gameplay* no aumento da auto-estima nos idosos. Cobriu, brevemente, os efeitos de videogames na performance cognitiva dos idosos, e explorou, em mais detalhe, o efeito de *exergames* (como por exemplo, jogos na Nintendo Wii) na performance física e cognitiva dos idosos. Alguns benefícios foram identificados, no entanto, ainda há espaço de melhoria, visto que *exergames* não proporcionam a intensidade de exercício recomendada, e oferecem baixos benefícios cognitivos. Adicionalmente, foi abordada a problemática do baixo uso de *exergames* em grupos de idade mais avançada apesar dos seus benefícios. Para resolver estas questões, foi sugerida uma abordagem de Human Centered Design com foco na experiência do utilizador. Neste contexto, este estudo também incluiu entrevistas com peritos e um questionário para os utilizadores-alvo, de modo a melhor compreender os hábitos de exercício, dores, incentivos, preferências e nível de autoestima dos mesmos. Esta dissertação também resultou numa ideia de produto, um produto interativo que disponibiliza exercício físico, fisioterapia e exercício cognitivo com orientação profissional e de maneira divertida e desafiante.

Keywords

interactive product, elderly, self-esteem, physical activity, cognitive stimuli, ux

abstract

This dissertation explored ageing and active ageing, discussing the several factors that influence self-esteem and the extent of the effects of gameplay on enhancing self-esteem in the Elderly. It briefly looked at the effects of video games on the Elderly's cognitive performance and took a deeper look at the effects of exergames (e.g., played on Nintendo's Wii platform) on the Elderly's physical and cognitive performance. Some benefits were perceived. However, there is room for improvement as exergames do not provide the recommended exercise intensity and offer low cognitive benefits. Furthermore, it addressed the issue of low use of exergames in older age groups, despite their benefits. To solve these issues, a Human Centered Design approach with focus on user experience was suggested. In this context, this study also included expert interviews and a user questionnaire to better understand the target users' exercise habits, pains, motivators, preferences, and self-esteem level. This dissertation also resulted in a product idea: an interactive product that offers physical exercise, physical therapy, and cognitive exercise in a fun and challenging way, with professional guidance.

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1.Introduction

1.1 Framework

Over the last decades, there has been a continuous increase in ageing population worldwide, and with it, an increase in people whose self-esteem, physical and cognitive capabilities deteriorate faster over time (Azevedo, 2015; Soeiro, 2010). Simultaneously, there has been a growing interest in the study of well-being. Several studies about the Elderly's overall well-being (e.g., Robins et al., 2002; Tresniewski et al., 2003; Chodsko-Zajko, 2009; Orth et al., 2010; Becker, 2013) have been conducted as well as some attempts to develop products that improve it (Liu et al., 2018). Research has been done to understand how Elderly's well-being may be positively affected by self-esteem (e.g., Tresniewski et al., 2003), social contact (e.g., Denissen et al., 2008), physical stimuli (e.g., Becker, 2013; Rodrigues, 2015), cognitive stimuli (e.g., Pruessner, 2009), video gaming (e.g., Ijsselsteijn, 2007) and exergaming (e.g., Kappen et al., 2018). Furthermore, the so-called "active-ageing industry" which includes wellness and fitness technologies, is expected to grow substantially in the coming years (Halpert, 2019). Consequently, there is ample space for research in this area.

Recent studies (e.g., Orth et al., 2010) on self-esteem suggest that Elderly tend to have lower self-esteem compared to younger age groups and that it is further diminished by the decline in cognitive and physical abilities (França, 2015). Other studies have been done to understand whether video games and "exergames" can improve their physical and cognitive abilities. Some of these studies suggest that video games can in fact enhance Elderly's cognitive abilities. However, there is still a debate on whether the cognitive skills gained through video games actually transfer to everyday activities (Cardoso et al. 2017). Comparatively, several studies (e.g., Kappen et al., 2018; Chao et al., 2014; Willaert, 2020) indicate that "exergames" (e.g., played on Nintendo's Wii platform) can have a positive cognitive and physical impact on Elderly people. Despite these positive outcomes, the percentage of Elderly playing them is still low (Loos, 2017), mainly due to lack of interest; however, almost no research has been carried out to understand how User Experience could address this specific issue.

Existing studies about Elderly people and their overall well-being have contributed to the understanding of both the ageing process and the solutions that may appease the biological aspects of it. However, they do not compare the long-term benefits that physical activity through exergaming might provide with those of regular physical exercise. Moreover, the needs and motivations of the Elderly are not always taken into account when proposing video games or exergames as solutions and, as previously mentioned, few studies consider experience when designing such games.

1.2 Problem Statement

The main problems addressed in this study are 1 - self-esteem decline in Elderly people which is aggravated by the lack of physical and cognitive training, and 2 – Elderly people are not adopting interactive products that could solve the former. Consequently, the main question driving this study is *what kind of product can enhance Elderly people's self-esteem?*

1.3 Research objectives

For a product to truly work, it must be accepted by the target users. If it is not being used by the users, it is not really solving the problem. So, the general goal of this study was *to create an impactful product to enhance Elderly people's self-esteem and guarantee its acceptance by Elderly users.*

To achieve this, the specific goals were [1] to understand what factors influence self-esteem; [2] to know the state of the art and identify shortcomings and gaps in those studies; [3] to understand the target users' profile, needs and motivations; [4] to do a comparative analysis of existing products; and [5] to suggest a design concept for the interactive product, using a Human Centered Design approach focused on user experience.

1.4 Research Contributions

This study may be relevant to designers, researchers, and medical and fitness professionals. We argue that, to suggest or design products as a means to increase the well-being of older adults and elderly, more user experience studies should be conducted to better understand their habits, needs, motivations, goals, preferences and struggles before, and while using such a product. This can be achieved by following a Human

Centered Design approach focused on developing a positive user experience that genuinely satisfies Elderly needs and motivations.

Furthermore, an article, “An interactive Product to Enhance Elderly people’s Self-esteem: Results from the User Research Phase” by Laura Matos, Rodrigo Hernández-Ramírez and Hande Ayanoglu, was published and presented at DIGICOM 2021 – 5th International Conference on Design and Digital Communication, that took place on November 4-6, 2021, in Teatro Gil Vicente, Barcelos, Portugal.

1.5 Document organization

This dissertation is divided into 10 chapters which are as follows:

Chapter 1 describes the framework, problem, and research objectives as well as what is proposed as a solution.

Chapter 2 is a literature review that discusses the main research topics of this study, ageing, self-esteem, gameplay, and interactive technologies.

Chapter 3 describes this study’s methodology.

Chapter 4 consists of the customer discovery stage, which includes expert interviews, user questionnaires, personas and a customer segment table.

Chapter 6 describes the competitive benchmark and identifies business opportunities.

Chapter 7 describes the outlook of the eServices, market segment fitness and the total and target market.

Chapter 8 is the design development stage which discusses the definition of product, describes the design requirements, card sorting, navigation plan, wireframes, and UI.

Chapter 9 summarizes the study’s results, and describes its limitations, contributions, and next steps.

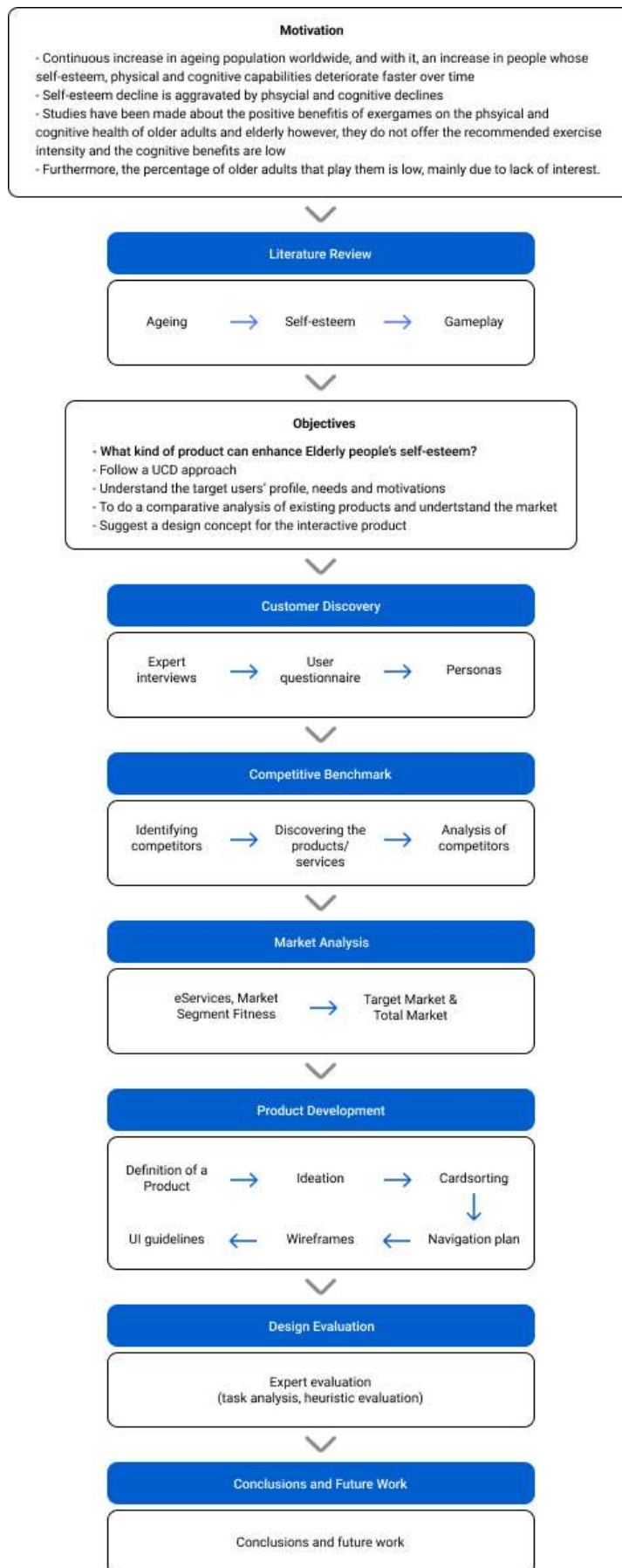


Figure 1: Research diagram

2. Literature Review

2.1 Ageing

The senior population is increasing at a global level, and alongside it, the importance of guaranteeing their wellbeing. WHO states that the pace of demographic ageing is significantly faster in comparison to the past (WHO, 2018). In 2019, according to the WEF, it was recorded for the first time, at a global level, a larger number of people over 65 years old than people younger than 5 years old (WEF, 2019).

Furthermore, during this life stage, people tend to suffer decreases in excitement, motivation, self-esteem, and self-image. This may lead to social isolation, inactivity, pessimism, and somatic complaining (systematic complaining regarding physical issues caused by thoughts and feelings) (Becker, 2013).

2.1.1 Active Ageing

Active ageing came to help lessen the symptoms of human ageing. WHO defines active ageing as enabling well-being in older age by maintaining and improving functional ability (WHO, 2020). This encompasses the elderly's functional capabilities to meet their basic needs; to learn; to make decisions; to be mobile; to build and maintain relationships; and to contribute to society (WHO, 2020). In more detail, the functional ability is compromised by the elderly's intrinsic capacity (i.e., mental and physical capacities), environmental characteristics (i.e., characteristics of their home, community, and society), and the relationship between them.

Furthermore, the active-ageing industry which includes wellness and fitness technologies is expected to grow substantially in the coming years. For instance, in the US alone, it is expected to triple to almost \$30 billion from 2019 to 2022 (Halpert, 2019). This growth is also a consequence of the silver economy in which older adults constitute a new consumer group that must be catered to (ISOfocus, 2017, p. 7-13). For instance, the fitness industry, which used to target people under 40, will launch new products and services to meet this consumer group's needs (e.g., maintain or improve physical and cognitive functions as well as self-esteem, prevent diseases, and lessen chronic pain) and goals (e.g., maintain a healthy and active life) resulting from the increasing life expectancy (*The Older Population Is Set To Transform The Fitness Industry*, 2018).

2.2 Self-Esteem (SE)

SE is the confidence in one's own worth (self-respect) and abilities (self-efficacy) (Branden, 1997).

SE should be assessed by evaluating SE level along with SE stability. Firstly, SE levels are related to the person's general feelings, and are evaluated as high and low. Secondly, some define SE stability as the magnitude of short-term fluctuations of the base level of SE (fluctuations that occur in people's current based feelings of self-esteem and in a certain context) (Seery et al., 2004), while others define it as the magnitude of short-term or long-term fluctuations (fluctuations that occur slowly and during an extended time period) (Baumeister, 2013, Chapter 9). Additionally, SE stability can be evaluated as stable or unstable. Therefore, considering both the level and stability of SE, the most used classifications are stable-high SE, unstable-high SE, stable-low SE, unstable-low SE.

2.2.1 Self-Esteem Predictors

After analyzing literature, 8 factors that influence SE became evident, [1] age and gender, [2] the big five dimensions of personality, [3] loneliness, [4] social contact, [5] wealth, [6] health and perceived health, [7] physical activity and physical exercise, [8] cognitive performance.

Age and Gender. The literature suggests that the way SE fluctuates throughout the lifespan of a person is universal (Robins et al., 2002; Tresniewski, 2003; Orth et al., 2010). Furthermore, while age appears to affect both SE levels and stability, gender only seems to affect SE levels.

Robins, R et al. (2002) argue that SE is high in childhood, decreases in adolescence (especially in girls), increases during adulthood (women on average have lower SE) until it peaks at 60, and then starts to decline. Additionally, some studies suggest that, when people reach their 80s and 90s, the SE level of men and women converge (Robins et al., 2002; Orth et al., 2010). Moreover, another study shows that the Elderly of ages between 75 and 84 years old present the highest loneliness levels, followed by the ages of 85+ and then the ages of 74- years old (França, 2015).

Regarding SE stability across the life span, some studies (e.g., Tresniewski, 2003) show that SE stability is low in childhood, increases in adolescence and young adulthood, and declines in midlife and old age, and that gender is not a factor.

Personality. Few studies have analyzed the connections between self-esteem and personality, and thus it is still a debated topic. However, the results of a study conducted by Besser et al. (2015) suggests that self-worth is associated with perceived personality features. In their studies, the level and stability of self-esteem were associated with the levels of the five dimensions of personality (extraversion, emotional stability, agreeableness, conscientiousness, and openness). The participants with stable high SE were the ones with high levels of the previously mentioned variables, and the participants with stable low SE reported low levels of said variables.

Wealth. Wealth, also referred to as material circumstances, is based on the amount of income. According to Ball & Chernova (2007), several studies support the hypothesis that absolute income (the individual's income) and relative income (income level relative to other people in the country) are positively correlated with happiness. Furthermore, relative income has a greater weight on happiness. However, the effect that income has on SE is lesser than other factors such as relationships, jobs, and health (Ball & Chernova, 2007).

Loneliness. Loneliness is the negative feeling of not meeting the desired amount of social contact and feeling inadequate to do so. It is a subjective experience and can be felt more (or less) deeply depending on the individual's perception of his situation and loneliness. It can lead to health problems, poor quality of life, increased mortality and the need for social support and health care. Furthermore, it is influenced by social, personal, and situational determinants (Fernandes, 2010) such as sociodemographic factors; residential area; wealth; health, diseases, and perceived health; life events; frequency of visitations, and level of activity (França, 2015).

Studies show (e.g., França, 2015) that, on average, the elderly that live in their own homes are less lonely than institutionalized elderly. Furthermore, the elderly living home alone feel lonelier than the ones living at home with their families. Besides, divorced elderly present the highest levels of loneliness, followed by the widowed, the single, and the married (or in equivalent situations).

Regarding the residential area, a study (França, 2015) conducted in Portugal showed that the elderly living in small villages feel the loneliest, followed by the ones living near a bigger village, and then by the ones living in bigger villages. Additionally, stressful life events (e.g., deteriorated financial situation, being a widower) (Vozikaki et al., 2018) and

rare visits from family members (França, 2015) tend to make elderly feel lonelier. Furthermore, the elderly who occupy their day with activities or engage in more social activity feel less lonely (França, 2015).

Social Contact. In accordance with the previous topic, several studies show that social contact influences SE. Denissen et al. (2008) states that the quantity and quality of intrapersonal interaction (relationship with oneself by thinking, interpreting and analyzing things) significantly predicts the fluctuations in SE throughout the day. Additionally, people with a good quantity and quality of interpersonal interaction (interaction with others) show higher levels of SE. The same authors also establish a connection between social inclusion and SE. They suggest that people have a need of belonging in both close and less close relationships, and such is achieved through regular interpersonal relationships.

Health and Perceived Health. Health implies both physical and mental health. Studies show that having diseases at a physical and/or mental level (e.g., depression) lowers SE and can also increase the feeling of loneliness. Perceived health also plays an important role. The Elderly who perceive themselves as healthy have a higher SE and feel less lonely (França, 2015).

Physical Activity and Physical Exercise. Physical activity is defined as any body movement produced by the contraction of skeletal muscles that increase energy expenditure whereas physical exercise is a repetition of movements which are previously planned and structured in order to help improve or maintain the individual's capacities, e.g., aerobics, strength, flexibility, and balance exercise (Chodzko-Zajko, 2009).

Studies (e.g., Becker, 2013) suggest that the quality of functional (physical) capacities influence mental health in the Elderly. Unfortunately, a consequence of ageing is a gradual decrease in functional capacity which, in turn, leads to a decrease in the level of physical activity. The same author mentions that aging causes loss in muscle, bone mass and flexibility. This occurs mainly in the ankles and hip which increases the risk of falling and sedentarism. The author concludes that the disuse of muscle, as a consequence of ageing; diseases, and lack of motivation to perform activities worsen the person's condition.

On a more positive note, Chodzko-Zajko et al. (2009) add that further evidence supports that regular participation in physical exercise by older adults leads to psychological and cognitive benefits, as well as helps increasing active life expectancy

by countering the development and progression of chronic diseases and other disabling conditions. Moreover, the authors suggest that older adults should perform aerobic, muscle strengthening and flexibility exercises as much as their condition allows. They mention that some physical activity will always have positive health outcomes. However, they emphasize that by increasing exercise frequency, intensity and duration, the health benefits will be greater.

Finally, several studies (e.g., Becker, 2013; Rodrigues, 2015) prove that older adults who perform physical exercise present higher levels of autonomy, quality of life, and global self-esteem as well as lower levels of anxiety.

Cognitive Performance. Studies show that cognitive performance declines with age and declines even faster in the presence of low SE (Karlman, 2009; Pruessner et al. 2009).

A study (Karlman, 2009) was conducted on the trajectories of cognitive function in late life considering demographic and socioeconomic predictors and compared their results with other similar studies. They concluded that cognitive functioning declines faster in old age and even faster in never married and widowed older adults. Consequently, there may also be a positive correlation between cognitive performance and social support.

Additionally, studies (e.g., Pruessner et al., 2009) show that global SE also affects the elderly's cognitive abilities. Pruessner et al. (2009) show that elderly with lower SE suffer from a greater cognitive decline in comparison to elderly with higher SE.

Furthermore, it is important to mention that some studies (e.g., Kirk-Sanchez & McGough, 2013; Angevaren, 2008) show a positive correlation between physical exercise and preservation of cognitive performance and increased brain health, while others show minimal to no correlation. Therefore, it is possible to conclude that to preserve cognitive performance one should practice physical exercise as well as cognitive training.

SE can be enhanced by improving one or more of the previously mentioned SE predictors. While many studies work towards improving one of the predictors such as cognitive performance or physical activity (for instance, through gameplay), they do not always link them to SE. This article will focus on how gameplay is being used to benefit the Elderly's cognitive and physical health and what else should be done to better the Elderly's self-efficacy and consequently SE.

2.3 Gameplay

Recently, more studies have been carried out regarding the effect of gameplay in the Elderly's well-being, physical and cognitive health, and how it may create social contact due to the increasing interest in enhancing the Elderly's QOL.

Gameplay is the players' interaction with a game which is guided by the game's rules, challenges and sometimes plot (Lindley, 2004). It can be beneficial for the Elderly by offering relaxation, entertainment, socializing, cognitive improvements, and physical exercise (e.g., Ijsselsteijn et al., 2007; Cardoso et al., 2017, Kappen et al., 2018).

Video games. Studies (e.g., Ijsselsteijn et al., 2007; Cardoso et al., 2017) have been made to evaluate the effect of video games in the Elderly's cognitive abilities, and some show that video games can in fact enhance Elderly's cognitive abilities by improving memory, hand-eye coordination, information processing, attention allocation, and game-related executive functions. However, there is still a debate on whether the cognitive skills gained through video games actually transfer to everyday activities, or simply improve the skills to play the video game. Moreover, the systematic review of Cardoso et al. (2017), on electronic games as instruments of intervention in cognitive decline, shows that many studies do not evaluate the latter; some state that the cognitive skills gained do not transfer to everyday activities while others say the opposite; and some say they only transfer to healthy Elderly (Cardoso et al., 2017).

Exergames. Contrary to video games, several studies (e.g., Kappen et al., 2018; Chao et al., 2014; Willaert et al., 2020) indicate that exergames (e.g., Nintendo's Wii platform) can have a positive cognitive and physical impact on Elderly people. Exergames or exertion games are a combination of physical exercise and game play. Kappen et al. (2018), divided exergames in nine categories: [1] balance training, [2] cognitive training, [3] cognitive physical training, [4] wellness, [5] physical training, [6] design, [7] mental health, [8] increased physical activity, and [9] rehabilitation. Several exergames were evaluated in their systematic review however, since not all were commercialized games, and Wii games were the most studied and were present in all nine categories, we focused on them. The average of ages studied ranged from 57.5 to 84.5 years old and most studies had an age average around 70 years old.

Overall, the analyzed studies in a literature review (Kappen et al., 2018) indicated that Wii exergames have positive outcomes regarding dynamic balance, postural control, psychological well-being, and social interactions (when comparing scores with other

players), and work as a complement to physical therapy as well as a motivator to be more physically active. However, based on the measured energy expenditure, Wii Fit activities alone do not meet the recommended exercise intensity (e.g., Kappen et al., 2018; Traywick, n.d.).

The studies (Kappen et al., 2018) also reported some physical difficulties while performing the tasks. Firstly, some participants had difficulties balancing and weight shifting during balance training exercises, and participants with higher fall tendency took longer to recover their balance than participants with less fall tendency. Furthermore, the participant's physical limitations affected their ability to perform some tasks as well as it decreased their confidence to do so. Moreover, close guidance and supervision were deemed necessary to ensure older adults' safety when playing Wii exergames.

Additionally, a few studies (e.g., Stojan & Voelcker-Rehage, 2019) analyze the effect of exergames on cognitive performance and their results vary. Stojan & Voelcker-Rehage's systematic review (2019), on the cognitive benefits of exergaming in healthy adults, shows that some studies argue that exergames can contribute to cognitive performance, especially due to the combination of exercise and gaming, while others argue that exergames have low to none cognitive benefits (Stojan & Voelcker-Rehage, 2019; Sala et al., 2019).

Regarding the product itself, its design helped participants' focus during the games and the games' visual content helped in balance training. However, some participants had issues understanding how the technology worked.

The Elderly enjoy gameplay because it is fun, challenging, rewarding, and it gives meaning to their day (Lansbury, 2009). Furthermore, when it comes to games, they are more familiar with traditional games such as chess, checkers, and cards (Lansbury, 2009). However, exergames may be more beneficial to them as they can help enhance physical and cognitive functions and can create social interaction amongst players.

They consider the health benefits as a plus (Lansbury, 2009) nevertheless, despite the positive outcomes of exergames, the percentage of Elderly playing them is still low (Loos, 2017), mainly due to lack of interest. Loos (2017) explains that some Elderly showed motivation to play exergames regardless of their physical and technological limitations and some find them fun though, many had no interest in playing them, even when spoke about intergenerational play. Furthermore, some preferred to exercise in other ways.

Additionally, some said that exergames were not fun to play alone while others mentioned that if the game was meant to be played with someone it should be to cooperate to achieve a better result (Loos, 2017).

Moreover, some older adults complained about having to get closer to the screen because not all games allow adjusting font sizes or are simply not great at it (Loos, 2017). Adjusting games' design to the users' biological capabilities is particularly important to their acceptance. Designers should consider the users' declining vision, attention allocation, hearing, visual-motor coordination, physical and cognitive performance, and sensory functions (Ijsselstein et al., 2007; Loos, 2017; Czaja & Lee, 2006).

Interactive Technologies. Interactive products and services are beneficial in several contexts (e.g., teaching, in-company training, marketing, games for children and Elderly) and their use is growing. Furthermore, interactive gameplay (e.g., played on Nintendo's Wii platform, Xbox, PlayStation, games for rehabilitation) can serve as a complement to enhance physical development and motor skills, memory retention and development as well as social skills. Additionally, interactive games can improve user experience by increasing engagement and providing real-time feedback (Opp & Stary, 2020). Moreover, it can encourage Elderly to adopt touchscreen technologies and consequently learn digital skills that can transfer to their daily lives (Opp & Stary, 2020).

2.4 Discussion

Self-esteem (SE) can be influenced by several factors. Some cannot be easily manipulated by the individuals (e.g., age and gender, personality, wealth, and loneliness, health) however, other factors (e.g., social contact, physical activity or exercise, and cognitive performance) can be more easily manipulated. Physical exercise contributes greatly to self-esteem and has numerous benefits such as maintaining cognitive performance (Chodzko-Zajko, 2009). Physical exercise also helps SE as it also improves one's health and perceived health.

We argue that regular physical exercise and some complementary cognitive training will enhance self-esteem, increase autonomy, and decrease feelings of anxiety or depression thus improving the Elderly's quality of life.

Many studies have investigated game playing as a way of helping the Elderly (e.g., through video games and exergames). However, to what extent do these kinds of games benefit Elderly users? As mentioned before, video games offer some cognitive benefits, though the developed skills rarely transfer to day to day. Comparatively, many studies indicate that Wii exergames allow tangible physical improvements (e.g., balance) and due to the combination of physical and some cognitive training, cognitive function can be improved to an extent. Therefore, one can say that exergames, such as Wii exergames, are more beneficial to the Elderly's physical and cognitive performance, and thus to their self-efficacy and consequently self-esteem. However, Wii exergames do not meet the recommended exercise intensity (Kappen et al., 2018) and therefore, do not fulfill the Elderly's exercise needs. Hence, on the one hand, they are not great contributors in lessening the biological symptoms of ageing. On the other hand, Wii exergames can motivate users to be more physically active and can be a complement to physical therapy or rehabilitation. Moreover, they are perceived and enjoyed as leisure and social activities.

Three main issues can be concluded. Firstly, Wii exergames are not enough to improve the Elderly's health (e.g., Kappen et al., 2018; Stojan & Voelcker-Rehage, 2019; Sala et al., 2019) since, the recommended intensity of physical exercise is not met, and it is a key factor to maintaining and improving motor functions, internal health, cognitive function, and consequently self-efficacy and self-esteem (Chodzko-Zajko, 2009; Becker, 2013; Rodrigues, 2015; Kirk-Sanchez & McGough, 2013; Angevaren, 2008). Secondly, Wii exergames are the most studied exergames regarding older adults and Elderly's well-being and, besides the extent of their benefits, they are not being widely adopted by these age groups (Loos, 2017). The few studies (e.g., Loos, 2017) that explore this subject indicate that elderly are not interested in such a product.

The main problems are defined as: [1] SE decreases in the Elderly after 60 years old; [2] Wii exergames are not an optimal solution to fulfill the Elderly's physical and cognitive needs (and thus SE), and [3] Wii exergames are not being used by the Elderly despite their benefits. This led to the research question "how to create an impactful product to enhance Elderly people's self-esteem by improving their physical and cognitive health, and guarantee its acceptance by Elderly users?".

Human Centered Design (HCD) is a creative problem-solving approach that puts the user at the center. It focuses on establishing empathy with the users and including them throughout the process to make sure the product meets their needs (Design Kit, n.d.). The

focus on user experience will make sure that the users' interactions with the product will contribute to a high-quality experience. Therefore, following a HCD approach focused on developing a positive user experience will genuinely satisfy Elderly's needs and motivations. Furthermore, to achieve the latter, some aspects to be considered are outlined: timing, physical exercise, professional help and training personalization, gameplay, interactivity, changing the perception of old, including the user in the process, user interface design, and testing.

Timing. It is important to understand the best point in time to insert such a solution in the users' lives. As previously seen, ageing diminishes physical and cognitive conditions as well as social relationships with the community we live in (e.g., less active role in society) (Santos, 2010). These symptoms are accompanied by a decline in SE that starts sometime after 60 years old. Therefore, timing is crucial. If the Elderly user already has his physical and cognitive skills deteriorated to a certain extent, using a product that offers physical activity and requires cognitive effort will be more difficult and will lead to limited results. We argue that, to enhance SE in the Elderly by improving their physical and cognitive health, the solution should be inserted before the beginning of the critical years as a preventive measure. For instance, the solution could target people in the older-adult age group (56-64 years old) and for the sake of consistency, maintaining the user's health, and SE levels, it could also cater to the youngest-old Elderly age group (65-74 years old).

Physical Exercise. The type of exercise, frequency, and intensity of exercise is critical to comprehend. Experts (e.g., personal trainers, physical therapists) recommend a regular practice of several types of physical exercise – endurance or aerobics exercises, strength training or weightlifting, balance exercises, and stretching or flexibility exercises (Traywick, n.d.). Moreover, frequency of exercise will dictate the extent of the benefits reaped by the user. Older adults should exercise 150 minutes per week and at least 10 minutes per session. Those 150 minutes can be spread throughout the week according to the user's preference. Furthermore, the individual should gradually increase the level of intensity (Traywick, n.d.).

Professional Help and Training Personalization. Additionally, to guarantee safety when performing the exercises, the training plan should be provided or guided by a professional (Traywick, n.d.). Moreover, the training plan should be personalized to meet the individual's current health status and capabilities. Furthermore, as older adults

exercise to remain active they will also need to do physical therapy to prevent function decline or to rehabilitate lost functions.

Gameplay. What makes exergames fun to play are the challenges they offer and the rewarding feeling when the player accomplishes them which also makes them want to try again when they fail. This can be incorporated into physical exercise in many ways and will certainly help the target users to engage more with the product and physical exercise. However, since the Elderly are mostly not interested in playing exergames, we need to question to what extent should the solution be gamified.

Interactivity. Interactive technologies are increasing and bring several benefits to the user and his experience, such as higher engagement (Deterding, 2012) or helping to perform physical and cognitive training (e.g., Wii fit, PRAMA). Additionally, the adoption of interactive products contributes to the gain of digital skills that are transferable to the Elderly' daily lives (Oppl & Sary, 2018). Furthermore, interactive technologies can increase access to the product or service since they can be used at home (which is particularly good for e.g., older users, time-conscious users, and in case of pandemics such as COVID-19). Therefore, an interactive product that offers physical exercise and some supplementary cognitive training could contribute to enhance Elderly's SE.

Changing the Perception of Old. Demographic ageing and better healthcare are continuously changing the definition of "old". The youngest-old elderly group (65-74 years old) is still able to be active in the community and embrace healthy habits. Our perception of age should change in response to this and products targeting the older population should have this in mind.

Including the User in the Process. This is an essential step to guarantee user acceptance. It can be done by using User Centred Design (UCD) methods (e.g., focus groups, cultural probe, diary study, think aloud, interviews, questionnaires, paper prototyping.) (Sujan et al., 2016) and Human Centred Design (HCD) methods (e.g., interviews, guided-tours, card sorting, co-creation sessions, collages) (IDEO, 2015). The main differences between UCD and HCD are that HCD is a more empathic approach that aims to fully understand the users and requires more ideation, testing, and iterating based on the potential users' feedback (IDEO, 2015) while UCD focuses more on adapting the design and technology to the user.

It is essential to find out the target users' capabilities, habits regarding physical exercise as well as knowledge and use of physical and digital exercise products (e.g., Wii games). The motivations of the users to be active (e.g., live longer, be healthier, have more energy, feel happier, live independently, etc.) are vital to examine. If the product could meet the motivations, the market positioning would be done accordingly to convince the users. Furthermore, when advertising the product, its benefits must be evident to the users since older users are willing to invest in a new technology if they deemed it beneficial enough to them (Ijsselsteijn et al., 2007; Czaja & Lee, 2006). Additionally, exercising preferences (e.g., individual or group exercise, indoors or outdoors, gym or home, type of sports, physical or digital products, game or not a game) should be known. Furthermore, target users should also be included in the product's development phase (e.g., co-creation sessions) as this will provide valuable insights and will increase user acceptance towards the new product.

User Interface (UI) Design When it comes to UI of a digital interface, designers must design for accessibility (Polyuk, 2019). For example, the interface should consider the decreases in eyesight when choosing font sizes, sizes of other visual elements and color contrast; and the sound design should consider the decline in hearing. Additionally, allowing the user to adjust some of these elements will enhance user experience.

Regarding the UI design of a physical product, designers must also consider the user's physical capabilities and motor dexterity.

Testing Once we have a good understanding of the users' needs, motivations, preferences, limitations, and we have selected the ideas with the most potential, we can start testing prototypes (e.g., moderated tests) and iterate from feedback until a satisfactory solution is reached.

Therefore, with all these aspects in mind, an interactive product can be a solution which offers physical exercise and cognitive stimuli in a fun and challenging way. Furthermore, if the former is met, it can have the potential to prevent or delay the fall in self-esteem in Elderly people and possibly contribute to delaying the need to institutionalize them. We also argue that the likelihood of such outcomes can be further increased by following a Human Centred Design approach focused on developing a positive user experience that genuinely satisfies Elderly needs and motivations.

2.5 Conclusions

The objective of this literature review was to find a design opportunity by understanding the biological symptoms of ageing and what can be done to lessen them.

After analyzing literature, three main problems became evident, 1 – Self-esteem (SE) decreases in the Elderly after 60 years old, 2 – Wii exergames are not an optimal solution to fulfill the Elderly's physical and cognitive needs (and thus SE), and 3 – despite their benefits they are not being used by the Elderly. This led to the research question “*what kind of product can enhance Elderly people's self-esteem* by improving their physical and cognitive health, and guarantee its acceptance by Elderly users?”. We argue that this can be achieved by following a Human Centered Design (HCD) approach focused on developing a positive user experience that genuinely satisfies Elderly user needs and motivations. Furthermore, we suggest that an interactive product that offers regular physical exercise and complementary cognitive training in a fun and challenging way, could help enhance SE in the Elderly, especially if used as a preventive measure before the critical years of biological ageing and decreasing SE.

Additionally, user experience studies should be conducted to better understand user habits, needs, motivations, goals, preferences and struggles when using the proposed product. Furthermore, to ensure the users invest in such products, they need to fully understand the benefits it offers and to be taught to use the technology.

3. Methodology

As previously mentioned, the general objective of this study was to discover *what kind of product can enhance Elderly people's self-esteem?* and the specific objectives were [1] to understand what factors influence self-esteem; [2] to know the state of the art and identify shortcomings and gaps in those studies; [3] to understand the target users' profile, needs and motivations; [4] to do a comparative analysis of existing products and understand the market; and [5] to suggest a design concept for the interactive product, using a human centered design approach focused on user experience.

In order to achieve these objectives, it was necessary to follow a UCD approach and gather qualitative and quantitative data. The following methods were used:

Literature review was used to learn the state of the art regarding ageing, self-esteem and gameplay and, as a result, identify a research gap. The data was found on scientific articles' data bases, such as Research Gate, b-on, Sciencedirect and Google scholar; books, academic dissertations, data of existing products, and statistics.

Expert interviews were done to gather insightful qualitative data about the topic and target users. The experts were asked to identify the target users' physical and psychological pains and their willingness (i.e., motivation) to improve their well-being; they were also asked specific questions regarding physical activity and how to motivate participants and, finally, to give their opinion on the potential benefits and adequacy of the Nintendo Wii fit platform to tackle those issues.

User questionnaire was done to gather quantitative data regarding the users' pains, habits, motivators, obstacles, and preferences. It was a structured questionnaire with close-ended questions, and it also measured the participants' self-esteem with the Rosenberg Self-Esteem Scale ("Rosenberg Self-Esteem Scale", 2014).

Personas were created to define the target users through demographic data, self-esteem level, mobility problems, behaviours, goals, needs, and pain points. Additionally, to further develop the target users, a customer segment table (from the Value Proposition Canvas) was made.

Competitive benchmark was done to identify direct and indirect competitors, understand how they work, what they offer, how much they cost, and to analyse them from an UX point of view.

Market analysis was done to learn what is happening in the eServices market segment Fitness and define the target market and total market in Portugal.

Card sorting was done to understand the potential users' mental maps and inform the interface's navigation plan. It followed FigJam's card sorting template (available in the Figma software).

4. Proposal for an Interactive Product

On a preliminary ideation stage, and keeping in mind what has been researched and discussed, these are some suggestions the interactive product's design should consider:

1. Visibility increases the ease of interaction for Elderly (Polyuk, 2019) therefore, the product should have a large screen.
2. Gamification increases motivation, engagement, and enjoyment (Deterding, 2012; Fitz-Walter et al., 2017) which one could associate with a positive User Experience. In this sense, the product can take advantage of gamification to motivate Elderly and increase their experience. Instead of functioning as a game (and be perceived as a leisure activity), it could use some gamification to motivate the users while still being perceived as a product for health and well-being.
3. Positive User Experience motivates the users (DeLuca, 2021). Experience should be designed to motivate the user to exercise regularly and, consequently, feel pride and accomplishment.
4. It should offer professional guidance (e.g., from personal trainers and physical therapists) in a remote way because guidance and training personalization are key to ensure older adults and young elderly's safety and to maximize their health benefits.
5. Elderly can get confused due to memory decline (Polyuk, 2019). To solve this, the product should offer follow-along video tutorials so the users know exactly what to do and how and can do so independently. Furthermore, cognitive training delays cognitive decline (e.g., Ijsselstein et al., 2007; Cardoso et al., 2017). This type of training should be a part of the product to increase/keep cognition.
6. Specific physical exercises (e.g., strength training, flexibility exercises and aerobics exercises) guarantee healthy ageing which the product would include in the exercise lists to meet the recommended energy expenditure (Traywick, n.d.).
7. Socializing counters loneliness therefore protects self-esteem (Denissen et al., 2008) Enabling social contact in person and/or online during exercises would help Elderly not feel lonely and accordingly protect their self-esteem.
8. Timing is crucial, if the solution is implemented before the critical years of biological ageing and decreasing SE, it can be used as a preventive measure. By adopting a routine of physical exercise earlier on, they will be able to maintain or

improve their physical and cognitive function and delay the symptoms of ageing (e.g., Becker, 2013; Rodrigues, 2015; Chodzko-Zajko et al., 2009).

5. Customer Discovery

This section discusses the results of surveys, that were conducted to have a deeper understanding of the target user's needs, pains, level of motivation to adopt healthier habits, gameplay habits, exercise habits, obstacles to exercising and possible motivators, among other information. Furthermore, this phase has three steps, expert interviews, a questionnaire for the target users: older adults (56-64 yo) and youngest-old elderly (65-74 yo), and personas.

5.1 Expert Interviews

In this stage, experts identified the target users' physical and psychological issues and their willingness (i.e., motivation) to improve their well-being; the experts also made recommendations regarding physical activity and how to motivate participants and, finally, gave their opinion on the potential benefits and adequacy of the Nintendo Wii fit platform to tackle those issues.

5.1.1 Sample

The interviews were answered by 6 experts: 1 personal trainer, 2 physical therapists, 2 nurses, and 1 day center director with a background in psychology.

5 of the experts were Portuguese and 1 was Romanian. Furthermore, they were also chosen due to their different work locations (Lisbon, Cascais, Caldas da Rainha, Benfica Ribatejo, UK, Romania) to get perspectives from different population contexts. Moreover, most have worked in other Portuguese cities as well as abroad (Ireland, UK, Saudi Arabia) which equips them with a more holistic view of the target users in question.

5.1.2 Material

The interviews were structured (Appendix A) and the scripted questions were open. The possible respondents were divided into two groups of experts. Group 1 includes Personal Trainers and Physical Therapists. Group 2 includes Nursing Home and Day Centre staff, Nurses, Doctors, Psychologists, and Psychiatrists. The interview scripts were

almost identical. Group 1 and 2 shared 16 identical questions and, due to their areas of expertise, group 1 had 2 extra questions regarding physical exercise, and group 2 had one extra question regarding self-esteem. At the beginning of the interview an introduction was provided to disclose information about the scope of the study.

Group 1's interview consisted of 7 sections that are as follows: [1] Initial data, [2] Clients, [3] About the youngest-old elderly (65-74), [4] About physical exercise, [5] About self-esteem, [6] Compare Wii fit with PRAMA, [7] Optional comments. Group 2's interview consisted of 6 sections that are as follows: [1] Initial data, [2] Clients, [3] About the youngest-old elderly (65-74), [4] About self-esteem, [5] Comparing Wii fit with PRAMA, [6] Optional comments.

5.1.3 Procedure

The interviews were shared and collected through emails and WhatsApp from November to December of 2020. After reaching the number of responses we aimed for, the interviews were closed to analyse the data.

5.1.4 Results

The researcher created a word document where she included all 6 answers per question to then look for patterns and interesting insights.

Section 1. Initial data. The experts were as follows: [1] physical therapist, F, 61 years old, [2] physical therapist, M, 65 years old, [3] personal trainer, F, 33 years old, [4] day center director, F, 54 years old, specialized in Work Psychology, [5] nurse, F, 32 years old, specialised in Intensive Care and Family Health and has also worked in a nursing home, and [6] nurse, F, 32, specialised in elderly care.

Section 2. Clients. Physical therapists and the day centre director reported they have many clients 65+ (ranging from 65-104 years old) and most are female (around 70-80%). A nurse reported 11 clients a day from 65-98 years old, and 70% of them are male. The second nurse has 30 patients with 70-95 years old and 50% are female. The personal trainer has a few clients 65+, she has 3 clients from 67-80.

Interestingly, the male physical therapist has some 56–64-year-old clients, 80% of them male, while the female physical therapist reported to have many 56-64-year-old clients, most of them female. The personal trainer has some clients (5 clients) from 59-64 with a balanced gender distribution. The first nurse has some clients (around 4 per

week) of 56-64 and 60% are male while the second has 15 clients around 60 years old and 67% are female. The day centre director does not have clients in this age-group.

From this information, one can conclude that 65+ people do more physical therapy (especially women) and practice little physical exercise with the professional guidance of a personal trainer. Furthermore, women in this age range tend to go more to day centres than men and men are more likely to go to the hospital.

Regarding people from 56-64 years old, some to many do physical therapy and the gender majority is difficult to define based on the obtained answers, it may vary depending on the location and/or gender of the physical therapist. Regarding physical exercise with professional guidance, there is a slight increase in the number of people (from 3 to 5) and the gender distribution is balanced. In comparison to the previous age group, this younger age group is less likely to frequent a day centre, and there is a decrease of hospital visits (from 11 to 4 weekly), though most are still male.

Section 3. About the youngest-old elderly (65-74). Regarding the main physical pains, the responses were very similar, and the experts identified the main physical pains as: mobility of inferior members and superior members (especially shoulder mobility), lumbar area, spine, and fine motor skills (especially hand dexterity).

Regarding the main psychological pains, the experts reported that this age group suffers with anxiety, fear of growing older, the feeling of being unvalued (“a life of sacrifice unvalued”), loss of abilities, loneliness (with emphasis on the lack of attention and visits from family), isolation and decrease of cognitive abilities over time, when hospitalized, due to lack of interaction with people, other than professionals. Furthermore, some already show symptoms of dementia.

Regarding their main goals in this life stage and what they value the most. According to the expert’s answers, the goals of 65-74-year-olds and what they value are similar. However, it is possible to differentiate them to an extent. Their main goals are to be active, feel good, care about family, and keep in touch with them. What they value most is health, family time, quality of life, and their daily habits (“even when harmful to their health”, e.g., smoking, poor diets).

Regarding their motivation to maintain or improve their health at a physical and cognitive level, several interesting points arose. One can argue that there is a clear

difference between desire, motivation, and action. The physical therapists report that their clients are motivated to improve their health (good cognitive health contributes to this motivation), while the day care centre director and nurse report a lower motivation. Additionally, while most desire to maintain or improve their health, few seem to understand that they can, and should, have an active role in their health and well-being. They are “stuck on the old paradigm of health – a healing model instead of a preventive one”. The experts left some thoughts and recommendations as well: [1] Many 65-74-year-olds perceive physical activity as work or discomfort; [2] They should be made aware that they should self-manage their ageing process, health and well-being, instead of mainly relying on the health system; [3] They will feel more motivated if they see fast results and/or observe evolution; [4] Performing exercises that help accomplish the former helps; [5] talking to friends and family motivates them to cooperate in their recovery.

Section 4. About physical exercise. Overall, regarding the most important exercises/activities to maintain mobility in older adults, the experts recommended [1] marching (e.g., in different physical environments); [2] flexibility, strength, aerobics and balance exercises (which can include movements that they do daily e.g., sit-stand-up, push, pull, core flexing, rotation); [3] swimming; [4] bicycle. There was an emphasis on the importance of professional guidance (e.g., to inform them of what kind of exercises they can perform, to personally help during the exercise sessions) as well as training personalization, and providing safety (e.g., crutches, walkers if needed).

Furthermore, the experts recommended physical activity three times per week with intensity variation, according to the person’s abilities and medical recommendations. One of the experts suggests marching daily and alternating the group of flexibility, strength, aerobics and balance exercises with swimming, and exercise for a minimum of 30 minutes.

Section 5. About self-esteem. The experts reported that the decline of physical abilities is psychologically painful for older adults. They add that big declines can cause [1] decreases in motivation to exercise and perform daily activities; [2] decreases in cooperation in their recovery (e.g., refusing to eat and drink, staying in bed); [3] decreases in their recuperation success rate; [4] lower self-confidence and thus insecurity when performing daily activities (e.g., fear of falling while walking).

Furthermore, a decline in self-esteem, due to a decline in physical performance, can manifest in several ways, [1] in basic activities of daily life (e.g., hygiene, dressing, putting on shoes, position transfers, ambulation); [2] in the instrumental activities of daily life (e.g., instrumentalization of domestic activities, medication management, finance, driving, use of public transport). Furthermore, the decline in self-esteem is a progressive event that can lead to anxious and/or depressive states. It is also observable when older adults start presenting negative behaviours (e.g., saying “whatever”, “it doesn’t make a difference/ it doesn’t matter”, getting grumpy, verbally aggressive).

It was said that motivation, to maintain or improve their self-esteem, can be obtained in an intrinsic and/or extrinsic way. The used pattern, that is usually constant throughout life, depends on the psychological profile of each individual. We can help extrinsic motivation by providing access to meaningful activities for the elderly person. It is important to note that the value or meaning of such activities can be perceived in different ways depending on environmental, social, cultural, economic, and spiritual factors. Furthermore, other motivators were listed: [1] contact with family and friends; (2) psychological support, if needed; [3] promoting autonomy, and [4] maintaining an explanatory, never condescending, speech on the why/importance of each activity.

Additionally, it was also said that, nowadays, youngest-old elderly are more motivated than before (e.g., due to still being an active working member in society). Some even have the initiative to practice physical exercise to enhance their abilities.

Considering that physical and cognitive abilities influence self-esteem, experts recommended: [1] active ageing because cognitive and physical abilities should be worked in a preventive way; [2] providing products/devices that offer physical stimuli; [3] providing devices that allow for communication with friends and family (as socialization benefits cognitive performance); and [4] maintaining a schedule/daily routine.

Section 5. Comparing Wii fit with PRAMA. The experts were asked to compare two physical exercise interactive technologies, Wii-fit and PRAMA. Wii-fit was chosen due to the several studies on it, and PRAMA because, in contrast to Wii-fit, it interacts with the user in a physical dimension, as opposed to digital; it offers a greater exercise intensity; and is usually monitored by a personal trainer.



Figure 2:Wii fit vs PRAMA

When asked which of the technologies is more beneficial, one expert argued that both technologies cater to a very restricted youngest-old elderly population - healthy, sport lovers, and with tech knowledge. Two experts argued that Wii-fit is more beneficial to the youngest-old elderly because it is easier, more engaging and can exercise the user without him perceiving it as exercise. On the other hand, Wii-fit can be more prone to accidents and injuries with youngest-old elderly users, since it has no professional supervision. The personal trainer argues that PRAMA is more beneficial since it allows for professional guidance and has greater social, physical, and cognitive impacts. However, another expert points out that PRAMA only works in dark environments and using it in more illuminated rooms can harm performance and increase the risk of accidents.

When asked which of the two technologies 64-75-year-olds would feel more attracted to, all experts, except the personal trainer, answered Wii-fit. They argued that Wii-fit is effective, easier to use, more fun, does not pressure the user, makes the user feel like he has goals, and motivates him to fulfil them. In comparison, the personal trainer argues that they would be more attracted to PRAMA because it is not just virtual and has a person present to help, motivate, and correct form.

Looking back at the literature review, we know that, despite working as a complement to recovery, Wii-fit does not meet the recommended exercise intensity and is not widely used by older adults (Loos, 2017). So, this perception that many researchers and experts have that Wii-fit is very beneficial and attractive to older adults does not fully reflect reality.

5.1.5 Conclusions

The expert interviews were useful to understand the experts' point of view on best practices regarding exercise and motivating the users, and to understand their clients' physical and psychological pains as well as their level of motivation to improve health and self-esteem.

Both physical therapists have many 65-74-year-old clients and some to many 56-64-year-old clients, which indicates that people in these age groups need physical therapy, and the more so with age.

Overall, the experts' recommendations were: active ageing; exercise tailored to the person (this includes the type of physical activities, frequency, and intensity); walking/power walk, flexibility, strength, aerobics, and balance exercises (which should include movements that they do daily e.g., sit-stand-up, push, pull, core flexing, rotation); swimming; professional guidance and/ or supervision; and, explain to the user, in a non-condescending way, the value of the suggested activities/ product.

Experts believe that Wii Fit is more beneficial to older adults because it is easier to use, and some believe it is safer. They also believe that older adults would feel more attracted to Wii-fit because it can be a fun way to exercise, it is more engaging, it sets goals, and motivates the user to achieve them. However, the interviews do not reflect the users' point of view. One must ask, do the target users perceive Wii-fit as the experts do? Are they interested in such a product, and would they prefer to use it instead of exercising in other ways? Since we are following a Human Centred Design approach, it is necessary to conduct user questionnaires to better understand the user.

5.2 User Questionnaire

A structured questionnaire was used to gather in-depth information. It consisted of predefined, closed-end questions to obtain more detailed information about older adults and the Elderly.

5.2.1 Sample

The questionnaire was answered by 150 Portuguese citizens ($n=150$, $MOE=0.08$), 77 female, 72 male and 1 other, with an age equal or above 56 years old. The chosen age

target comprised the age groups of older adults (56-64), youngest-old (65-74), middle old (75-84), and oldest-old (85+) elderly (Sang et al., 2018).

5.2.2 Material

The questionnaire (Appendix B) consisted of 7 sections with explanatory titles to make the change of topic easier to follow. At the beginning of the questionnaire an introduction was provided to disclose information about the target and scope of the study. In total, 46 questions were asked. The sections are as follows: [1] Initial Data, 3 questions; [2] Physical and Cognitive Habits, 8 questions; [3] Game Habits, 2 questions; [4] Knowledge about physical products, 10 questions; [5] Final Thoughts, 9 questions; [6] About you, 9 questions; and [7] Demographic Information, 5 questions.

5.2.3 Procedure

The questionnaire was shared through the Google Forms service between December 2020 and January 2021. It was distributed by sending emails and posting on social platforms. The response rate was being monitored. After reaching the number of responses we aimed for, the questionnaire was closed to analyse the data.

Any person with an age equal or superior to 56 years old answered the questionnaire alone or with assistance, if needed.

5.2.4 Results

The data was analysed through SPSS Statistics. Additionally, to obtain a visual description of the sample, a univariate analysis was performed, using frequency tables and graphic representations. Secondly, to better compare, visually, variables related to the same topic, box plots with several independent variables were created.

Section 1. Initial data. 51.7% of the respondents said they prefer an activity that contributes to their physical health, 46.2% preferred an activity that contributes to their psychological health, and 43.3% preferred an activity that helps them develop as a person. These answers may be influenced by the social desirability bias (Grimm, 2010), but it is still possible to conclude that they value activities that improve their overall health and well-being.

Section 2. Physical and cognitive habits. According to Traywick, n.d., the minimum recommended exercise time per week is 150 minutes (2h 30 min). In general, the respondents practice less than 1h per week, or do not practice exercise at all (Figure 3). The dominant activity is low intensity exercise, which includes a casual walk and riding a bike at a slow pace. Medium intensity exercise includes jogging, cycling, swimming, and dancing. High intensity exercise includes circuit training and medium intensity exercises done at a faster pace, e.g., running and cycling faster (Downing, 2021).

The results show that 70.7% of respondents never do high intensity exercise per week, 27.3% never do medium intensity exercise per week and 11.3% never do low intensity exercise per week.

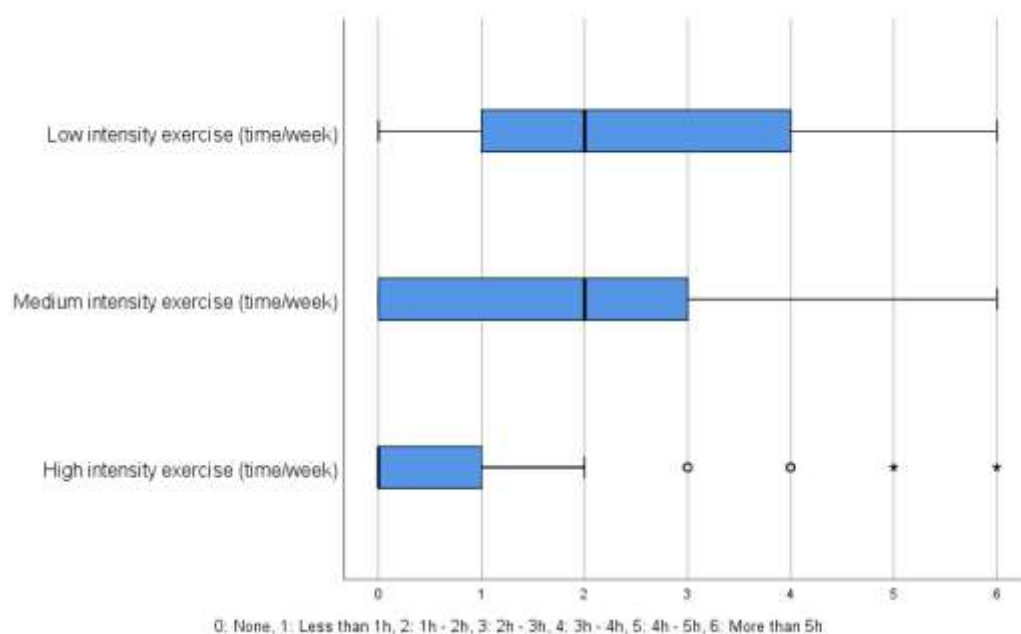


Figure 3: Summary of physical exercise intensity performed per week

Another question was whether respondents performed exercise with weights, which includes exercise using body weight or additional weights. This type of exercise can be of medium or high intensity depending on the weight, repetitions, and pace. The results showed that the exercise level with weights is quite low, as 49.3% never do it, as shown in Figure 4. This shows that almost 50% of the respondents do not perform strength exercises, which are very important for one's health, even as an older individual. (McLeod et al., 2016).

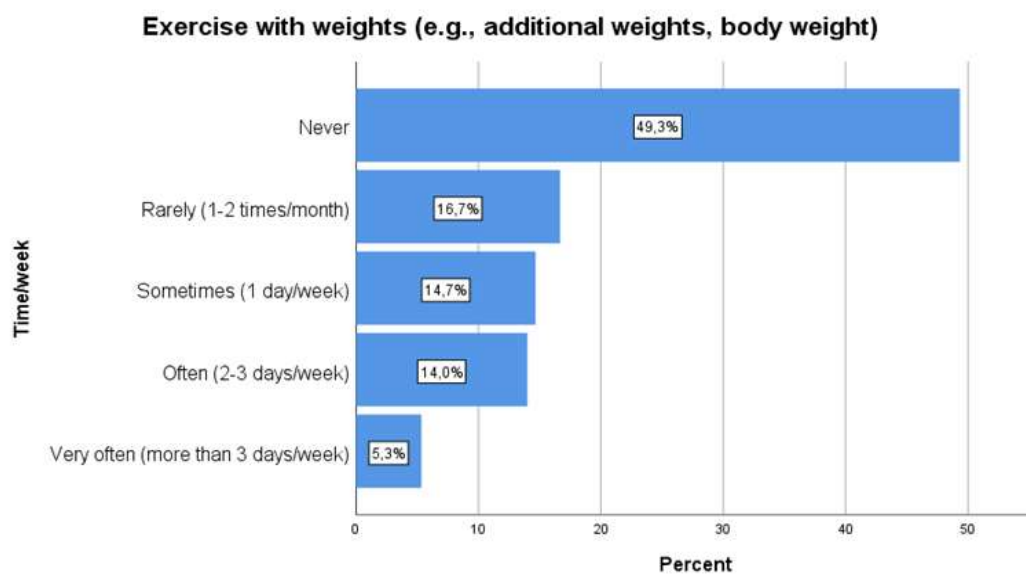


Figure 4: Frequency of exercise with weights

The respondents were also asked about their preferences on location and company when exercising. Most of the respondents (42.7%) prefer to exercise outdoors, 35.4% prefer indoors (i.e., homes, gym), and 18.7% chose both. Regarding company, most of them (45.3%) prefer sometimes alone and sometimes with company, 33.3% prefer only with company, and 15.3% prefer alone. This shows that the preferences regarding location and company to exercise are varied and may depend on the mood of the person, their location, and type of physical activity.

Additionally, the respondents were asked about their involvement in certain cognitive activities (i.e., reading, memory games, board games, sudoku, domino, crosswords, drama, dance, learning new things, and teaching) per week. Most of them (59.4%) do not practice any of these activities, and 18.1% do it for less than 1h per week (Figure 5). This can be due to lack of time, lack of interest or because they are unaware of the importance of cognitive training.

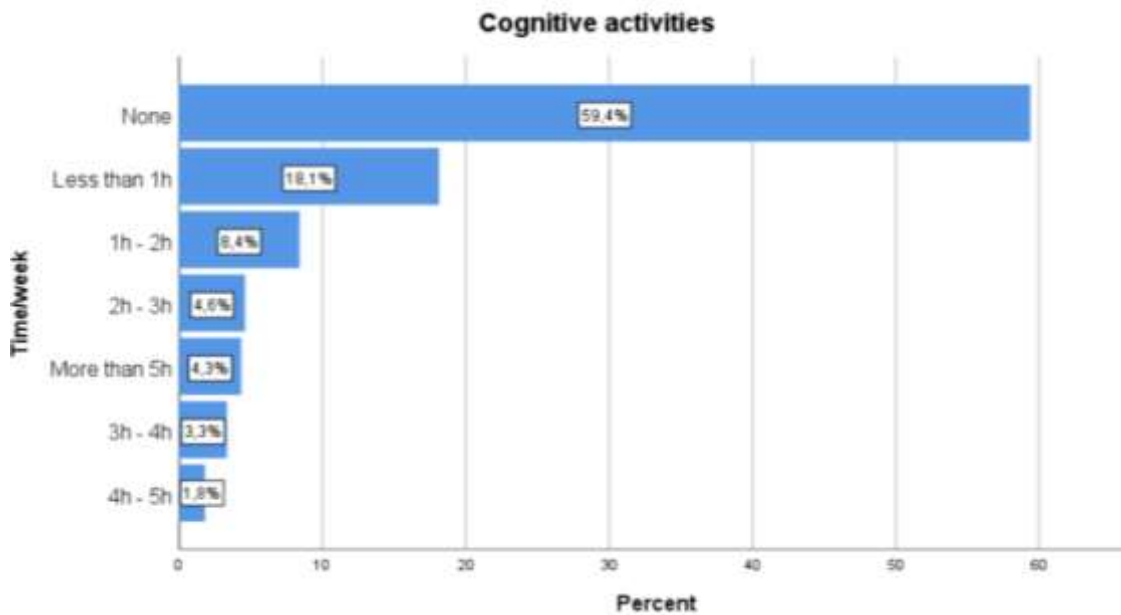


Figure 5: Cognitive activities (time/week)

Physical exercise improves cognitive health (Kirk-Sanchez & McGough) and, according to the results, most of the respondents are not performing the recommended exercise (Figure 3 and Figure 4) nor stimulating their cognitive performance (Figure 4), which may lead to a faster cognitive decline and fall in self-esteem (Karlamanla, 2009; Pruessner et al. 2009).

To better design a solution for the target users, it was also important to know what encourages them to take better care of their health (Figure 6) and what their obstacles to exercising are (Figure 7). The results show that the main motivation for most of the respondents is to feel better at a body and mind level (76.7%) followed by being healthier (60%). Their biggest obstacles to exercising are laziness (46.3%), lack of motivation (44.9%), and lack of time (27.9%).

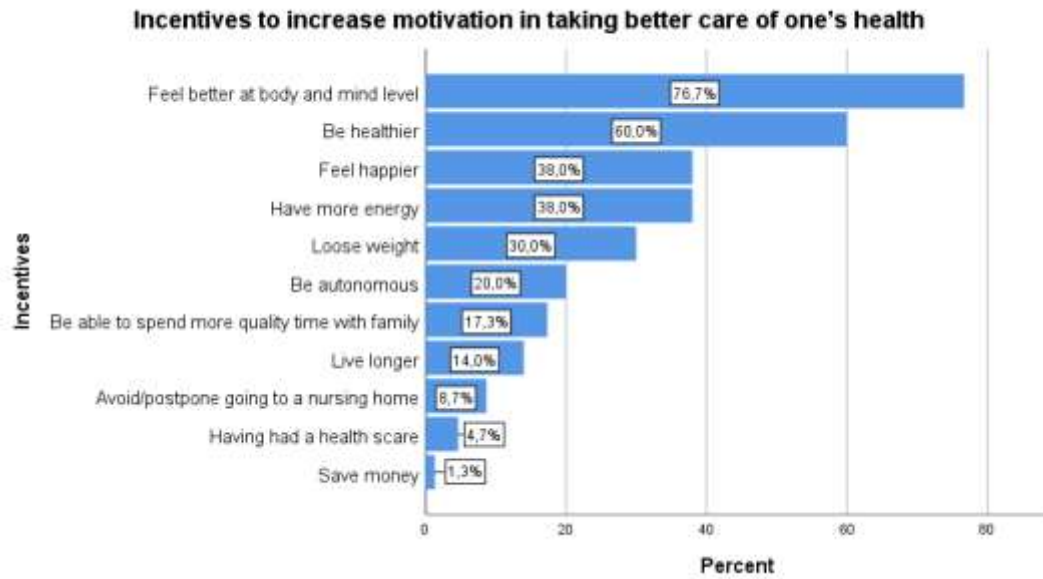


Figure 6: Incentives to increase motivation

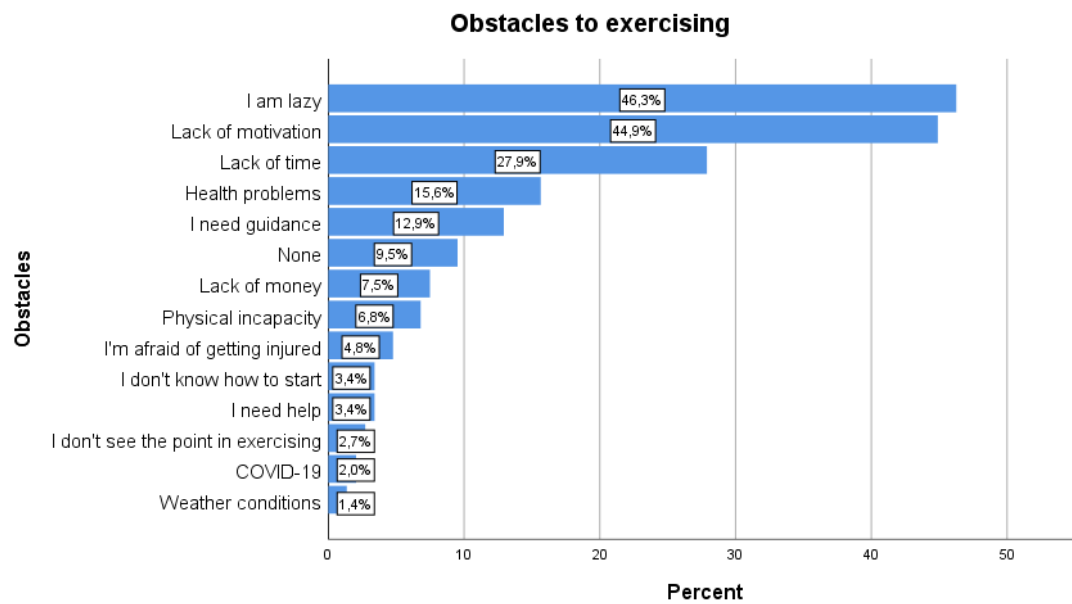


Figure 7: Obstacles to exercising

Section 3. Game habits. Some studies (e.g., Loos, 2017) have shown that older adults are not interested in exergames thus it was important to understand our users' gaming habits. 50.4% do not play any non-digital games and 46.3% do not play any digital games. The most played non-digital games are card games (31.9%) and a similar result is found for digital games (37.6%). The latter is followed by logic games, played by 30.9%. Even though approximately half of the respondents do not play any game, it is interesting to observe that the percentages of gameplay are higher for digital games. This may be due to several factors, e.g., higher adoption of technology which increases access to digital games, and the fact that digital games do not require the presence or availability of another person.

Section 4. Knowledge about physical products. Knowledge and use of certain fitness products was important to see what products they use and, especially, understand their knowledge and use of Wii Fit. This could help prove that people in this age range are not adopters of Wii fit which is an exergame widely mentioned in literature regarding elderly (e.g., Kappen et al., 2018; Chao et al., 2014; Willaert et al., 2020). 58.7% know but do not use physical exercise products (e.g., dumbbells, mattress, stepper, exercise bike) even so, only 37.3% use them. 42.7% know but do not use fitness apps, only 13.3% do. Finally, only 28.7% know but do not play Wii fit, 54% do not know what it is, thus it is the least known option, and only 8% play it. The percentages of knowledge and use of physical exercise products may be higher due to their higher visibility in physical stores.

To understand which fitness products are more likely to be used by the target users, they were asked agreement Likert scale questions regarding their willingness to use the products (Figure 9).

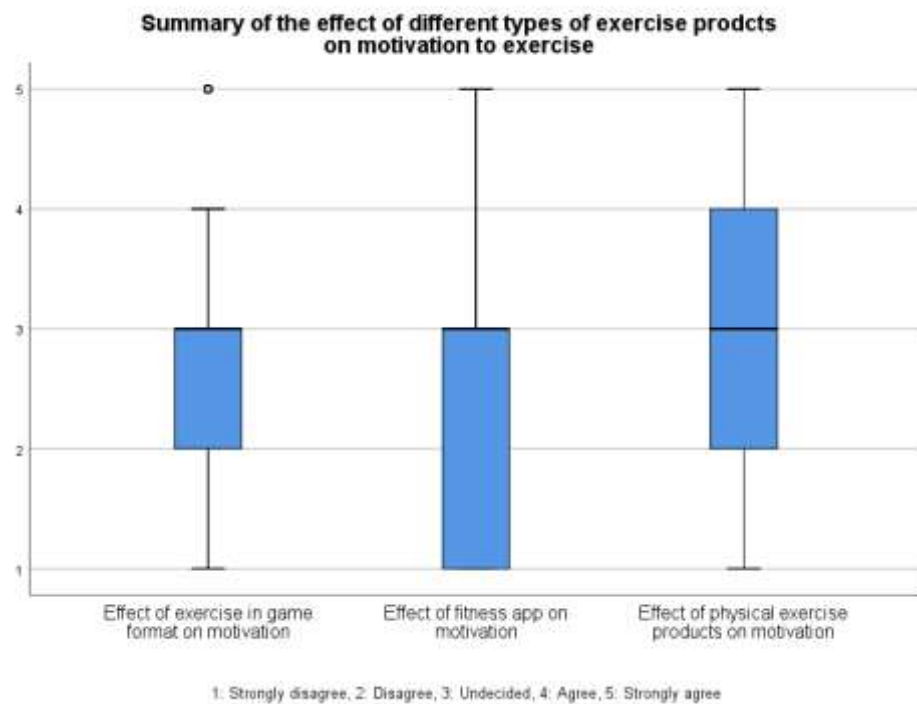


Figure 8: Summary of the Effect of different types of exercise products on motivation to exercise

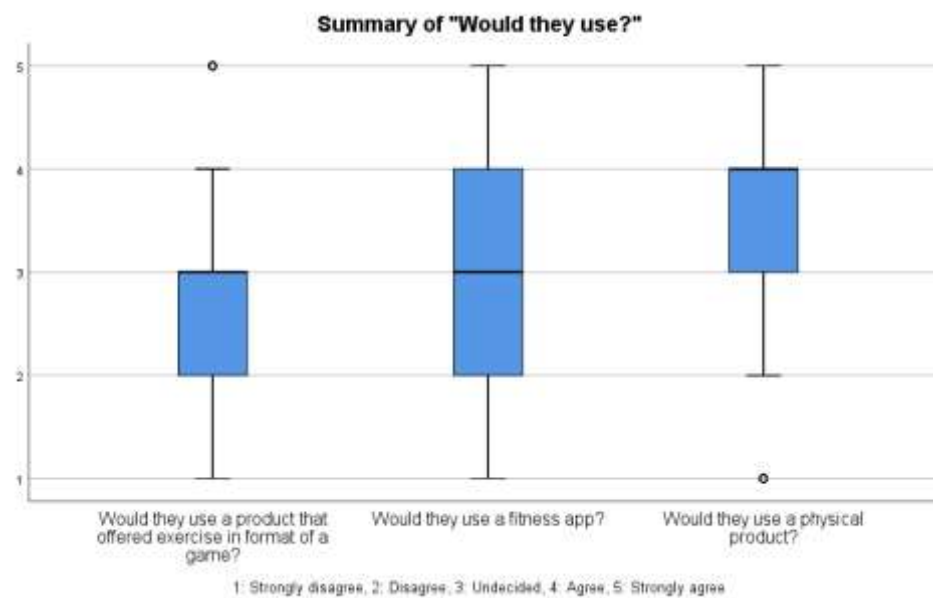


Figure 9: Summary of "Would they use?"

It was interesting to see the contrast in how the products affect their motivation to exercise (Figure 8) and how much they agree they would use them (Figure 9). In Figure 8, similarly to exercise in a game format, fitness apps also rank low when it comes to motivating the user to exercise (75% answered “strongly disagree”, “disagree”, and “undecided”). However, in Figure 9, respondents noted they would more likely use a fitness app than a product that offers exercise in a game format. Additionally, physical products have a bigger impact on motivation and are more likely to be used by the respondents.

Section 5. Final thoughts: Respondents were asked how much they valued their autonomy (ability to perform daily tasks) and their level of motivation to maintain it, 85.3% strongly agree that they value autonomy and 60.7% strongly agree that they are motivated to adopt habits to help maintain autonomy.

The study also included questions designed to understand users’ preferences, their motivations and which exercise products they would use. Figure 9 summarizes how much some variables can affect the target user’s motivation to exercise. Their motivation would be further increased if they followed a plan made by professionals and exercised with friends or family. The “medium of exercise” (physical product, game format or app) rates lower.

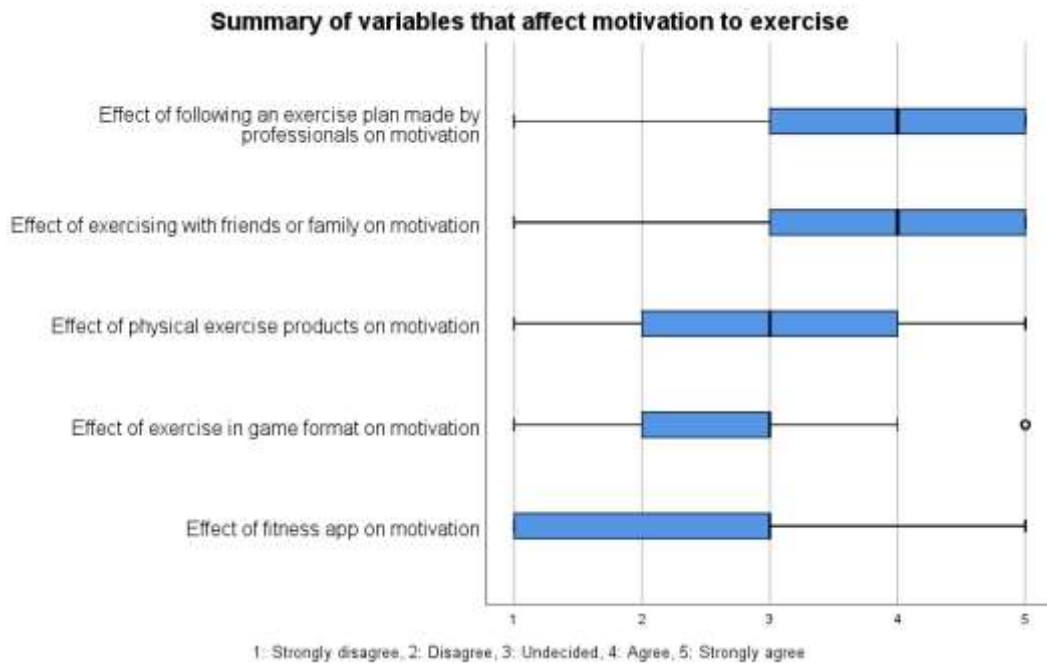


Figure 10: Summary of variables that affect motivation to exercise

Section 6. About you: It was important to assess the users' comfort with technology, physical and emotional pains. Firstly, most users have none to few problems when using technology (55.3% have no problems, 32% have few problems). Secondly, most have no problems with mobility (77.3%) nor personal care tasks (92%). Regarding pain frequency however, the data is more spread out as 39.3% rarely feel pain, 32.7% feel pain sometimes, and 14.7% feel pain often. For most, the pain felt is soft (39.3%) or moderate (36.7%). Furthermore, the results show that 34.7% of respondents rarely feel anxiety, 32% feel it sometimes, and 13.3% feel it often. Additionally, 41.3% rarely feel depressive feelings, 25.3% never do, and 23.3% feel it sometimes. To be able to determine whether anxiety and depression increase with age, we need a bigger sample with a more balanced distribution in the age groups.

We could assume that, if the questionnaire had reached more people from the older age groups, the percentages regarding physical (Nakano et al., 2014) and emotional issues (Robins et al., 2002; Tresniewski, 2003; Orth et al., 2010) would be higher.

Self-esteem (SE) was measured following the Rosenberg Self-Esteem Scale. Scores between 15 to 25 are considered average ("Rosenberg Self-Esteem Scale", 2014), which indicates that most respondents have an average level of SE (Figure 10). SE tends to peak at 60 and then decline (Robins et al., 2002; Tresniewski, 2003; Orth et al., 2010). As 66%

of respondents are 56-64 years old and 26.7% are 65-74 years old, it supports that most SE values are not low. Furthermore, the respondents' demographic profile suggests a higher SE level since, most respondents are married, live with their spouse or partner, are educated, and do not live in isolated places (França, 2015).

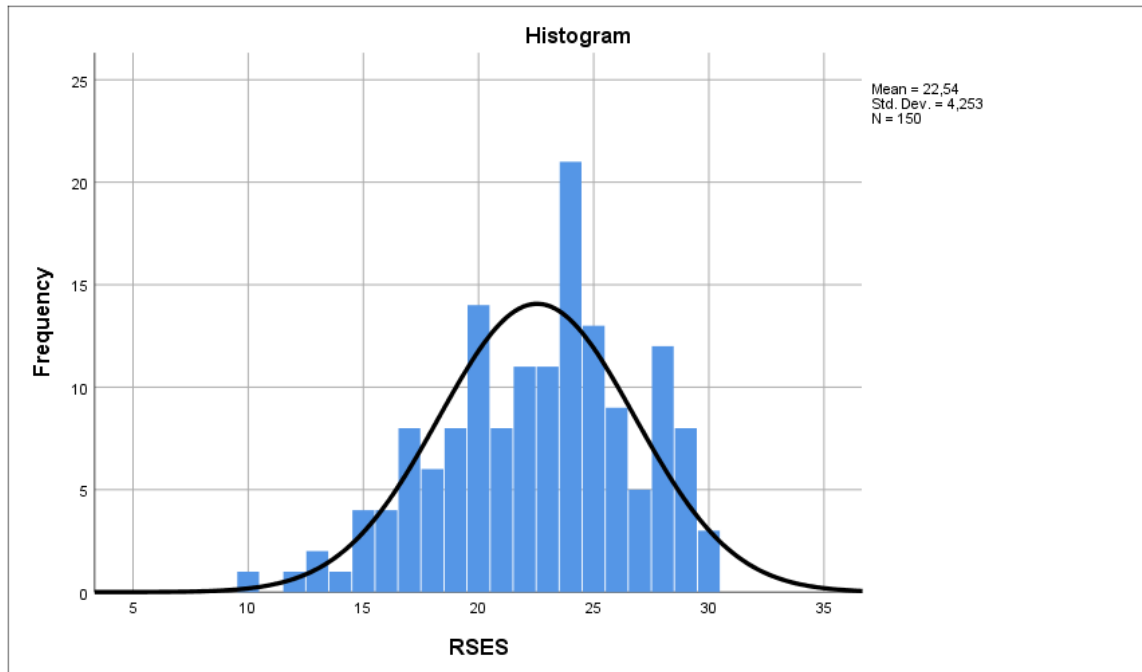


Figure 11: RSES's histogram

Regarding the relation between age and self-esteem, it is possible to see a tendency of decreasing SE with an increase in age (Figure 12) which is supported by other studies (e.g., Robins et al., 2002; Tresniewski, 2003; Orth et al., 2010). However, more data would be necessary to confirm this through this questionnaire (e.g., more respondents 75+, a wider range of demographic backgrounds).

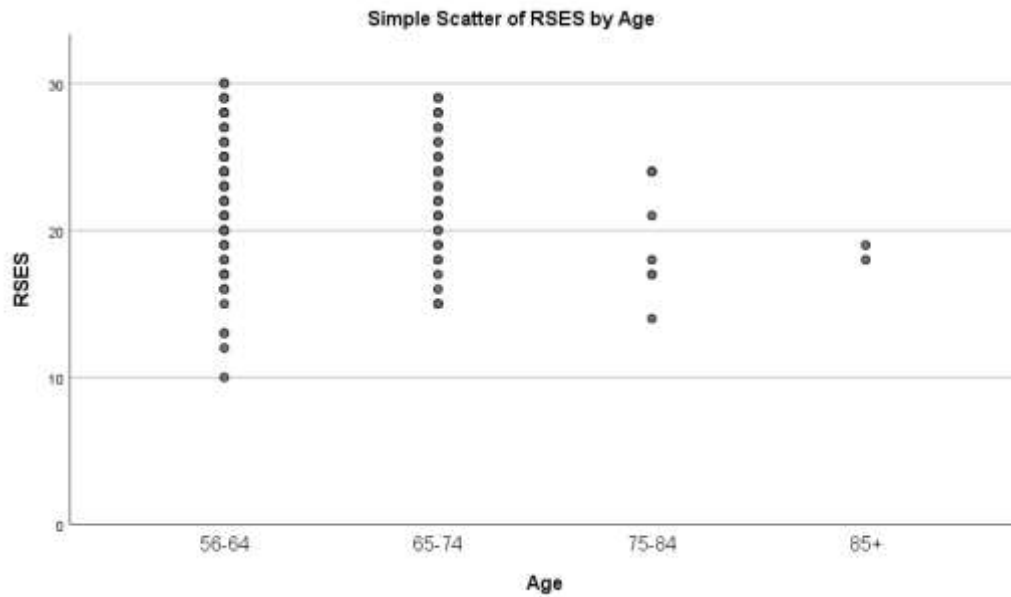


Figure 12: RSES by age

Section 7. Demographic Information. There was a total of 150 respondents, 66% are 56-64 years-old and 26.7% are 65-74 years old, and 51.3% female. 48% have a degree pre-Bologna and 23.3.% have a high school diploma or equivalent. A large number is still an active member of the workforce, 40.7% are working full-time, 14.7% are self-employed, and 34% are retired. 63.3.% are married, 17.3% are divorced, and 73.3% live with their spouse/partner. Unfortunately, due to COVID-19, it was not possible to obtain answers from more people of the older age groups, 75-84 years old and 85+, that were supposed to be collected in a day centre.

5.2.5 Conclusions

The user questionnaire showed that most respondents do not have an interest in game play. Most respondents do not know Wii-fit (54%) nor play it (only 8% play), most do not have the habit of playing games, whether they are non-digital or digital.

Furthermore, most respondents did not agree that exercise in a game format would increase their motivation to exercise nor showed interest in using such a product. 75% answered “disagree” and “undecided” to exercise in a game format increasing their motivation to exercise and gave the same answers regarding if they would use such a product. This can show that many studies (e.g., Kappen et al., 2018; Chao et al., 2014; Willaert et al., 2020) focused on gamified solutions as a means to increase the wellbeing

of older adults and elderly, do not reflect the target user's point of view. Therefore, to increase the target users' physical activity, a Human Centered Design approach is crucial to follow.

Moreover, when it comes to exercise in game format, fitness apps, or using physical products, the respondents are more likely to use physical products and then fitness apps. Additionally, considering what motivates them the most to exercise (following a plan made by professionals and being able to exercise with friends or family) and their main obstacles to do so (laziness, lack of motivations, and lack of time), it can be concluded that for a solution to succeed, from the target users' point of view, it should: (i) be used in the house to save commuting time and fight laziness; (ii) allow for the user to exercise with friends or family (e.g., in person or in a remote way); (iii) allow the user to use physical products; (iv) offer training plans made by professionals. Considering these needs, to maximize the access, the solution should be digital. Furthermore, the questionnaire also helped to create the personas for the ideation phase.

There are some limitations in this study. First, due to Covid-19, the study was not able to reach many people from the older age groups which makes it difficult to prove certain observations seen in literature (i.e., self-esteem declines with age, physical function declines with age). Second, since this study was conducted during the Covid-19 pandemic, some of the answers may differ from a "normal", non-pandemic context (i.e., regularity of exercise, anxiety, depression).

This study may be relevant to designers as well as researchers, and medical and fitness professionals. We argue that, to suggest or design products as a mean to increase the wellbeing of older adults and elderly, more user experience studies should be conducted to better understand their habits, needs, motivations, goals, preferences and struggles before, and while using such a product. This can be achieved by following a Human Centered Design approach focused on developing a positive user experience that genuinely satisfies Elderly user needs and motivations.

The next steps of this project are to [1] define and develop the target users (i.e., personas, user journeys, customer segment table); [2] ideate; [3] develop a solution with a positive user experience that meets the users' needs; [4] test it; and [5] iterate. The resulting digital solution can contribute to healthy ageing and well-being, as it will help to maintain or increase physical exercise, cognitive stimuli, and ultimately self-esteem.

5.3 Personas

This section focuses on developing and defining the target users. It includes 2 personas created according to the information from the user questionnaire, and a customer segment table that will also help to inform the Product Development stage

The primary personas (Figure 13 and Figure 14) include older adults (56-64 yo) and youngest-old elderly (65-74 yo) since they are the focus of this study due to their great need of exercising to improve their current health and well-being and to help their quality of life later on. Additionally, there is the problem of low adoption of exercise solutions in these age groups, possibly due to the lack of solutions with the user in mind. To increase the marketability and profitability of the digital solution, secondary personas would include Millennials (25-40 yo) and Gen X (41-56 yo) however, these will not be the focus of this study.

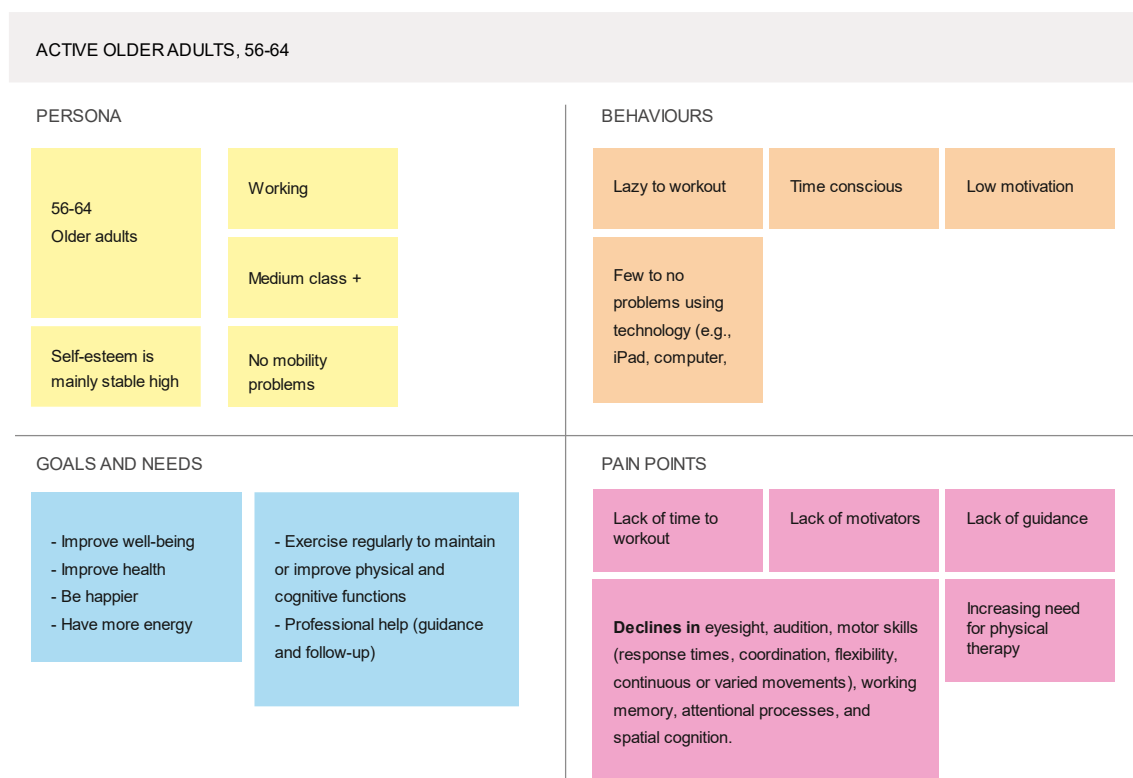


Figure 13: Primary personas – active older adults, 56-64yo

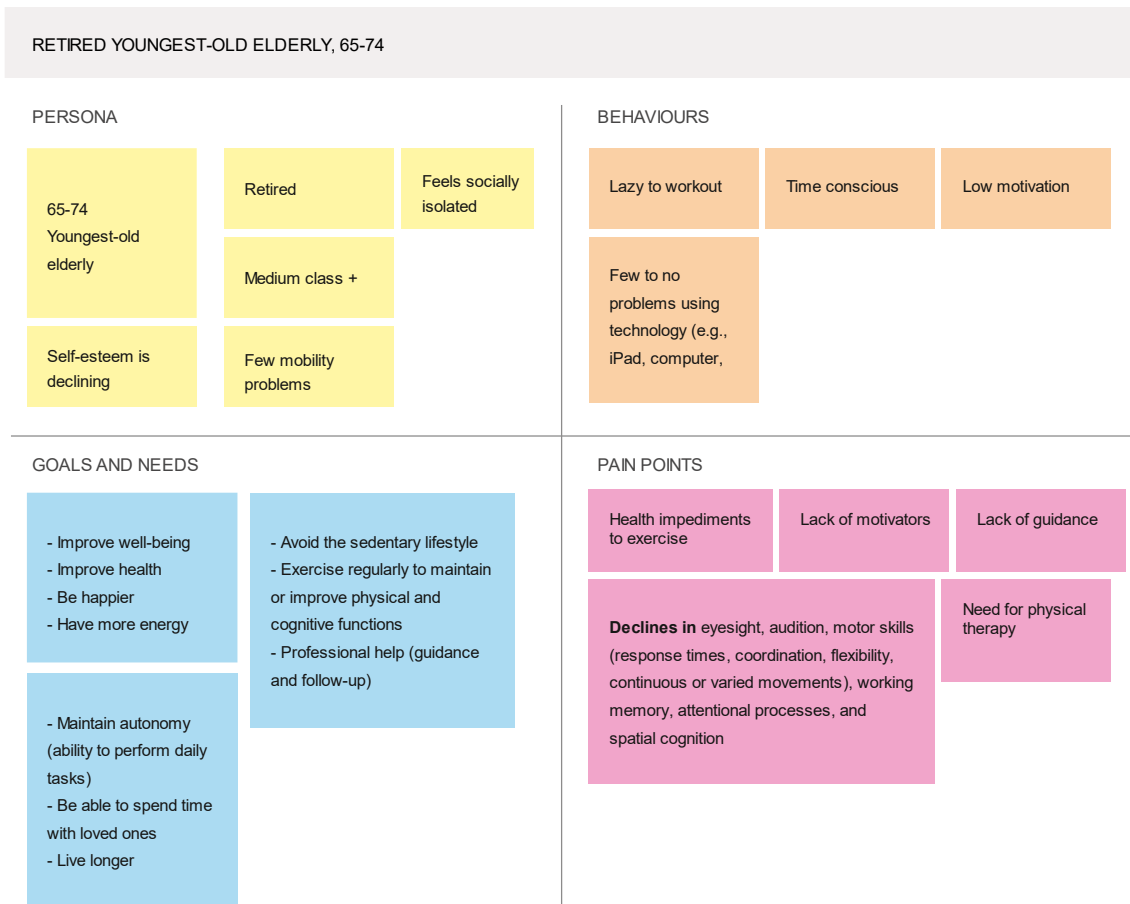


Figure 14: Primary personas – retired youngest-old elderly, 65-74yo

Based on the latter, a customer segment table (Table 1) was created to further develop the personas and help in reaching a solution. The table summarizes customers' demographics, problems and needs; expectations and factors that could surprise them; their challenges and risks, and what complicates their task of using a digital fitness solution.

Table 1: Customer segment of VPC for primary personas

Customer Segment - Primary Personas

Customer Job(s)	Gain	Pains
- What specific tasks are your customers trying to perform? - What problems are they trying to solve? - What needs do they have?	- What benefits do your customers expect? - Are there financial, social or emotional benefits they might expect or could be surprised by?	- What challenges and risks might your customers experience? - What complicates or prevents your customers from completing a job?
User Demographics - 56-74 - M/F/Other Problems - Sedentary lifestyle - Declining physical and cognitive health - Declining self-esteem - Decreasing social contact Needs - Regular physical exercise - Cognitive stimuli - Social contact - Motivation for the above - Time conscious solution for the working users	Health & Well-being expectations - Active ageing - Prolongs autonomy and delay the need of institutionalization - Enhance SE - Improves overall well-being Emotional expectations - Fun - Challenging - Pride - Accomplishment - Motivation eService benefits that would benefit/surprise them - Professional content - Recorded videos - Live sessions - Physical therapy content - Professional guidance and follow-up - Being able to workout with friends or family Financial expectations - H1 - An affordable product - H2 - Value-based pricing	Decrease in Health & Well-being - Decrease in physical abilities and physical pains (they might need physical therapy) - Decrease in cognitive abilities - Lack of motivation - Low self-esteem Bad UX - Difficult to use - Not motivating - It does not boost engagement - Functionality issues - Does not add value to make them switch from free to paid apps Bad UI - unappealing - confusing to use

6. Competitive Benchmark

Considering the literature review, expert interviews, and user questionnaire, a digital platform that offers physical exercise could be a possible solution, if it [1] offers sessions with personal trainers and physical therapists, [2] offers follow along video tutorials, [3] sets goals, [4] motivates the user to conquer said goals, [5] shows progress. Additionally, other features could be considered, for example, [1] social features to increase the users' social contact and fight elderly isolation (e.g., allow user to exercise with friends or family, live classes), [2] allow for extra personalization to better cater to the user's needs,

tastes, and engage the user to have a more active role in the process (e.g., allow the user to create his own exercise routine and schedule).

Therefore, these features were considered when choosing competitors for the comparative benchmark analysis.

This benchmark analysis starts by identifying indirect and direct competitors, explaining what they are, how they work and what they offer. That is followed by a discovery stage which includes a visual evaluation of competitor products and services, based on a list of factors, and information regarding pricing. Finally, there is a UX analysis that summarizes the main discoveries ("Benchmark analysis - UX Toolkit Scripts", n.d.).

6.1 Identifying Competitors

This step describes the selected indirect competitors (Wii Fit Plus, Fitness Hut) which offer a relatively similar type of product or service but use a different medium, and direct competitors (Peloton, The Class, Nike Training Club, Holmes Place app) which offer a similar digital service.

6.1.1 Wii Fit Plus

Wii Fit Plus is an exergame for the Wii console and an improved version of Wii Fit. The Nintendo Wii "Wii Fit Plus Pack" (Konsole inkl. + Wii Fit Plus disc + Balance Board + remote + schwarz) can cost €166.90 ("Nintendo Wii "Wii Fit Plus Pack"", n.d.). Wii Fit Plus's disc comes with a total of 69 exercises including yoga, strength training, aerobics, and balance games. Users can build their own routine or choose a pre-built routine and count their burnt calories with the calories burned meter (see Appendix E figure E.2). Additionally, the product conducts body and balance tests (*Wii Fit Body Test*, 2020) and one mental test. It also provides the option of creating a profile for the user's pet or baby to measure and track their weight (*Wii Fit Plus - Official Trailer*, 2012; "Wii Fit Plus", n.d.).

6.1.2 Fitness Hut

Fitness Hut is a gym chain, with 40+ gyms in Portugal, that positions itself as premium low-cost, premium quality with competitive low-cost pricing. Its membership costs from €6.60-€20/week ("Benefícios do Ginásio | Fitness Hut", 2021). The gyms have seven

areas targeting cardio fitness, resistance training, strength training, functional training, combat, sprint, and stretch ("Conheça os ginásios Fitness Hut | Fitness Hut", 2021). Fitness Hut also offers classes (e.g., indoor, outdoor, studio classes, and V-Classes given by 3d instructors) ("Aulas no Ginásio | Fitness Hut", 2021) and personal training services.

6.1.3 Peloton

Peloton is a digital studio that offers online fitness classes (strength, yoga, outdoor running, stretching, cycling, bootcamp, meditation) ("Peloton app", 2021). Its app can be accessed through two types of membership: [1] Peloton Digital Membership, that allows access to their library of classes (with equipment or without) through their phone, tablet, computer, or connected TV for €10.71/month; [2] Peloton All-Access Membership, for people who have purchased the Peloton Bike or Tread, for €32.39/month ("Peloton - Membership", 2021). The Peloton Bike costs €1864.25 (and is currently on sale for 1573.61€) and can be paid with a monthly fee of €40.69 ("Peloton", 2021). The Peloton Tread costs €3566.57 or €92.17/month ("Peloton Tread", 2021). Furthermore, the app shows workout statistics and completed achievements.

6.1.4 The Class

The Class is a digital studio that offers live classes of 45-60 minutes every day of the week as well as access to their “library of on-demand classes” and it costs €33.86/month or €281.17/year ("The Class", 2021). Users can view classes on a smartphone, tablet, computer, or connected TV. Furthermore, the workout is described by the brand as cathartic for both body and mind as it is a “music-driven workout experience that borrows from yoga in its spirit, a rock concert in its energy, and bootcamp in its grit”, and a consumer describes it as “spiritual aerobics” ("The Class", 2021). Besides the classes, The Class offers “experiences” (e.g., The Remote Treatment, The Summit, The Retreatment, The Immersion) more focused on emotional well-being, as well as public events to support charities and personalized custom digital events for groups of friends, co-workers and family ("Experiences - The Class", 2021).

6.1.5 Nike Training Club

Nike Training Club is an app that allows the user to “filter workouts by categories like specific muscle group, time [they] have to spend, and workout types - [they can] choose from strength, cardio, yoga, and mobility” (Winderl, 2020). Additionally, the user can choose exercises according to equipment options: body-weight-only, basic (free

weights e.g., dumbbells, kettlebells, resistance bands), and full (with equipment that can be found at the gym or, sometimes, at home e.g., pull-up bar or barbell) (Winderl, 2020). Furthermore, some workouts are hosted by celebrities and athletes (e.g., Simone Biles, Serena Williams, and Julie Ertz) (Winderl, 2020). Finally, the app download is free and there are in app purchases.

6.1.6 Holmes Place App

Holmes Place is a gym chain that positions itself as premium, and has gyms in seven countries (Austria, Germany, Greece, Poland, Portugal, Spain, and Switzerland) ("Holmes Place | Premium Fitness Clubs", 2021). Due to COVID-19 they have improved their app which currently allows the user to schedule classes, schedule sessions with their staff, track the activities the user chooses to do, track their progress, access training content, challenges, and playlists. Regarding the training content, the user can access on demand videos of recorded classes; choose pre-made exercise routines and follow a 3d modelled human figure or create his own workouts using the same 3d models ("Holmes Place Member App", 2021). Finally, the app is exclusive to gym members and gym memberships can vary around €60-80/month depending on the gym's location.

6.2 Discovering the Products/ Services

This discovery stage's purpose is to help the UX analysis by allowing us to better understand the competitors. It starts with a table that evaluates the competitors on a list of factors, which were chosen based on the problems and needs identified in the literature review stage and on the competitor's description. This is followed by a table that lists the prices of each competitor (Table 2).

Table 2: Competitors Analysis - Conclusion of Strengths and Weaknesses Analysis

	Indirect competitors			Direct competitors					
Factors	Wii Fit Plus	Fitness Hut	Peloton	The Class			Nike Training Club	Holmes Place App	
Professional guidance	●	●	●	●			●	●	
Training tailored to user	●	●	●	●			●	● ●	
Continuous professional monitoring	●	(with PT) ●	●	●			●	● (with PT)	
Strength exercises	●	●	●	●			●	●	
Flexibility exercises	●	●	●	●			●	●	
Aerobics exercises	●	●	●	●			●	●	
Meets recommended exercise intensity	●	●	●	●			●	●	
Complement to physical therapy/ rehabilitation	●	●	●	●			●	●	
Cognitive stimuli	●	●	●				●	●	
Suitable for declining eyesight	●	●	● TV Laptop, tablet Smartphone	● TV Laptop, tablet Smartphone	● Laptop, tablet Smartphone	● Smartphone	●	● TV Laptop, tablet Smartphone	
Suitable for declining motor dexterity	●	●	● TV Laptop, tablet Smartphone	● TV Laptop, tablet Smartphone	● Laptop, tablet Smartphone	● Smartphone	●	● TV Laptop, tablet Smartphone	
Motivation	●	●	●	●			●	●	
Remains fun	●	●	●	●				●	
Storability	●	NA	● Digital + Bike/Tread	●			●	●	
Time conscious	●	● Close to home Not close to home	●	●			●	●	

Tracks progress	●	●	●	●	●	●
User can create/edit his own workout	●	●	●	●	●	●
User can schedule workouts	●	●	●	●	●	●
Users can train with other users in person	●	●	● (with digital membership)	●	● (with the smartphone's screen)	●
Users can train with other users online	●	●	● (with bike and tread)	●	●	●
Users can compete with other users in person	●	●	●	●	●	●
Users can compete with other users online	●	●	●	●	●	●

- Fulfils the factor
- Does not fulfil the factor completely
- Does not fulfil the factor at all

It was also useful to register the prices of each competitor (Table 3) to, later in the UX analysis, be able to understand if what the competitors charge their consumers maintains a balance between price and value.

Table 3: Competitors Analysis – Pricing comparison

	Indirect competitors		Direct competitors			
	Wii Fit Plus	Fitness Hut	Peloton	The Class	Nike Training Club	Holmes Place App
Price	Wii Fit Plus Pack: €166.90	€6.60-€20/week	Digital Membership: €10.71/month	€33.86/month or €281.17/year	Free installation In app purchases	Free but exclusive to gym members (membership:

			<i>All-Access Membership:</i> €32.39/month <i>Peloton Bike:</i> €1864.25 or €40.69/month <i>Peloton Tread:</i> €3566.57 or €92.17/month			around €60- €80/month, depending on the gym's location)
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6.3 Analysis of Competitors

This stage builds on the previous discovery stage. Focusing on UX, it aims to analyse the products/ services regarding physical exercise, accessibility, price, design, as well as describe what they have that really improves UX and what negatively impacts it ("Benchmark analysis - UX Toolkit Scripts", n.d.).

6.3.1 Physical exercise

Exercise offered. Overall, the competitors offer the recommended exercise types - strength, flexibility, and aerobics. The Class is the exception as it focuses more on flexibility and aerobics.

Tailoring the training to the user. The competitors that allow one on one contact with a personal trainer are the best in this parameter (Fitness Hut, Holmes Place App).

Customization. All competitors allow the user to choose what exercise routines they will perform however, only Fitness Hut (due to its non-digital nature), Wii Fit Plus, and the Holmes Place App allow the user to create or edit their own workout. Fitness Hut allows the user to choose which machines to use and the number of sets and repetitions. The Holmes Place App allows the user to create his own workout by choosing the level of difficulty, goal, days per week, and exercises which will be exemplified by 3d human models. Similarly, in Wii Fit Plus the user can create his own workout by choosing exercises which will also be exemplified by 3d human models.

6.3.2 Accessibility

Availability. The best in this parameter are the competitors that have their service available in a range of mediums (Peloton and The Class). Their services are available on a mobile phone, iPad or tablet, computer, and connected TV.

Familiarity. According to the user questionnaire, the target user has a few issues with technology (e.g, mobile phone, iPad or tablet, computer, connected TV) which may mean that they are becoming more and more familiar with these devices. Therefore, a product that is available in these mediums would be more intuitive to use and would also encourage the users to learn more digital skills that can transfer to their daily lives (Opp & Sary, 2020). In comparison, Wii Fit's interface, at a physical and digital plane, is not similar to products that the target users tend to use in the day-to-day, thus it is not as intuitive to the user.

Ergonomics. Older people have declining eyesight and so, it is important that the content of the products/ services can be easily seen. The products/ services accessible on TV rank higher in this parameter however, a laptop or a tablet can also be appropriate for many users.

6.3.3 Price

Regarding Wii Fit Plus, users make a one-time payment of €166.90 for a product that does not meet the required exercise intensity and will probably not be used on a regular basis as it is regarded as a playful activity. Therefore, if older people purchase this product with the goal of improving their health, they will not be getting what they paid for.

Fitness Hut is known for its affordable low-cost prices and premium quality gym experience. Furthermore, it offers a wide range of machines, classes, and personal trainers, for an added cost. Overall, their pricing is competitive when compared to other gyms that offer a similar experience.

Peloton's digital membership is accessible at €10.51/month and offers several exercise classes however, to have the all-access membership plan, which includes bike and running classes, the user must pay €32.39/month in addition to a Peloton Bike (1864.25€ or 40.69€/month) or a Tread (€3566.57 or €92.17/month) which is rather expensive.

The Class costs €33.86/month or €281.17/year, which is similar to a gym fee but more expensive than Fitness Hut and the digital membership of Peloton. However, their quality service and user experience, considering the customer's positive reviews, may justify the price.

Nike Training Club is a free app with in-app purchases, which can make the user perceive the product as a low-quality product. Customers' reviews point out that the app is slow, it lags frequently, sometimes the video and sound are not in sync, the training plans change without the user's consent and it is impossible to recover the previous plan, and the slightest touch in the screen changes the exercise. Therefore, the customers do not spend money, but they also do not get a high-quality experience.

The Holmes Place App is free to Holmes Place gym members. It is a great added value to their premium gym's membership that can cost around €60-80/month, depending on the gym's location.

In conclusion, the services that offer a better price-quality ratio are Peloton (digital membership), The Class, Fitness Hut, and Holmes Place (app).

6.3.4 Design

Regarding the competitors with digital products, Peloton, The Class, and the Nike Training Club app have the cleanest design however, the Holmes Place app's design is also aesthetic and very functional. In comparison, Wii Fit's aesthetic is more childish (see Appendix E, figures E.1-E.6) which may not appeal to older adults.

Additionally, besides Wii Fit, the other digital products' main colors are black and white accompanied by their brand colors.

6.3.5 What do they offer that really improves UX?

Community spirit. Some of the digital products create a sense of community spirit, weather through live classes (e.g., The Class, gyms) or access to groups that share similar interests (e.g., Holmes Place app). This helps to keep the user motivated and makes him want to come back on a regularly basis.

Professional content. Professional content is valuable and more easily trusted. Without it, users would not consume the product.

Videos with people. Videos with people, when compared to 3 human models, tend to be more attractive to users and can improve UX during a training session (e.g., more engagement, higher motivation to complete each exercise). However, 3 models may be more practical when creating a library of isolated exercises that the user can choose from to create his own training routine.

Music. Live streamed or on demand recorded classes that have soundtracks (e.g., The Class, Holmes Place app) help to immerse the user in the workout and make the experience more fun. “Music-driven workout” (“The Class”, 2021) can create a better UX and the user will associate the experience with fun and achievement.

Personal trainer. Fitness hut and the Holmes Place gym and app, offer sessions with personal trainers that adapt the training to the user’s capabilities, needs, and goals. This improves UX because the users will see faster results, they will perform training routines they are able to complete, and will minimize the probability of injuries. Additionally, frequently scheduling sessions with a personal trainer makes the user work more to show progress in the next session as it holds them accountable.

6.3.6 What negatively impacts UX?

Slow speed. Wii Fit Plus onboarding takes about 8 minutes to complete (*Wii Fit introduction*, 2008). In this process the device is explaining that posture has been deteriorating over time, why it is happening and how Wii can help fight this trend, as well as collecting the user’s age, BMI test results, balance tests results, and asking the user for his goal and deadline. Additionally, customers’ reviews point out that Nike Training Club app is slow and tends to lag frequently.

Poor functioning. Users report frustrating experiences when using the Nike Training Club app. For example, when they are following an exercise session and want to keep the phone on, the slightest touch in the screen changes the exercise. Furthermore, users complain that the video and audio are not always in sync.

Sound design. In Wii Fit, the sound design can get annoying (e.g., sound of messages being typed, sound of the Wii Fit balance board character talking, overweight jingle, failed challenge jingle). Sound should be used to immerse the user and give feedback however, if used in excess (e.g., Wii Fit) it can harm UX.

Motivation approach. Wii Fit's approach to motivating the user is not the most effective. For instance, in the onboarding process, Wii Fit calculates the user's BMI and, if the person is overweight or obese, those labels will show up on the screen (Figure 15) while the Wii character acts disappointed or ashamed.



Figure 15: Wii Fit Plus, BMI Test Result

There are customers reviews that highlight these problems along with disliking the jingle “you’re overweight”, and regarding Wii Fit “guilting” the user into not skipping days of exercise (Figure 16). Ultimately, this negative experience can make the users train more, because they feel worse about their body, but not with Wii Fit as they will look for another solution.

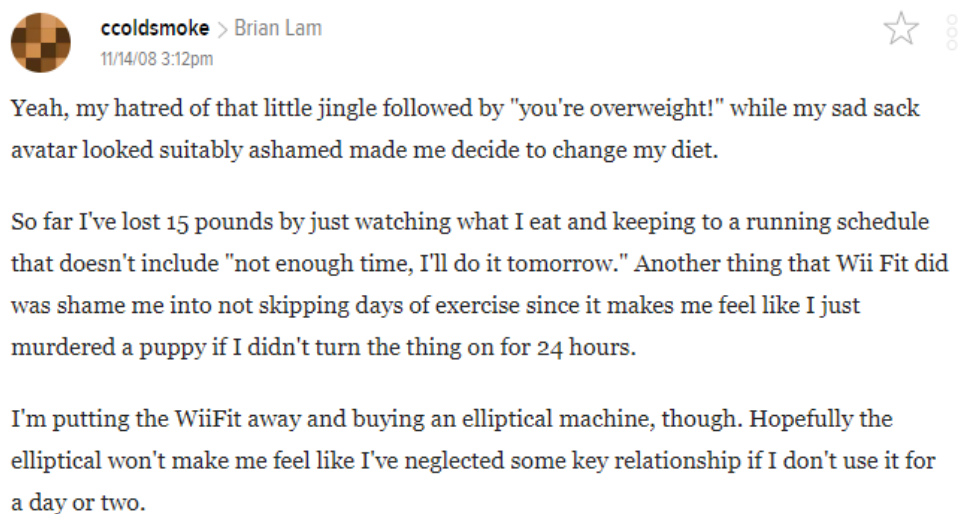


Figure 16: Wii Fit Plus, customer review (Lam, 2008)

7. The Outlook of the Market

Since we are steering for a digital solution to help older adults and young elderly to exercise, this topic focuses on understanding what is happening in the eServices market segment Fitness and in defining the target market and total market in Portugal. It was concluded that, at a global level, the eServices market segment Fitness, which includes wearables and fitness and nutrition apps, is growing in revenue and number of users ("Global eServices fitness industry to hit \$22.5bn in revenue in 2020", 2020). Furthermore, looking specifically at the apps segment, the number of users is growing globally however, in Portugal, the growth of paying fitness apps users is slow ("Fitness - Portugal | Statista Market Forecast", 2020), which could indicate that paid apps do not offer enough value to make users start using them nor switch from free to paid apps. Finally, it was concluded that there is a profitable business opportunity in creating a digital solution that fulfils the users' needs.

7.1.1 eServices, Market Segment Fitness

The eServices market segment Fitness includes fitness wearables and fitness and nutrition apps.

Portuguese market. In Portugal, the revenue for the fitness segment is predicted to reach €33m in 2021 and have an annual growth rate of 2.04%, which translates into a market volume of €34m by 2024 ("Fitness - Portugal | Statista Market Forecast", 2020).

Additionally, the demand for fitness wearables and apps has increased with the contemporary trend of "health and lifestyle awareness". However, while wearables are the market's largest segment when it comes to revenue (predicted market volume of €28m in 2021), and even though more people use apps than wearables (in Portugal and in Europe, see figure 15 for European users), paying app users' growth is still low for apps that detect/track/analyze and share vitality and fitness achievements ("Fitness - Portugal | Statista Market Forecast", 2020).

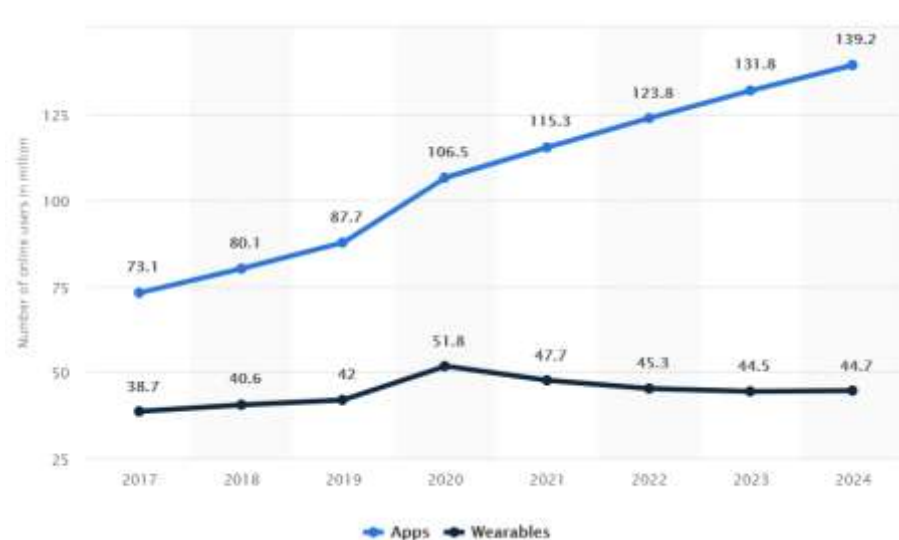


Figure 17: Forecast for the number of online users in the eServices Fitness market in Europe from 2017 to 2024 (Forecast for the number of online users in the eServices Fitness market in Europe from 2017 to 2024, 2021)

One could argue that the existing paid fitness apps do not offer enough value for the user to switch from a free app to a paid one. Furthermore, the analyst that conducted this market analysis report, is of the opinion that the innovation in the app market “is underwhelming”. So, keeping in mind the growing Fitness segment, associated with a market pull related with the health and wellness awareness trend, as well as the slow growing number of paying fitness app users, and the “underwhelming” innovation in fitness apps, it can be concluded that there can be a profitable business opportunity in the innovation gap the fitness apps’ market presents.

Global market. While gyms have suffered with the COVID-19 pandemic, the eServices fitness market benefited as more and more people turned to “fitness apps, online and at-home workout” (“Global eServices fitness industry to hit \$22.5bn in revenue in 2020”, 2020).

Statistical studies (“Global eServices fitness industry to hit \$22.5bn in revenue in 2020”, 2020) were done in 2020 to predict the number of users in the global eServices fitness market and revenue, for the remaining of 2020. The number of users was projected to grow 25% each year which indicates over 1.2 billion users. More specifically, the number of app users was projected to rise to 825.7 million, a 26% increase in a year, and the number of wearables users was projected to rise to 441.5 million, a 24% increase in a year. Furthermore, statistical data shows that the main user groups of this segment are

Millennials (25-40yo) and Gen X (41-56yo), holding respective market shares of 35% and 41%. Regarding revenue, the fitness apps segment was foreseen to grow by almost 32%, compared to 2019, to €2938.6m and the wearables segment to almost €1007.52m, a 30.6% increase. Additionally, it is relevant to mention that China and the US are responsible for more than 50% of the eServices fitness segment revenue ("Global eServices fitness industry to hit \$22.5bn in revenue in 2020", 2020).

7.1.2 Target Market & Total Market

The digital solution's main design focus and target market are 56-74 years old, which is the combination of the older adults group and youngest-old elderly group. However, for this market analysis, we will also look at the potential total market (18-80yo) because [1] adopting an active lifestyle benefits health in all ages and works as a preventive measure to lessen physical and cognitive decline in the years to come, [2] the digital solution should work for almost everyone, and [3] reaching the current main user groups of the eServices fitness segment - Millennials (25-40yo) and Gen X (41-56yo) – can be a possible gateway to introduce the product to the target market (i.e., if a 45-year-old person uses it and likes it, they may recommend it to their parents).

Statistics about older population in Portugal. To get a sight of the statistical trends regarding the older population in Portugal, the researcher looked at statistical data (*Estatísticas Demográficas 2019, 2020*) (Appendix E). The main conclusions were that [1] the average life expectancy at birth is increasing (in 1970 it was 67.1 years old and in 2018 it increased to 80.9 years old) (Appendix E, Figure 55); [2] the ageing index has been rapidly increasing in the last decades (Appendix E, Figure 56); [3] the elderly dependency index has been increasing (Appendix E, Figure 57) and is projected to continuously increase until 2080 (Appendix E, Figure 58); and [4] the number of active individuals aged 55-64 have been continuously increasing since 2011 and the same has happened for individuals aged 65+ since 2016 (Appendix E, Figure 59). These results confirm an increase in older population and active older individuals, which need to exercise to maintain a good physical and cognitive performance as well as self-esteem and energy levels to have a good quality of life.

Furthermore, to calculate an estimate number of potential users from the total market, in Portugal, the researcher used INE's estimated numbers of people by age groups in 2019. According to the previously established total market age range, 18-80 years old,

and how the available statistical data was presented, the researcher looked at the age groups from 20-24 to 75-79 (figure 15). This resulted in an estimate of 2.589.443 55-74-year-old users (target market) and an estimate of 7.677.776 20 79-year-old potential users (total market) (Figure 18).



Figure 18: Estimate of target market and total market

From this 7.677.776 people, only a certain percentage currently uses eServices from the market segment Fitness. Even so, in Portugal in 2020, there were 1.4 million users ("Fitness - Portugal | Statista Market Forecast", 2020), and the numbers are projected to continue to grow. Furthermore, if the digital solution is designed with a human centred approach with focus on experience, if it fulfils the user needs, and if it adds value to the user when compared to existing free apps, it will increase the chances of successfully penetrating this big market.

8. Product Development

8.1 Definition of a Product

In this dissertation, we are steering towards a more holistic understanding of a product. We argue that a product can be both physical and digital if it respects the design process and Rams' 10 principles for good design.

“In a nutshell, product design encompasses the process of creating a product, from understanding the problem to creating a solution.” (Merryweather, 2020).

For many years product design was related to the design of physical products. In that context, Dieter Rams, one of the most influential industrial designers worldwide, defined 10 principles for good design. He argues that good design is innovative and develops alongside technology; it makes a product useful and emphasizes its usefulness; it is aesthetic and that aesthetic contributes to the product's usefulness and impacts the users' life in a positive way; it is understandable, or even self-explanatory; it is unobtrusive as it leaves room for the users to express themselves; it is honest in the sense that it offers what it promises; it is long-lasting as it is not designed for fast fashion; it is detail oriented because it respects the user; it is environmentally friendly by minimizing resources and any kind of pollution throughout its lifecycle; and, it is as simple as possible since it only focuses on the essentials ("Dieter Rams - 10 principles for good design", 2021).

The definition of product has evolved, much like Rams first principle, alongside technological development. In today's digital era, product can mean a physical or digital product. The creation of both is based on the same process - understanding the problem to create a solution that will benefit the consumers. Furthermore, all Rams' good design principles can be applied to digital products. Therefore, in this dissertation, we will consider this more holistic understanding of product.

Additionally, one could argue that adopting this definition also enhances the human design approach, as by focusing on the users and not on the solution's medium, e.g., physical, or digital, we can better define which type of solution could benefit them most.

8.2 Ideation

Due to the results of the literature review, expert interviews, and user questionnaires four important things became clear, [1] older adults need to exercise physically and cognitively to maintain or improve their capabilities, [2] professional guidance is recommended to avoid injuries and maximize benefits, [3] target users would feel more motivated to exercise if they had personalized plans made by professionals, and [4] their main obstacles to exercising are laziness, lack of motivation and lack of time. Taking this information into consideration, the solution should be digital. This would allow for the user to have professional content, guidance, and personalized plans in a few clicks; it would save time since they would not have to commute somewhere else to exercise, and hence may help fight laziness.

Furthermore, the target users also answered they would feel more motivated if they could exercise with friends and family, and a digital solution could allow that.

8.2.1 Design requirements

In this step the researcher prioritized user needs and listed features that could solve them. Additionally, some thoughts regarding the features were written down (see yellow rectangles) to be further reflected upon in the future (Figure 19).

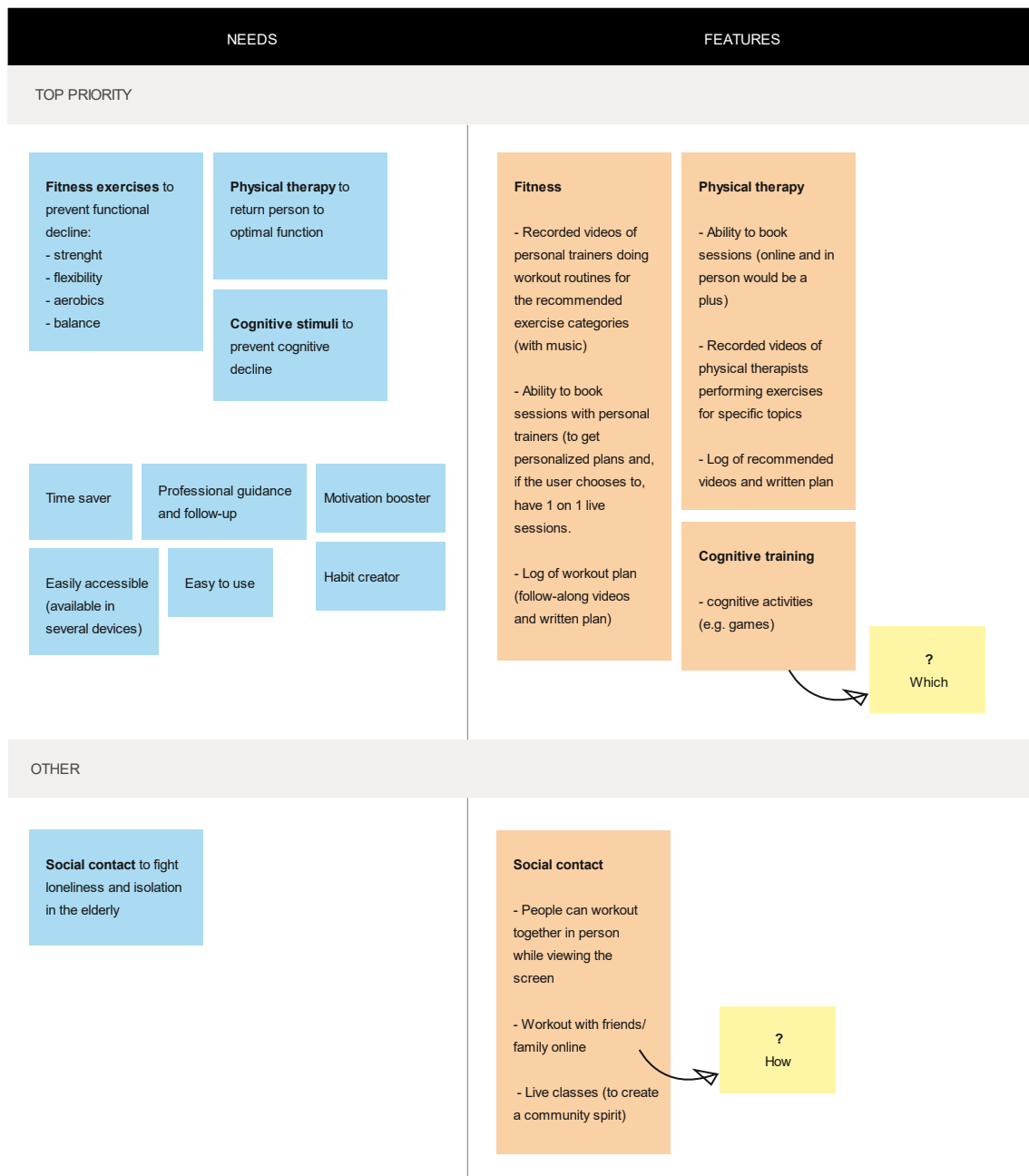


Figure 19: Design requirements – needs and features

8.2.2 UX/UI

Besides the required features, it is important to consider the UX/UI aspects of the digital solution. So, the following image shows what should be considered as well as some more specific aspects the solution should include (Figure 20).



Figure 20: Design requirements – needs and UX/UI

8.2.1 Prioritization

For this study, the solution can be a digital platform that offers physical exercise, physical therapy, cognitive training. Furthermore, to offer a more personalized experience, the users can schedule online sessions with professionals and obtain personalized plans.

The main goal at this stage is to create a wireframe-based prototype with these main features in mind, so other features (i.e., exercising with friends and family online) will not be explored at this stage. Furthermore, to get a sense of the target users' mental maps, a card sorting can be done.

8.3 Card Sorting

Based on the research and ideation stages, the researcher defined cards and categories. A closed card sort was conducted to understand the potential users' mental maps and inform the interface's navigation plan. It consisted of asking participants to place the predefined cards in predefined categories.

8.3.1 Sample

The questionnaire was answered by 10 Portuguese citizens, 6 female, 4 male ($M=56$; $SD=17.31$). The chosen group of participants was chosen based on age (8 of the respondents were 55-87 years old), diversity of exercise habits (some do not exercise, and some do), and diverse experiences with gyms and apps (some have no experience, some have experience with gyms and some with gyms and exercise apps). Furthermore, 2 of the respondents were chosen because they work in physical therapy and in the sports field.

8.3.2 Material

The card sorting activity included 7 categories with pre-defined titles and 33 cards. At the beginning of the activity an introduction was provided to disclose information about the goal of the study and instructions. The categories are as follows: [1] Physical exercise; [2] Physical therapy; [3] Cognitive training; [4] My plans; [5] Profile; [6] Filters; and [7] I am not sure.

8.3.3 Procedure

The card sorting activity (Appendix F) was done on Miro in August 2021. The respondents were invited to participate via message and upon agreeing they were sent the link to Miro where they had all the necessary information and card sorting board (Figure 21). The response rate was being monitored and, after reaching 10 responses, the activity was closed to analyse the data.

Each participant did the activity individually in Miro, except for the 87-year-old that did an in-person card sort with paper cards due to her low technological skills and health. Furthermore, when possible, the participants were asked questions to better understand the reasoning behind some of their choices.



Figure 21: Card sorting board on Miro

8.3.4 Results and Discussion

The data was analysed by following Shanshan Ma's method (Ma, 2010). Firstly, in excel, a table was created to list the categories and cards used as well as the number of times a card was placed in a certain category. Secondly, those numbers were turned into percentages. Furthermore, to facilitate the analysis, only the percentages above 30% were considered substantial to take into consideration. Afterwards, for each category, the cards were grouped by percentages (see highlighted cells in Table 4) and some percentages above 30% were ignored due to [1] the same card had a higher percentage in another category) and [2] due to their nature (e.g., physical exercise, physical therapy, cognitive training) some cards could not belong outside its category.

Table 4: Card sorting data

Cards	Physical exercise	Physical therapy	Cognitive training	My plans	Profile	Filters	I am not sure
Strenghts	100%	10%			10%	10%	
Aerobics	90%					10%	10%
Balance	80%	10%	20%		10%	10%	
Flexibility	70%	30%			20%	10%	
Mobility	30%	70%				10%	
Posture	30%	80%		10%	10%		
Localized treatment		90%		10%			
Fine motor skills	20%	60%	30%				
Coordenation	50%	20%	50%			10%	
Memory			90%		20%	10%	
Perception			90%				
Reasoning			90%		20%		
Speed	50%		50%	20%			
Sessions with professionals	20%	60%	10%	20%		20%	10%
Personalized plan	30%	10%		80%		10%	10%
To do today				60%		40%	
Goals accomplished	10%			70%	10%	10%	
Goals		10%		50%	30%	10%	10%
Profile picture					90%		
Sex					80%	10%	10%
Age					90%	10%	
Health problems		20%			80%		
Subscription plan information (price, cancel)	10%			30%	30%	10%	30%
Equipment	50%	20%	10%			20%	10%
Level of difficulty	70%	10%	40%	20%	10%	10%	
Level of intensity	80%		10%	10%	10%	20%	
Personal trainer	90%		10%				10%
Duration of training	80%		30%	10%		10%	
Physical therapist		100%					
Recomended for you		20%		20%		50%	
Trending				20%	10%	70%	
New				20%		80%	

Besides this quantitative data, other observations regarding the participants' mental maps are worth mentioning. Firstly, some participants interpreted the Profile category as a place to keep information on their health as well as performance – they placed cards thinking they were doing a self-evaluation of their skills i.e., memory (“My memory is not that great”), physical therapy (“I do it”), flexibility (their flexibility level). Considering this and the benefits of offering a personalized experience, the Profile section could have a questionnaire where the users can rate their skills in several parameters which will influence the content shown in the app.

Secondly, prior to the card sorting, the researcher was considering including the following cards in the Filters category - “equipment”, “level of difficulty”, “level of intensity”, “personal trainer”, “physical therapist”, “duration of training”. However, the participants did not perceive those as filters and placed them in the “Fitness”, “Physical Therapy”, and “Cognitive Training” categories instead, while choosing the cards “recommended for you”, “trending”, and “new” as filters. On one hand, [1] the fact that the participants were not in the context of the app could have hindered their perception of the cards and where they could go, and [2] one could assume that older users could start associating the first mentioned group cards as filters (“equipment”, “level of difficulty”, “level of intensity”, etc.) by using the app. On the other hand, perhaps the screens for the categories “Fitness”, “Physical Therapy”, and “Cognitive Training” should give more emphasis to the cards the participants placed in those groups and the filters should be aligned with what they chose (“recommended for you”, “trending”, “new”).

8.4 User flow

This section shows the user flow for the concept solution that was done for the interface on iPad Pro. The chosen device was an iPad because of its screen size, portability, and because studies show older adults prefer tablets to smartphones (Polyuk, 2019).

Furthermore, the wireframes and prototype were made in Figma, and they include the account creation, sign up, sign in, the questionnaire screens for when the user first signs in, as well as the main content (personalized plans, physical exercise, physical therapy, cognitive training). To see the wireframes in more detail please follow the link:

<https://www.figma.com/file/bLLgRh2fooi6oHdJWkImne/Expert-review?node-id=1%3A2>

It is relevant to mention that there were a few versions of the navigation plan. Initially, the explorations were more closely based on the card sorting categories and results however, by sketching and doing low-fidelity wireframes, it was concluded that a different, and possibly more intuitive, navigation plan could be followed.

The navigation bottom bar includes [1] Your area, [2] Physical exercise, [3] Physical therapy, [4] Cognitive exercise, [5] Help.

Your area includes the client's profile, statistics (to motivate him to keep training), personalized plans made by professionals, and settings.

Physical exercise, Physical therapy and Cognitive exercise include follow-along videos organized by categories as well as the filter functionality.

Help was included in the navigation bar because older people are more likely to look for this functionality to find tutorials and information when they face a problem (Polyuk, 2019).

8.4.1 Sign up

The sign up can be done through the website's landing page or upon downloading the app. If the user starts the sign up in the landing page, he will insert the email on there and will be directed to the sign-up screens where the email will be auto filled. He will then create a password, choose a plan, choose a payment method, insert payment method details, and download the app. If he downloads the app first, he will insert the email and complete the sign-up process.

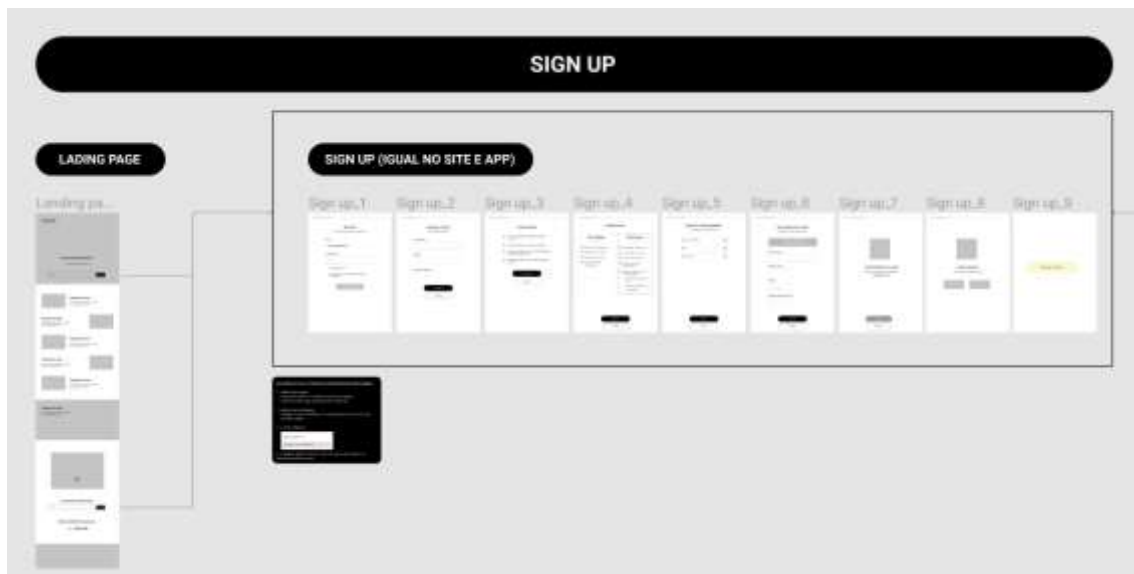


Figure 22: Sign-up flow

The input fields followed the recommendations (Wroblewski, 2014) of Luke Wroblewski, an acclaimed digital product leader and Product CEO at Google. For instances, the title of the input field is above the field and the password is not hidden unless the user checks the “hide password” box. The latter, in comparison to the dots that usually show up when

typing a password, allows for the user to view the password and discards the need to insert it again, which is a better solution for older adults.

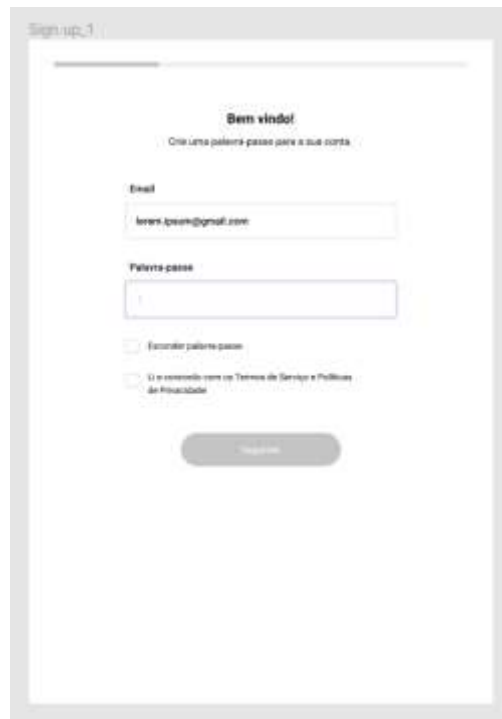


Figure 23: Sign-up flow detail – input fields

Additionally, in order to further reduce user errors and considering the design implementation (coding), the design follows other suggestions made by Wroblewski (2014). Firstly, the input type should be set according to the input field's nature, for example, if it is an input field for an email (Figure 24), the input type should be set to “email” which includes the “@” and reduces the size of the spacebar; if the user has to insert a phone number, the input type should be set to “number”, so when the user clicks on it, it opens the number keyboard).



Figure 24: Input type email

Secondly, input attributes should be defined (e.g, turn off auto capitalize in email and password input fields). Thirdly, there should be in-line validation for e.g., the email input-field (Figure 25) so when the user types the email wrong, he can understand which part needs correcting and correct it faster.

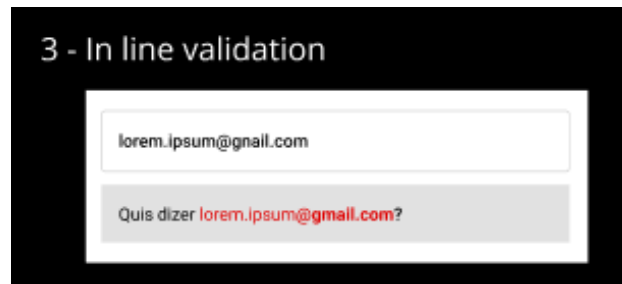


Figure 25: In line validation example

8.4.2 Sign in

This is the sign-in screen inside the app, which is similar to the sign-up one except it has the “Create account” button in case the person has not gone through the sing-up flow.



Figure 26: Sign-in screen

After signing in for the first time, the user will answer a questionnaire.

8.4.3 Questionnaire for personalized content

The questionnaire's (Figure 27) objective is to collect data about the user's health and physical and cognitive pains as well as goals and available time in order to personalize the app's content to the user. The questionnaire was designed as follows: [screen 1] explains the goal of the questionnaire and has the CTA to start the questionnaire; [screen 2] asks for the client's gender, birthdate, height and weight; [screen 3] asks if the client has any of the mentioned diseases, if he does or needs physical therapy, if he has mobility issues, and if he has been experiencing cognitive declines; [screen 4] asks for the client's goals and available time to exercise; [screen 5] shows an informative message e.g.. "Please wait while we personalize the app for you. Do not turn off your device nor the internet. This will take about 2 min"; [screen 6] shows the personalization is complete and the user can click on the button to go to the homepage.



Figure 27: Questionnaire after the first sign-in

Once the questionnaire is answered, the user will not have to answer it again, the app will continue to adapt its content with CRM, according to what the user does on the app.

8.4.4 Your area

This would be the app’s homepage which includes configurations, the user’s profile, some statistics to help motivate the user to exercise more (e.g., number of follow-along exercise videos completes, number of minutes spent exercising, number of sessions with professionals), the entry point for “personalized plans” as well as to “sessions with professionals”.

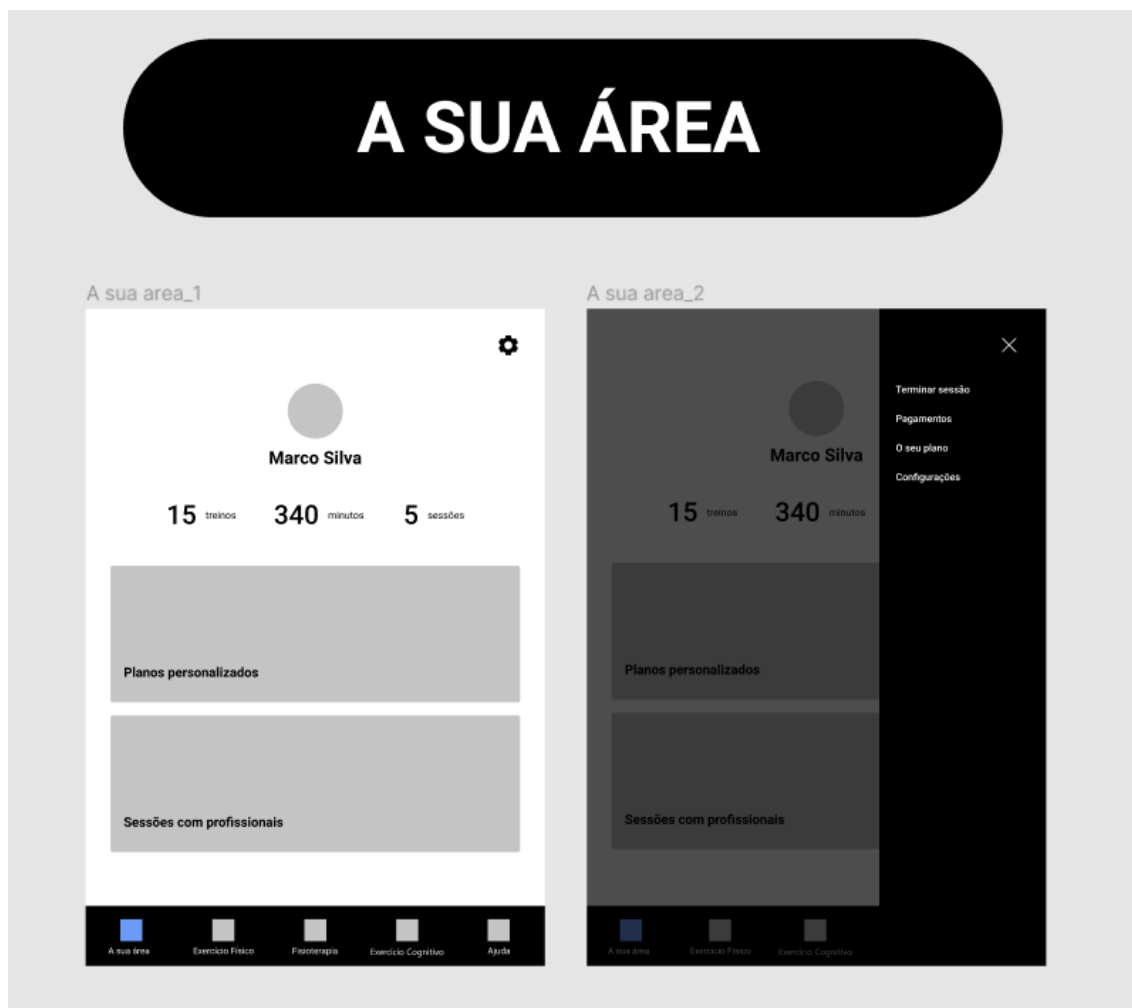


Figure 28: Your area screens

This part should be further iterated upon: do they want to see the statistics of their training inside the app? Do they want a profile picture, something else or nothing at all? Is the navigation intuitive and clear when it comes to the “personalized plans” and “sessions with professionals”, should it be designed in another way?

The personalized plans are obtained by scheduling sessions with professionals. Thinking of a business perspective, the feature of scheduling sessions would only be included in the premium plan so an empty state was created for those clients who need to upgrade their plan in order to access this feature. Furthermore, there would be an entry point for personalized plan for physical exercise, physical therapy, and cognitive exercise. Moreover, inside each personalized plan there would be a line with the day numbers (e.g., 1, 2, 3, 4, 5) with progress loaders for each day so the user knows how much he has completed, as well as follow-along videos for each day.



Figure 29: Your area – Personalized plans

The following image shows the screens of “Sessions with professionals” which include the screens for the clients who need to upgrade their plan, an empty state, how it would look with scheduled sessions as well as the flow to schedule a session.

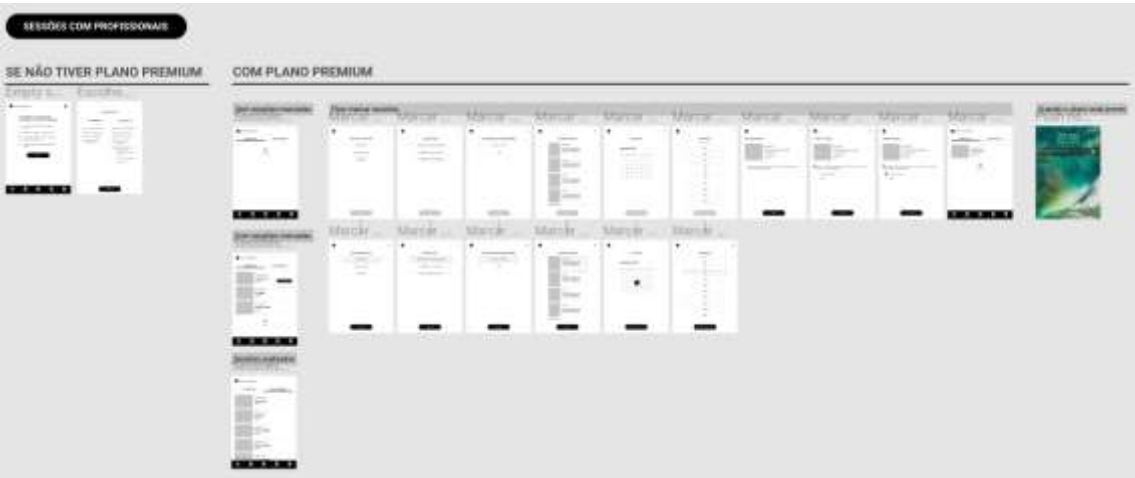


Figure 30: Sessions with professionals screens

If the user has scheduled sessions before, he can see his future sessions as well as a history of his past sessions (as seen in the tabs on the screen bellow). Furthermore, if it is time for the online session with the professional, the user can press the button “Start meeting”.



Figure 31: Sessions with professionals – scheduled sessions

He can also schedule another session by clicking on the last rectangle with the “+”.

Additionally, to schedule a session the user will choose [1] If it is a session of physical exercise, physical therapy or cognitive exercise, [2] choose the type of session (to get a personalized plan, a training session, or a follow-up session), [3] if he wants to choose the professional or not, and if so [4] choose the professional, if not goes straight to [5] choose a date, [6] choose a time slot, [7] confirmation screen with the summary of the booking and where he can check a checkbox to be reminded before the sessions takes place.



Figure 32: Scheduling session – a sample of the screens in the flow

8.4.5 Physical Exercise & Physical Therapy & Cognitive Exercise

This sub-section shows the screens for 3 areas in the app: physical exercise (Figure 33), physical therapy (Figure 34) and cognitive exercise (Figure 35), as their layout is the same.

Even though in the card sorting the participants seemed to not understand the concept of “Filters”, they were included in the final design suggestion with a different copy that could facilitate their interpretation, “Filter exercises”, so that the follow along videos could be immediately visible. Moreover, if the user wants to filter content, he can click on “Filter exercises”. However, this solution should be tested with target users to see if the copy is clear to them and if a different navigation approach should be followed.



Figure 33: Physical exercise



Figure 35: Physical therapy



Figure 34: Cognitive exercise

8.4.6 Help

The last option on the navigation bar is “Help” since older adults are more likely to turn to the help page for support (Polyuk, 2019). It is important to note that this screen was not as explored as the others due to time restrictions so it is more an indication of what type of content it could have: a search bar, tutorials for frequent asked questions, and the available contacts for support.



Figure 36: Help screen

8.5 UI Guidelines

The main goal for the product development stage was to build a prototype and evaluate it so that we can steer towards a better design solution. When it comes to UI, the interface should follow interface Design guidelines for older adults (Polyuk, 2019) which can be summarized as follows:

Vision guidelines. Older adults suffer from decreased vision so the interface should have high contrast and big font sizes, fonts should be a minimum of 16px (Polyuk, 2019).

Motor control guidelines. The buttons should be at least 44x44x44 pixels on an iPad, and bigger for apps and websites. Furthermore, gestures should be simple to perform,

they should not require more than two fingers - simple horizontal, vertical, or diagonal gestures are more recommended (Polyuk, 2019).

Cognitive guidelines. Older adults have a slower processing speed due to cognitive declines so they may need more time to absorb information and may take longer to complete tasks. Furthermore, memory declines should also be considered. Notifications can help remind them of things they have to do in the future and clear feedback and reminding the user of the end goal can help overcome working memory decline (Polyuk, 2019).

Additionally, older adults are not as used to icons as younger users thus icons should be labelled with text when possible (Polyuk, 2019).

Motivation guidelines. Older adults need more motivation to keep using an app. In order to increase their motivation to use the app, its benefits should be clear, and it should be useful and easy to use (Polyuk, 2019).

9. Conclusion and Future Work

The general objective of this study was to discover *what kind of product can enhance Elderly people's self-esteem?* In order to answer this, the following methods were used: literature review, expert interviews, user questionnaire, competitive benchmark, market analysis, personas, card sorting, and expert evaluation.

The literature review showed that there has been a continuous increase in ageing population worldwide, and with it, an increase in people with lower self-esteem, as it tends to decline with age (Robins et al., 2002; Tresniewski, 2003; Orth et al., 2010). It was also identified that self-esteem is further diminished by the decline in cognitive and physical abilities inherent to biological ageing (Azevedo, 2015; Soeiro, 2010; França, 2015).

Other studies have been done to understand whether video games and exergames can improve their physical and cognitive abilities. It was concluded that exergames do not offer the recommended exercise intensity (Kappen et al., 2018) and have low to none cognitive benefits (Stojan & Voelcker-Rehage, 2019; Sala et al., 2019). Moreover, the percentage of elderly playing them is low mainly due to lack of interest (Loos, 2017).

The target chosen was older adults (56-64-year-olds) and youngest-old elderly (65-74-year-olds) and the remainder of the study was done with these age groups in mind.

The expert interviews pointed out that while most older individuals desire to maintain or improve their health, few seem to understand that they can, and should, have an active role in their health and well-being. They are, as said by an expert, “stuck on the old paradigm of health – a healing model instead of a preventive one”. Other data gathered in the expert interviews reflects this mental model. Firstly, few 56+ year-olds practice physical exercise with professional guidance. Secondly, many 56+ year-olds do physical therapy with professionals, especially 65+ year-olds. Lastly, many 65+ years-old visit the hospital daily, especially men. Furthermore, the experts corroborated that the decline of physical abilities is psychologically painful for older adults and it is reflected by a decrease in self-esteem. On a more positive note, it was also said that, nowadays, youngest-old elderly are more motivated to improve their physical and cognitive health than before (e.g., due to still being an active working member in society).

The user questionnaires also showed that older individuals value activities that contribute to their well-being however, overall, 56+ year-olds do not practice activities that benefit their physical and cognitive health. Moreover, the questionnaire showed that most of them do not have an interest in game play nor agree that exercise in a game format would increase their motivation to exercise nor showed interest in using such a product.

This dissertation’s answer to the research question, *what product can enhance Elderly people’s self-esteem?*, is that a digital product, created with a Human Centred Design approach focused on user experience, that offers physical and cognitive stimuli can enhance the Elderly’s self-esteem.

It is proposed that the product can be a digital platform, accessible from several devices, which offers professional guidance from personal trainers and physical therapists, and physical exercise and cognitive stimuli in a fun and challenging way. If the former is met, the product can have the potential to prevent or delay the fall in self-esteem in Elderly people and possibly contribute to delaying the need to institutionalize them. Furthermore, this study argues that the likelihood of such outcomes can be further increased by following a Human Centered Design approach focused on developing a positive user experience that genuinely satisfies Elderly user needs and motivations.

This proposal was explored to an extent in the product development stage. It is important to note that, some of the features were not explored in detail:

- Cognitive activities and games (e.g, which activities and games should be included, how should they be presented, and what would the interactions be?)
- In “Your area” there is a profile picture with the person’s name – that area could open a profile page with more information.

Furthermore, some ideas were not explored in the wireframes due to time limitations and could be included later on:

- Live streamed online classes (can increase motivation and spirit of community)
- Gamification (to increase motivation, fulfilment, and fun) - list of achievements/badges (e.g., like Nike Running Club)
- Social feature (to increase social contact) - users could be able to exercise with friends and family (in person looking at the screen and in a remote way through the app)
- Offer the option to schedule in-person training (by partnering up with personal trainers and physical therapists)

Additionally, it is essential to conduct user testing to detect more usability problems, namely, to learn if they understand filters and horizontal scroll, and test different navigation plans to see which works best for these age groups.

In conclusion, this study answered the research question *what kind of product can enhance Elderly people’s self-esteem?* and attempted a design solution which helped uncover some pertinent usability issues that need more exploring (e.g., if they understand filters and horizontal scroll) as well as raised the question *what would be the best navigation plan for older individuals?* Furthermore, since we are following a Human Centered Design approach, future work would include [1] expert evaluation, [2] user testing [3] iteration, [4] consult exercise experts to validate and improve the app’s questionnaire and content, [5] expert validation, and the necessary iterations and testing until a viable solution is reached.

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Appendix A – Expert Interviews Guide

Context and guidelines

Hi, my name is Laura Matos. I am working on my master thesis “Enhancing the Elderly’s Self-Esteem Through an Interactive Product”, and I have a few questions regarding your area of expertise. Understanding your clients’ needs will help me come up with a product that is valuable to them and maybe even to you.

If that is okay with you, type your answers in this document, under the related questions.

When you’re done you can send the doc back to me (laura_matos@live.com.pt). I would appreciate if you could rename the doc as **E2_Name_Surname**.

If you need anything, you can send me an email or text me on Whatsapp to +351 915 326 482.

Thank you!

Fill in your data

Age:

Gender:

Nationality:

Field of expertise:

Countries where you have worked in:

Email:

Interview (Group 1: personal trainers, physical therapists)

Clients

1. Do you have Elderly clients (65+)? If so, how many (few, some, many)? What is their age range? What is their gender distribution (approximately)?

2. Do you have older adults as clients (56-64 years old)? If so, how many (few, some, many)? What is their age range? What is their gender distribution (approximately)?

Regarding the “youngest-old” Elderly (65-74 years old)

3. What are their most common struggles/pains at a physical level?
4. What are their most common pains at a psychological level?
5. What are their goals in this life stage? What do they care about?
6. How motivated are they to maintain or improve their health at a physical and cognitive level? If the motivation is low, what could be done to motivate them?

Regarding physical exercise

7. What are the most important movements/exercises to maintain mobility and strength as an “older adult” (56-64 years old) and “youngest-old elderly” (65-74 years old)?
8. What is the ideal exercise frequency and intensity for “older adults” (56-64 years old) and “youngest-old elderly” (65-74 years old)?

Regarding self-esteem

9. How do you think the decline in physical abilities reflects on self-esteem?
10. How do you observe the decline in self-esteem?
11. How motivated are they to maintain or improve their self-esteem? If the motivation is low, what could be done to motivate them?
12. Given that physical and cognitive abilities influence self-esteem, what are the physical and cognitive stimuli that can help maintaining self-esteem?
13. Do you know any other ways that could help self-esteem?

Comparing Wii fit with PRAMA

14. In your professional opinion, and considering the “youngest-old” user (65-74 years old), can you compare the benefits (at a physical, cognitive, and psychological level) derived from playing Wii vs another exergaming technology like PRAMA? Watch the short videos to know more about these technologies.
 - a. Wii fit - <https://www.youtube.com/watch?v=hHwxP9Vlpjw>

b. PRAMA – https://www.youtube.com/watch?v=rHb_n8U8yFI

15. In your opinion, which one is the easiest to use for the “youngest-old” user?
16. Which one do you think attracts them more? Why?
17. If the technology that attracts them more, is the one with the lowest health benefits, how can we shift that attraction to the other one?

Your feedback (optional)

18. Is there anything I missed, or that you would like to add?

Interview (Group 2: nursing home staff, day center staff, nurses)

Clients

19. Do you have Elderly clients (65+)? If so, how many (few, some, many)? What is their age range? What is their gender distribution (approximately)?
20. Do you have older adults as clients (56-64 years old)? If so, how many (few, some, many)? What is their age range? What is their gender distribution (approximately)?

Regarding the “youngest-old” Elderly (65-74 years old)

21. What are their most common struggles/pains at a physical level?
22. What are their most common pains at a psychological level?
23. What are their goals in this life stage? What do they care about?
24. How motivated are they to maintain or improve their health at a physical and cognitive level? If the motivation is low, what could be done to motivate them?

Regarding self-esteem

25. How motivated are they to maintain or improve their self-esteem? If the motivation is low, what could be done to motivate them?
26. How do you think the decline in physical abilities reflects on self-esteem?
27. How do you observe the decline in self-esteem?
28. What has been done to help self-esteem in the Elderly? (If you do not know, answer: I don't know).
29. Do you know any other ways that could help self-esteem?

30. Given that physical and cognitive abilities influence self-esteem, what are the physical and cognitive stimuli that can help maintaining self-esteem?

Comparing Wii fit with PRAMA

31. In your professional opinion, and considering the “youngest-old” user (65-74 years old), can you compare the benefits (at a physical, cognitive, and psychological level) derived from playing Wii vs another exergaming technology like PRAMA? Watch the short videos to know more about these technologies.
- c. Wii fit - <https://www.youtube.com/watch?v=hHwxP9Vlpjw>
 - d. PRAMA – https://www.youtube.com/watch?v=rHb_n8U8yFI
32. In your opinion, which one is the easiest to use for the “youngest-old” user?
33. Which one do you think attracts them more? Why?
34. If the technology that attracts them more, is the one with the lowest health benefits, how can we shift that attraction to the other one?

Your feedback (optional)

35. Is there anything I missed, or that you would like to add?

Appendix B – User Questionnaire Guide

Questionnaire title

Study of physical and cognitive habits of people that are 56+ years old

Section 1: Introduction

Hello! This questionnaire is part of a thesis for the Master's Degree in Product and Space Design taught at IADE.

This study is aimed at all people aged 56 and over. No prior knowledge is necessary, as the study only intends to learn about your physical and cognitive habits as well as preferences.

It takes about 10 minutes, and all collected data will remain anonymous.

Thank you for participating!

ATTENTION!

You can only participate if you are 56 years or older.

Section 2: Initial data

Age (do not answer this questionnaire if you are under 56 years old. Thank you!)

- ☐ 56-64
- ☐ 65-74
- ☐ 75-84
- ☐ 85+

Gender

- ☐ Male
- ☐ Female
- ☐ Other

When you chose an activity, what kind of activity do you value the most? (choose a maximum of 3 options)

- An activity for entertainment
- An activity that helps me develop as a person
- An activity that contributes to my physical health
- An activity that contributes to my psychological health
- An activity to socialize

Section 3: Physical and Cognitive Habits

How much time per week do you dedicate to the following activities?

	None	Less than 1h	1h-2h	2h-3h	3h-4h	4h-5h	More than 5h
High intensity exercises (eg., running, cycling)							
Medium intensity exercises (eg., marching, dancing)							
Low intensity exercises (eg., standing, walking slowly, riding a bike slowly)							

How many days per week do you do weight exercises (eg., with additional weights, with body weight)?

- Never
- Rarely (1-2 times per month)
- Sometimes (1 day per week)
- Frequently (2-3 days per week)
- Very frequently (more than 3 days per week)

Select what applies to you. I prefer to exercise:

- ☐ At home
- ☐ Outside (street, park)
- ☐ At the gym
- ☐ Sometimes at home, sometimes outside
- ☐ Sometimes at home, sometimes at the gym
- ☐ I do not enjoy exercising
- ☐ Other...

Select what applies to you. I prefer to exercise:

- ☐ Alone
- ☐ With someone
- ☐ Sometimes alone, sometimes with someone
- ☐ I do not enjoy exercising
- ☐ Other...

How much time per week do you dedicate to the following activities?

	None	Less than 1h	1h-2h	2h-3h	3h-4h	4h-5h	More than 5h
Reading							
Memory games							
Board games							
Sudoku							
Dominos							
Crosswords							
Drama							
Dance							
Learning new things (eg., a new language)							
Teach something to someone else							

How much you agree with the following statement?

I'm confident that I can have healthier habits (eg., do more physical and/or cognitive exercise).

Strongly disagree 1 2 3 4 5 Strongly agree

Which incentives would motivate you to take better care of your health? (choose a maximum of 3 options)

- ☐ Live longer
- ☐ Be healthier
- ☐ Have more energy
- ☐ Feel better at a body and mind level
- ☐ Feel happier
- ☐ Save money
- ☐ Lose weight
- ☐ Be able to spend more quality time with family
- ☐ Be autonomous (be able to perform daily tasks)
- ☐ Avoid going to a nursing home
- ☐ Having had a health scare
- ☐ Other...

Which obstacles are preventing you from exercising? (choose a maximum of 3 options)

- ☐ Lack of time
- ☐ Lack of money
- ☐ Health problems
- ☐ Physical incapacity
- ☐ Lack of motivation
- ☐ I need help
- ☐ I need guidance
- ☐ I am lazy

- I don't know how to start
- I don't see the goal in exercising
- Other...

Section 4: Gameplay Habits

Which non-digital games do you play in your free-time? (select all options that apply)

- Board games
- Card games
- Puzzles
- Foosball
- Pingpong
- Dards
- Team sports (eg., football)
- None
- Other...

Which digital games do you play in your free-time (eg., games on your mobile phone, iPad, computer, Playstation, Wii)? (select all options that apply)

- Logic games (eg., Tetris, Trivia games)
- “Exergames” – physical exercise games (eg., Wii fit)
- Board games (eg., traditional games like chess)
- Card games (eg., solitaire, poker)
- Party games (eg., Mario Party, Wii Party)
- Sport games (eg., races, team sports, fight games)
- Strategy games (eg., Tower defense, war games, Minesweeper)
- Rhythm games (eg., music or dance games like Piano, Guitar Hero, just Dance)
- None
- Other...

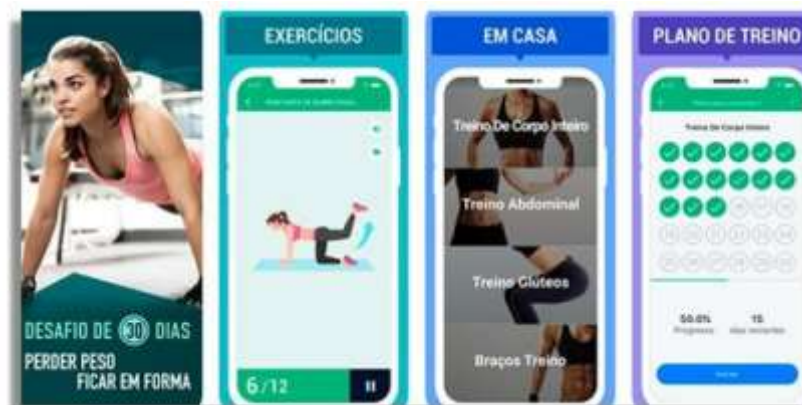
Section 5: Knowledge about physical exercise products

Your knowledge about Wii fit



- I know and play
- I know and I don't play
- I don't know
- I've heard about it but I don't know what it is

Your knowledge about physical exercise apps (eg., used on your smartphone or iPad)



- I know and use them
- I know and I don't them
- I don't know them
- I've heard about them but I don't know what they are

Your knowledge about physical products for exercising (eg., exercise bike, weights, pull-up bar, stepper)



- ☐ I know and use them
- ☐ I know and I don't them
- ☐ I don't know them
- ☐ I've heard about them but I don't know what they are

How much you agree with the following statements?

I would be more motivated to exercise if it were in a game format.

Strongly disagree 1 2 3 4 5 Strongly agree

I would be more motivated to exercise if I used an exercise app.

Strongly disagree 1 2 3 4 5 Strongly agree

I would be more motivated to exercise if I had physical products for exercising at home (eg., exercise bike, weights, pull-up bar, etc.).

Strongly disagree 1 2 3 4 5 Strongly agree

I would use a product that offered exercise in a game format.

Strongly disagree 1 2 3 4 5 Strongly agree

I would use an exercise app that offered exercise plans and follow-along videos.

Strongly disagree 1 2 3 4 5 Strongly agree

I would use a physical product for exercising (eg., exercise bike, weights, pull-up bar, etc.).

Strongly disagree 1 2 3 4 5 Strongly agree

Section 6: Final Thoughts

How much you agree with the following statements?

I wish to maintain or improve my health (state of complete physical, mental and social well-being, and not just the absence of diseases or illness).

Strongly disagree 1 2 3 4 5 Strongly agree

I wish to maintain or improve my well-being (state of feeling comfortable, healthy or happy).

Strongly disagree 1 2 3 4 5 Strongly agree

I value my autonomy (ability to perform daily tasks)

Strongly disagree 1 2 3 4 5 Strongly agree

I am motivated to adopt healthier habits that will contribute to maintain or improve my health.

Strongly disagree 1 2 3 4 5 Strongly agree

I am motivated to adopt healthier habits that will contribute to maintain or improve my well-being.

Strongly disagree 1 2 3 4 5 Strongly agree

I am motivated to adopt healthier habits that will contribute to maintain or improve my autonomy.

Strongly disagree 1 2 3 4 5 Strongly agree

If I exercised with friends or family, I would be more motivated.

Strongly disagree 1 2 3 4 5 Strongly agree

If I followed an exercise plan created by professionals, I would be more motivated.

Strongly disagree 1 2 3 4 5 Strongly agree

I like challenging activities.

Strongly disagree 1 2 3 4 5 Strongly agree

Accomplishing challenges gives me satisfaction.

Strongly disagree 1 2 3 4 5 Strongly agree

[Section 6: About you](#)

Evaluate yourself on the following topics.

When using technologies (such as smartphones, iPad or a computer)

- ☐ I don't have problems when using technology
- ☐ I have few problems when using technology
- ☐ I have some problems when using technology
- ☐ I have many problems when using technology
- ☐ I can't use technologies when using technology

How is your mobility?

- ☐ I can't walk
- ☐ I have few problems walking
- ☐ I have some problems walking
- ☐ I have many problems walking
- ☐ I don't have problems walking

In your day to day, how frequently do you feel pain?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Very frequently

How do you classify those pains?

- ☐ No pain
- ☐ Soft pain
- ☐ Mild pain
- ☐ Strong pain
- ☐ Very strong pain
- ☐ Maximum pain

Do you feel anxiety in your day to day (eg., feelings of tension, worry, insecurity or even physical changes)?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Very frequently

Do you feel feelings of anguish or profound sadness?

- ☐ Never
- ☐ Rarely
- ☐ Sometimes
- ☐ Frequently
- ☐ Very frequently

Thinking about your loved ones, which of the following options better describes your situation?

- ☐ I have the social contact I want
- ☐ I have good social contact
- ☐ I have some social contact
- ☐ I have little social contact
- ☐ I don't have social contact

How much do you agree with the following statements?

	Strongly disagree	Disagree	Agree	Strongly agree
I feel I do not have much to be proud of				

I take a positive attitude toward myself				
On the whole, I am satisfied with myself				
All in all, I am inclined to feel that I am a failure				
I feel I'm not a person of worth, at least on an equal plane with others				
I certainly feel useless at times				
At times I think that I am no good at all				
I am able to do things as well as most other people				
I feel I have a number of good qualities				
I wish I could have more respect for myself				

Section 7: Demographics

Education – Please indicate the highest diploma you have obtained.

- ☐ Less than a high school diploma
- ☐ High school or equivalent
- ☐ Bachelor's degree
- ☐ Master's degree
- ☐ Doctorate degree
- ☐ Other...

Employment – Please indicate your current situation.

- ☐ Employed full time
- ☐ Employed part-time
- ☐ Unemployed (I am looking for a job)
- ☐ Unemployed (I am not looking for a job)
- ☐ Student
- ☐ Retired
- ☐ Self-employed
- ☐ Unable to work

Location – In what city do you live in?

Civil status

- ☐ Single (never married)
- ☐ Married
- ☐ I live with my partner
- ☐ Divorced
- ☐ Widowed

Living situation

- ☐ I live alone at my own home
- ☐ I live with my husband/wife/partner
- ☐ I live in a house with other people
- ☐ I live in a nursing home
- ☐ I am temporarily living with friends or family
- ☐ Assisted living

Appendix C – Results From the User questionnaire

This appendix contains the remaining data regarding the user questionnaire that has not been shown in the body of this study.

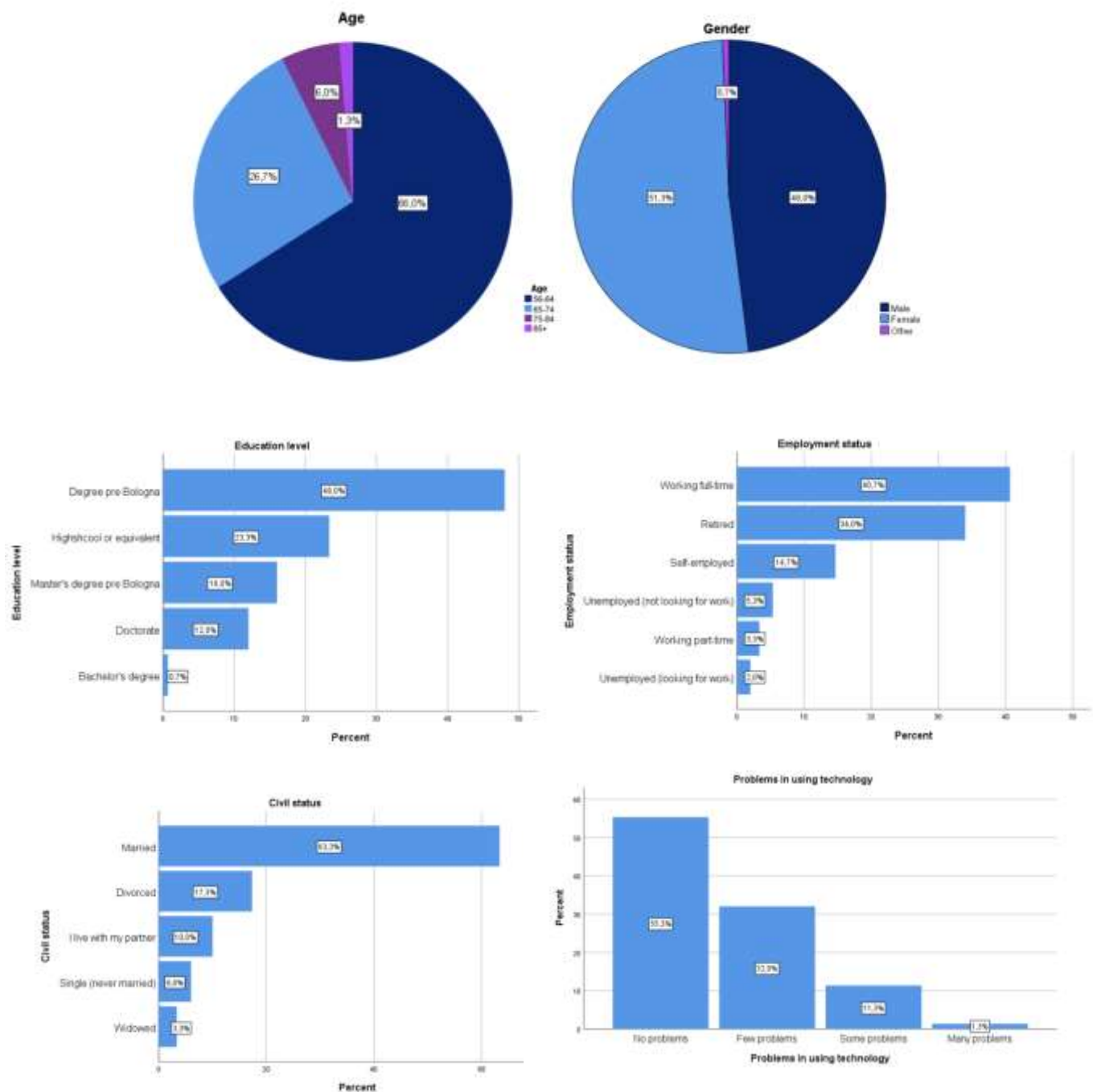


Figure 37: Demographic profile

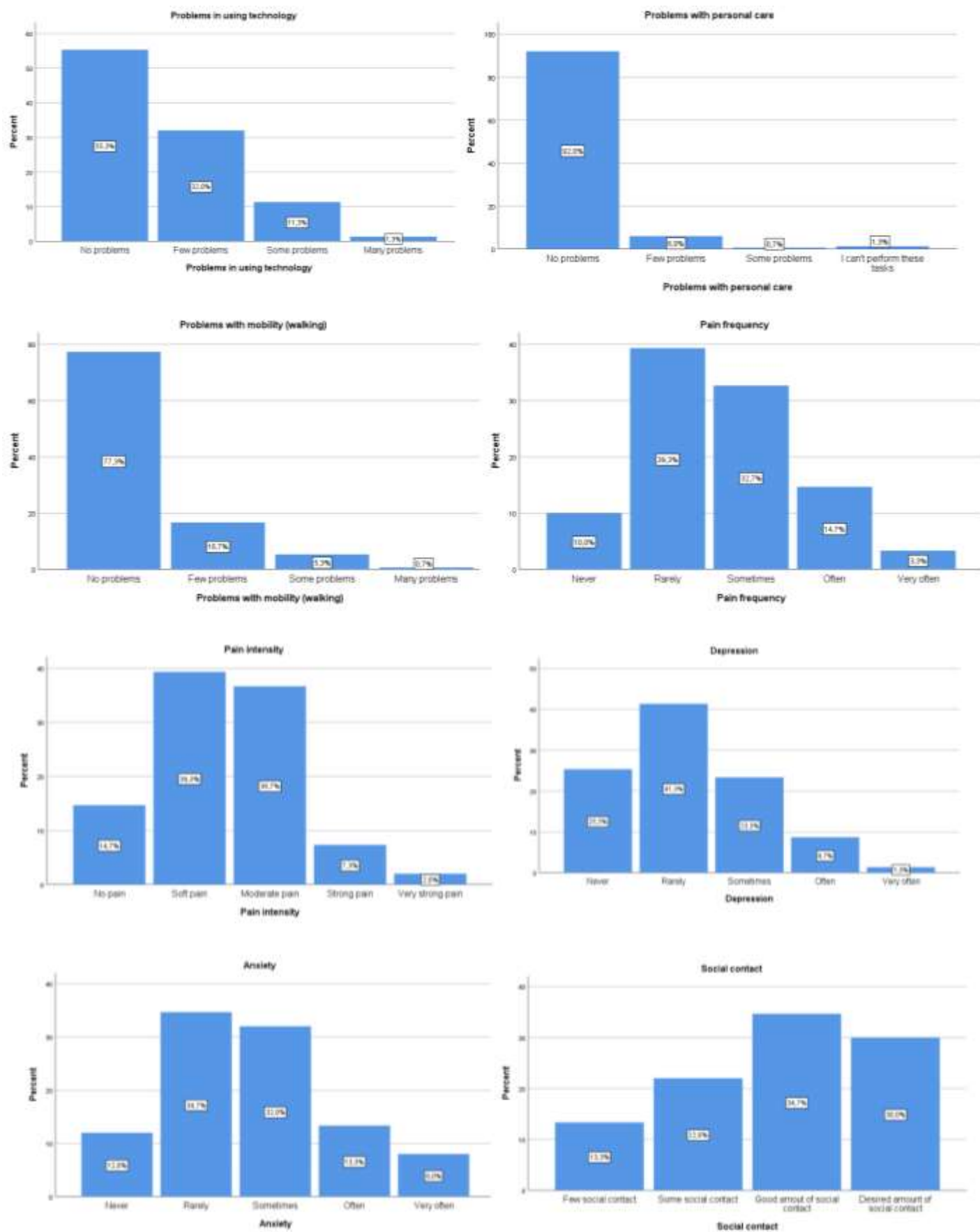


Figure 38: Target users' profile

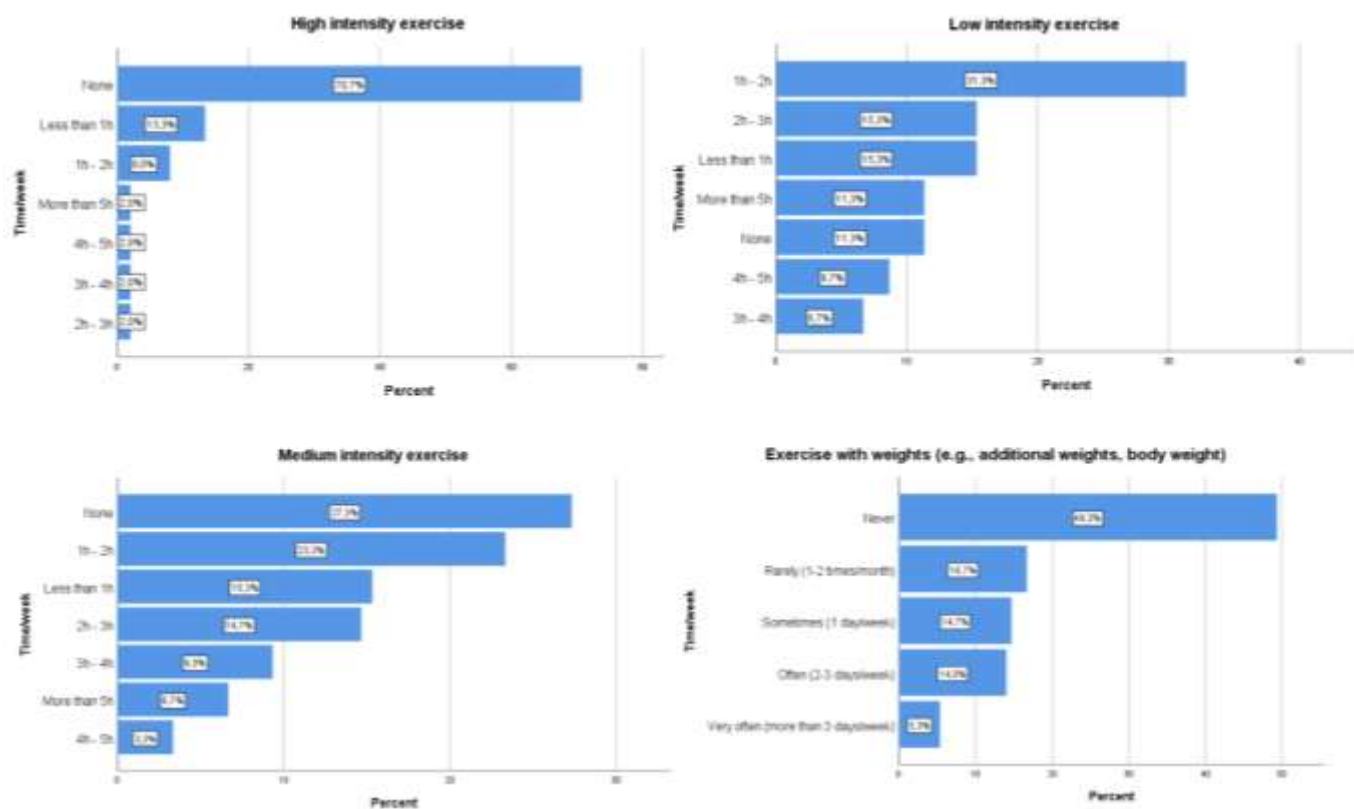


Figure 39: Exercise habits

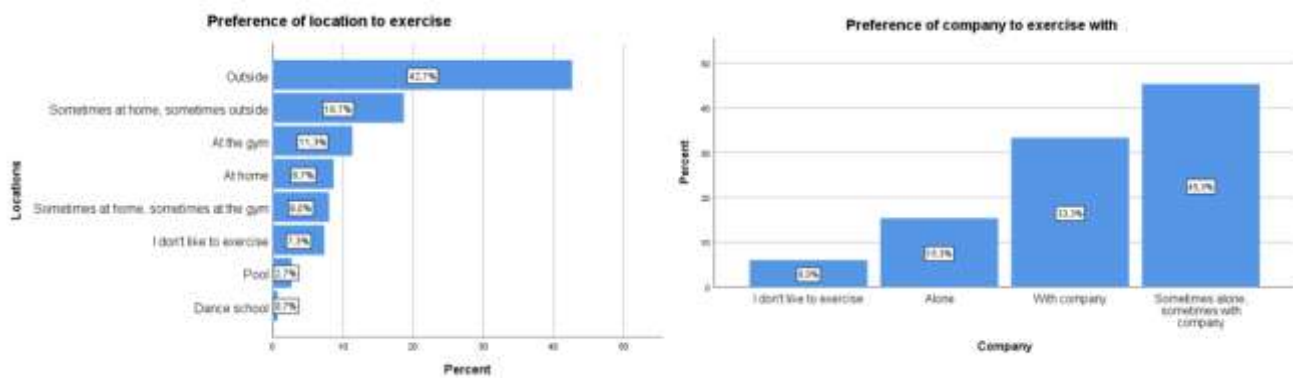


Figure 40: Preference of location and company to exercise

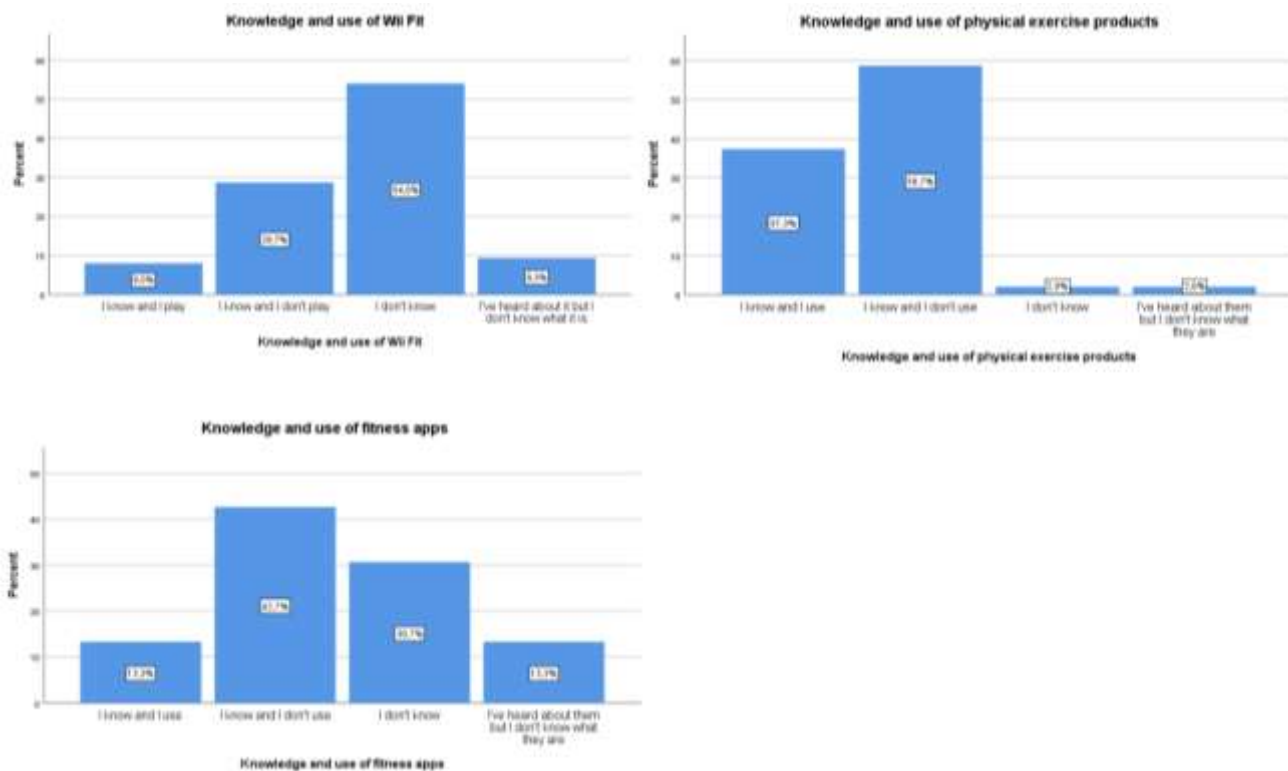


Figure 42: Knowledge and use of fitness products

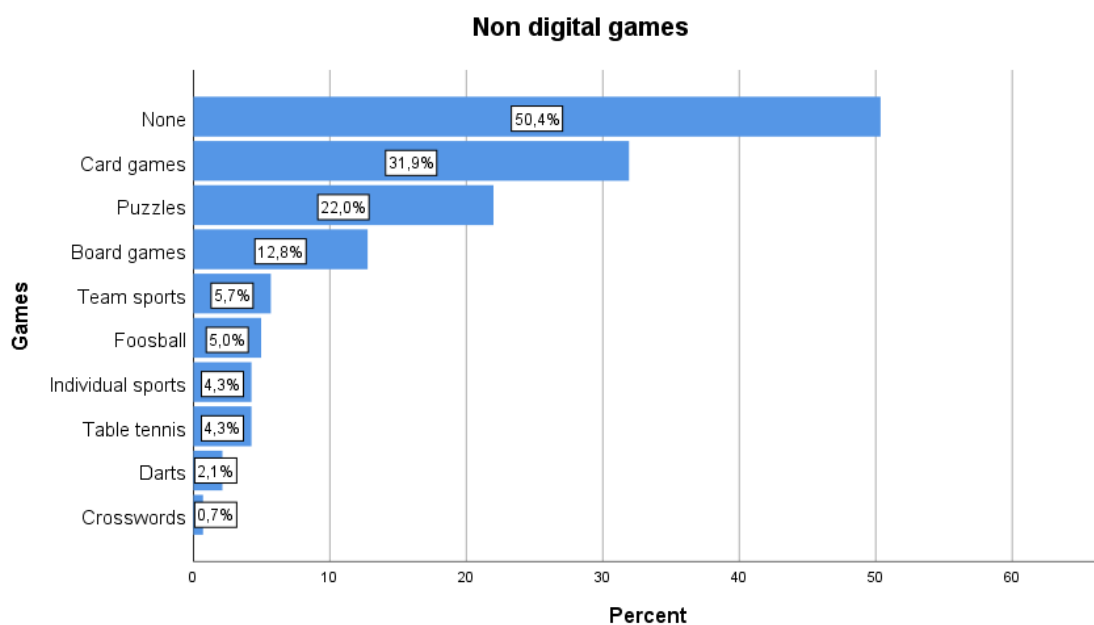


Figure 41: Non-digital games played

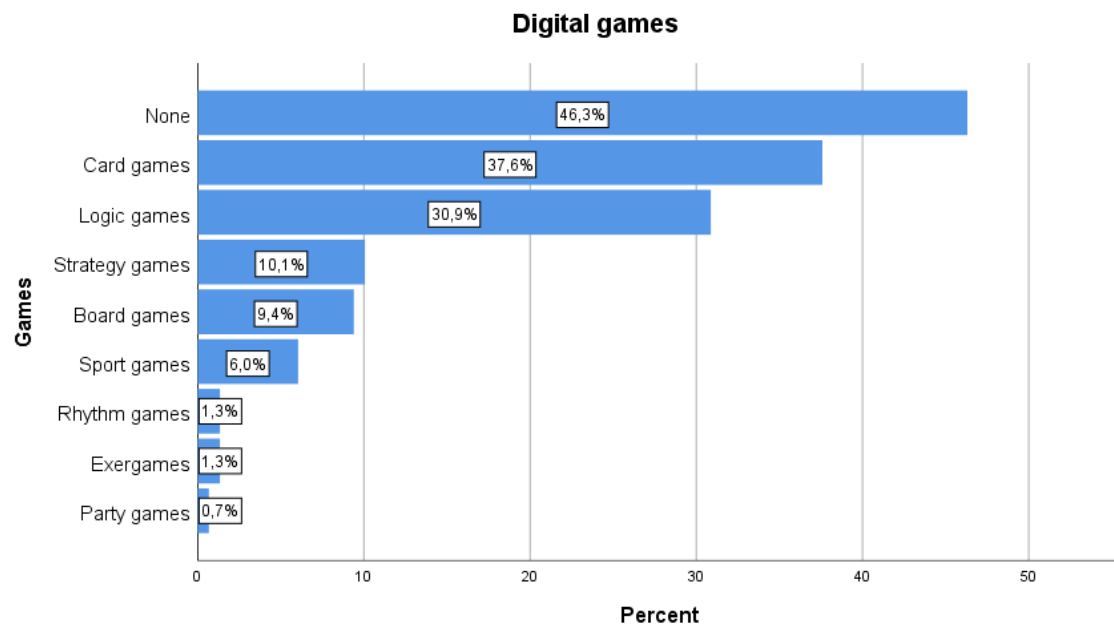


Figure 43: Digital games played

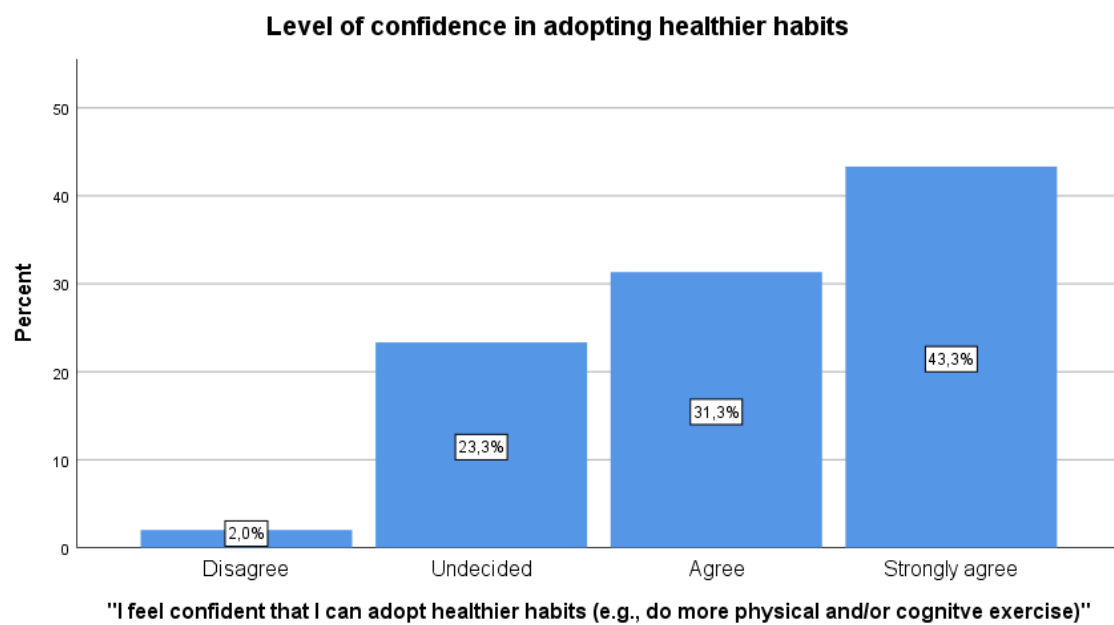


Figure 44: Level of confidence in adopting healthier habits

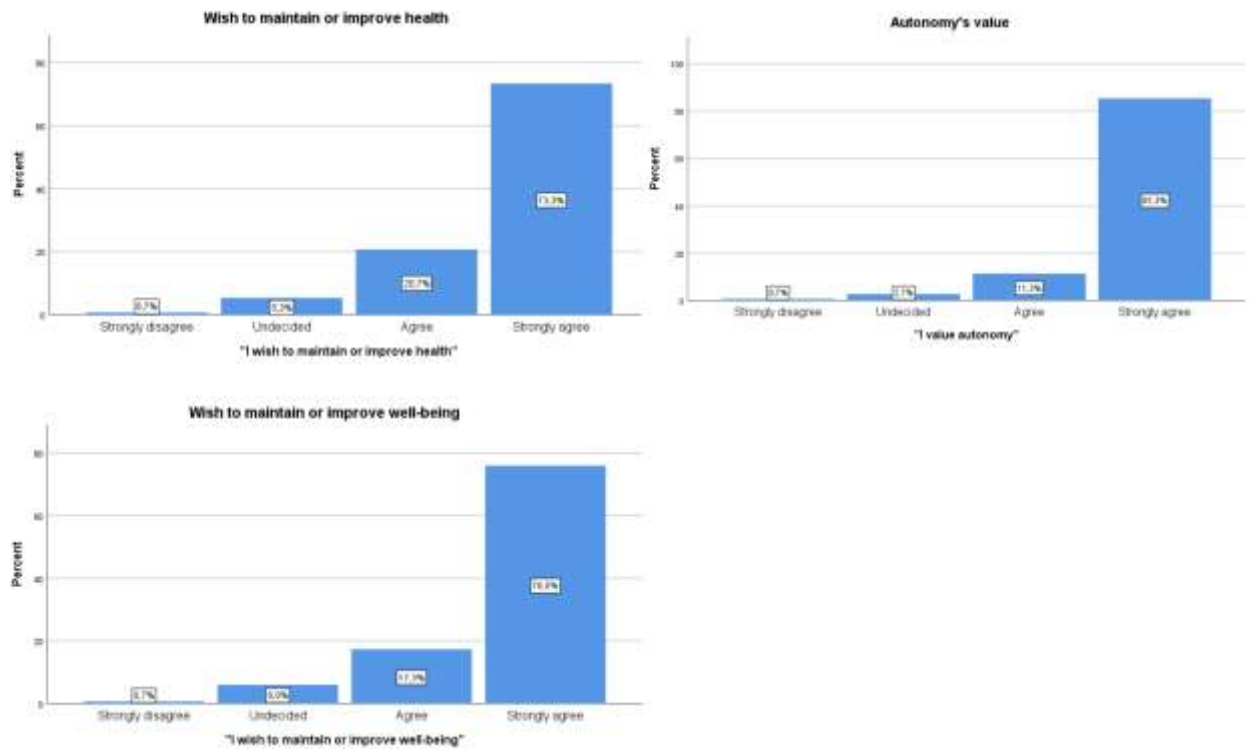


Figure 45: Wish to maintain or improve health and well-being, and autonomy's value

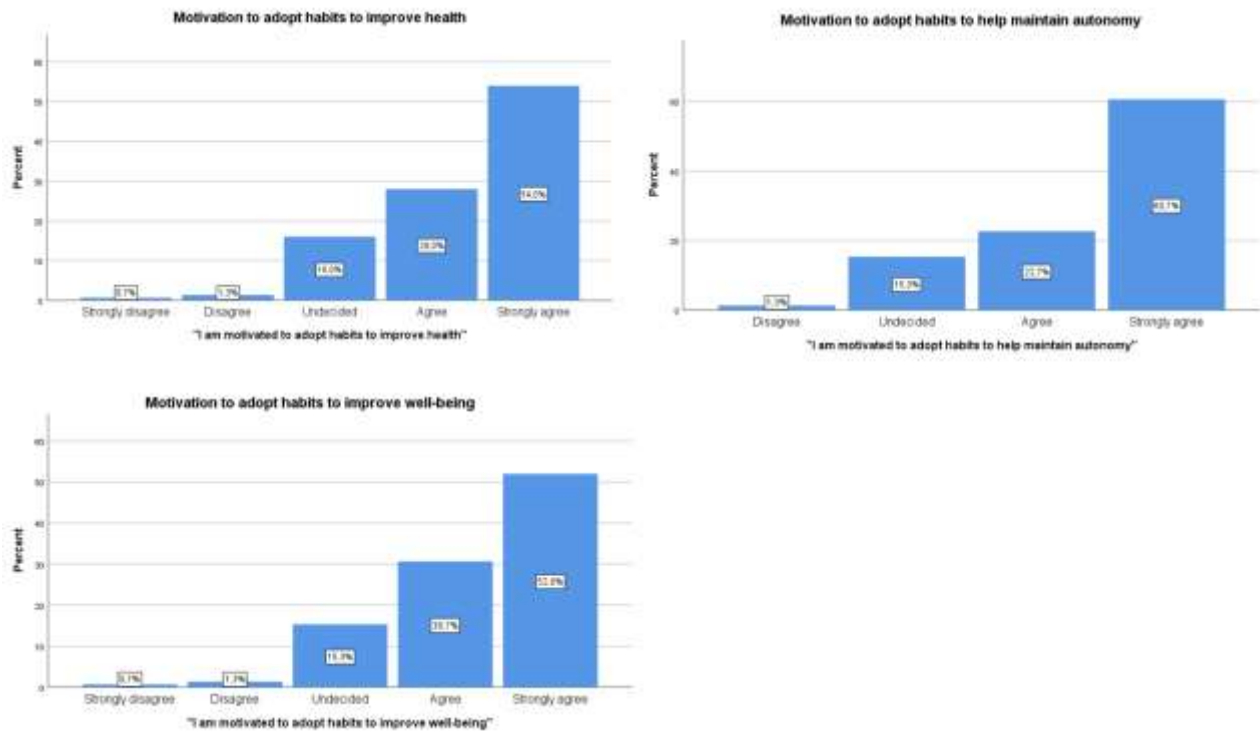


Figure 46: Motivation to adopt healthier habits to improve health, well-being, and maintain autonomy

This information was not taken into high consideration because, according to previous data, the second highest obstacle to exercising was low motivation and most of them do not exercise, hence their motivation is unlikely to be reflected by the data gathered in this question.

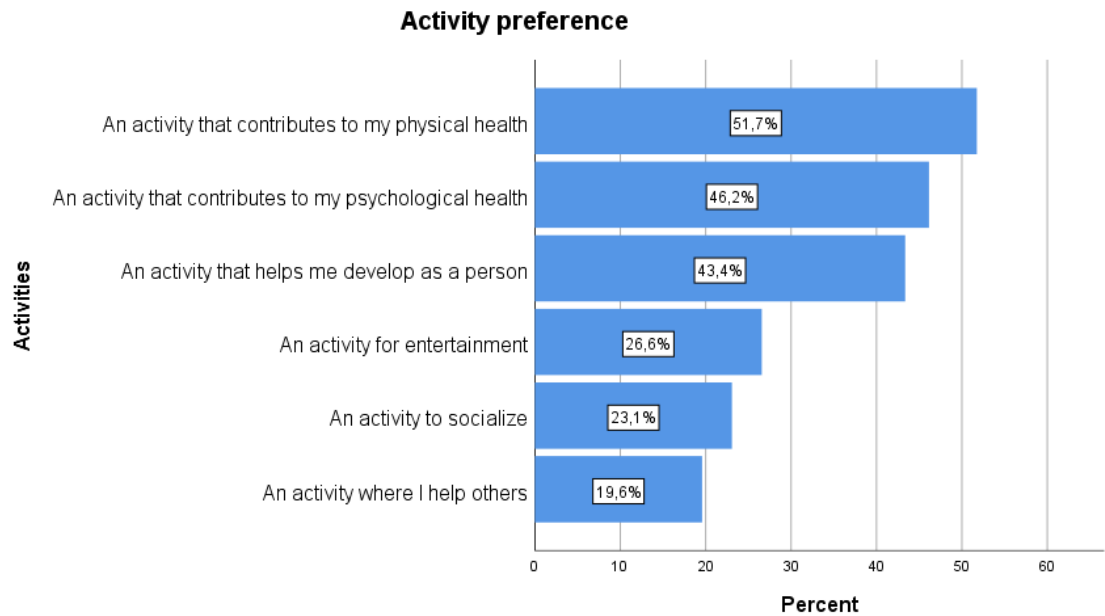


Figure 47: Activity preference

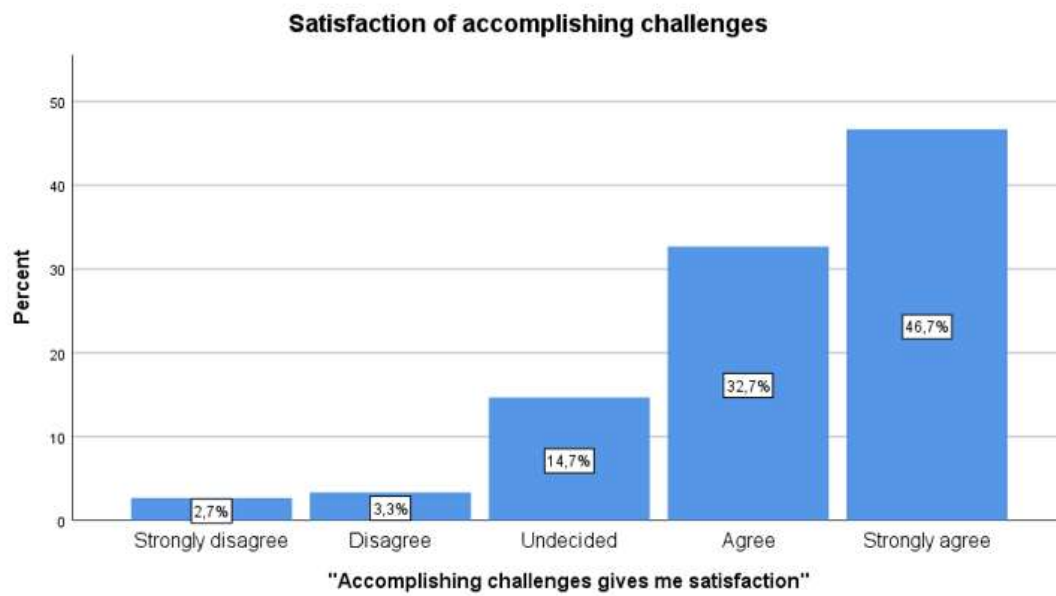
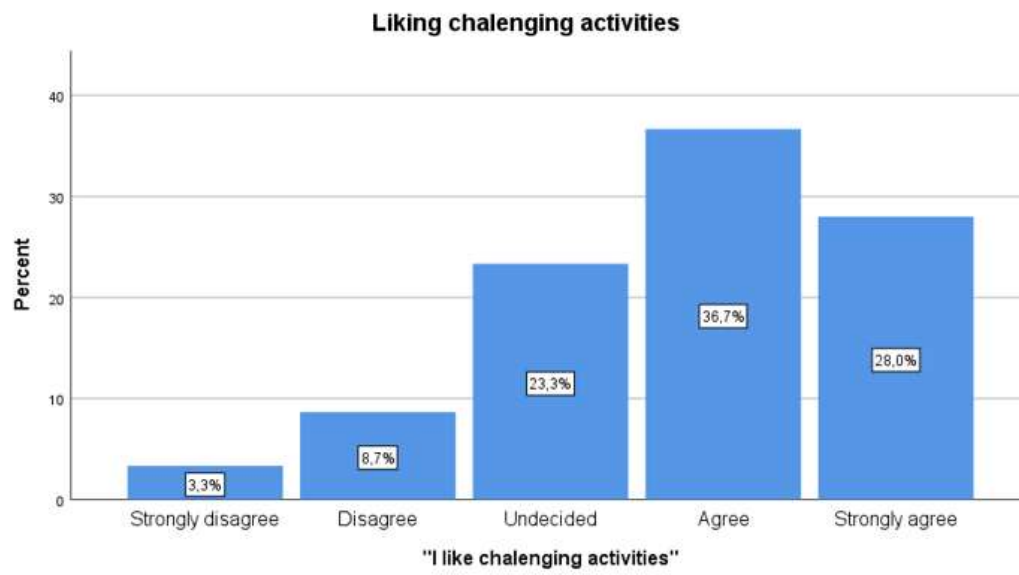


Figure 48: Variables on challenging activities

Appendix D – Competitive Benchmark

Images

This appendix contains images of the competitors identified in the benchmark section.

Wii fit Plus



Figure 49: Wii fit plus



Figure 50: Fitness Hut

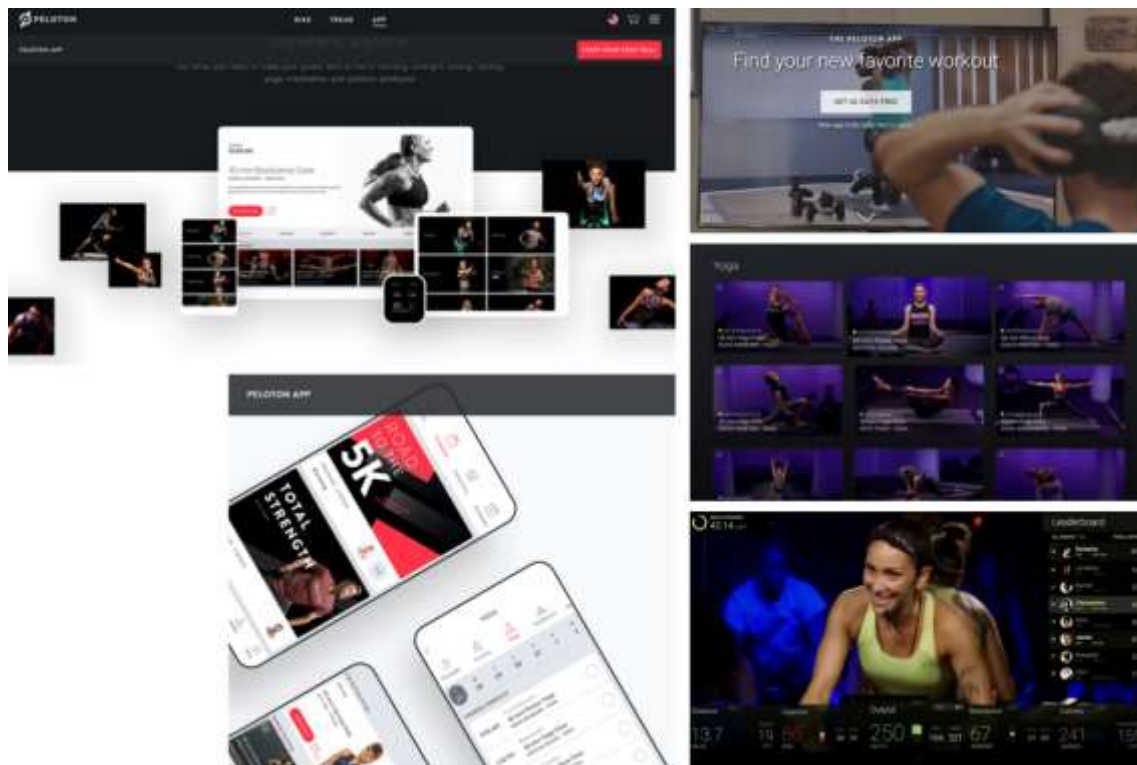


Figure 51: Peloton

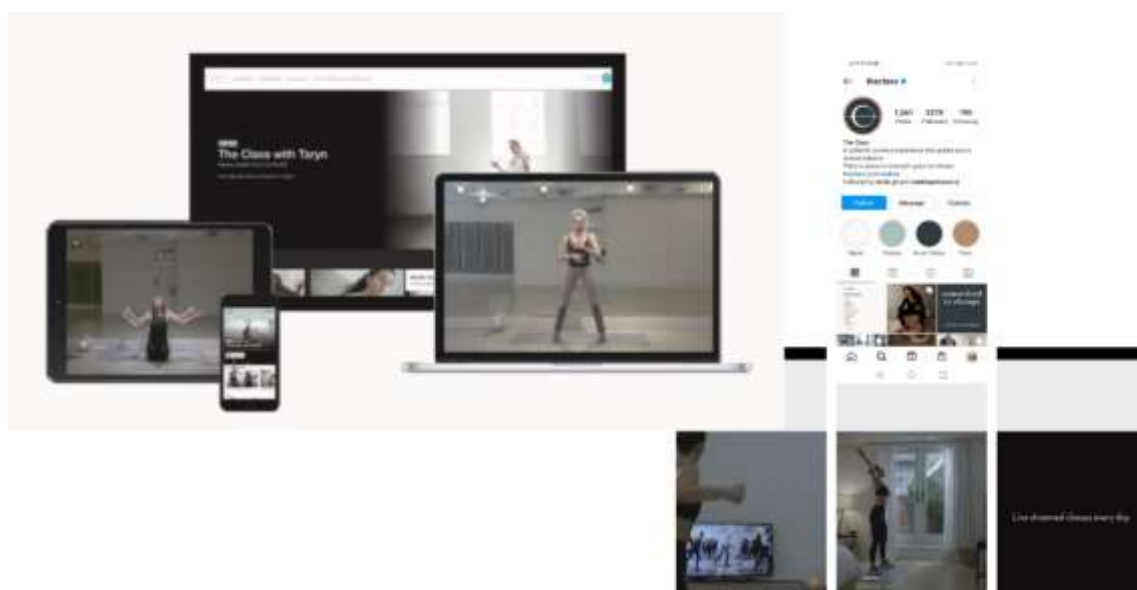


Figure 52: The Class

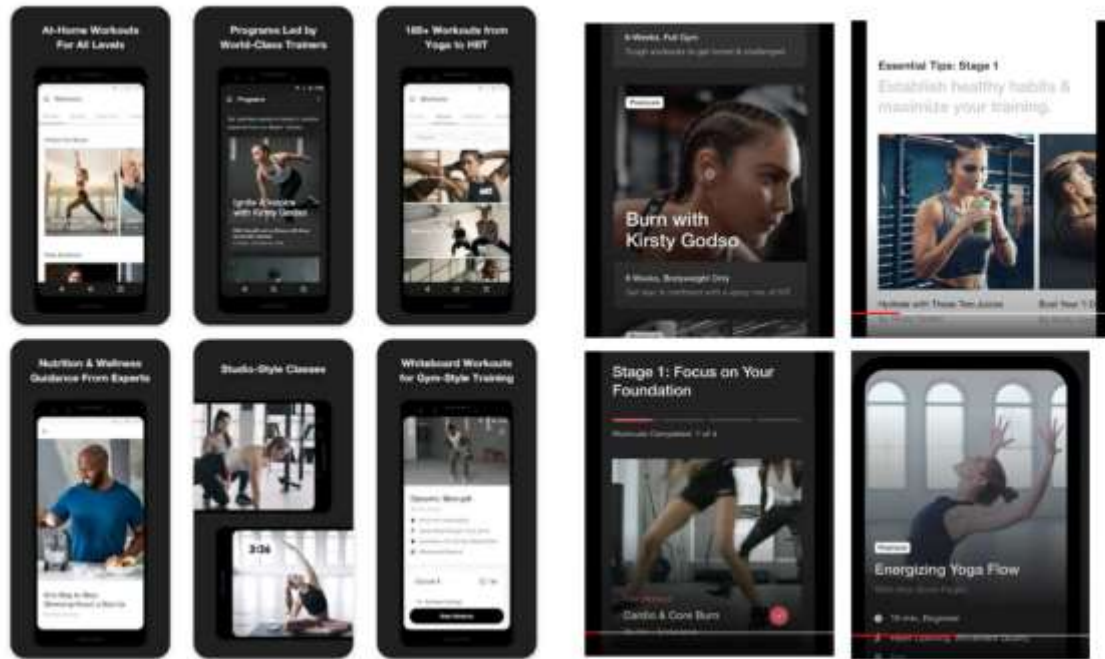


Figure 53: Nike Training Club

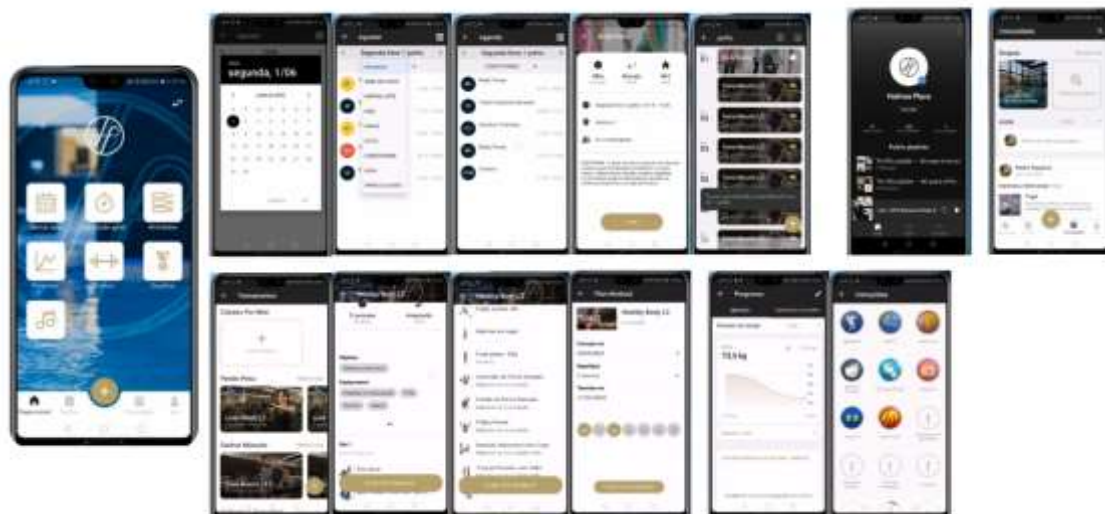


Figure 54: The Holmes Place member app

Appendix E – Market Analysis

This appendix contains statistical data regarding the target market and total market.

Ano (idade) - Média

Anos	Sexo		
	Total	Masculino	Feminino
2000	76,4	72,9	79,9
2001	76,7	73,3	80,1
2002	77,0	73,6	80,2
2003	77,4	74,1	80,6
2004	77,7	74,4	80,9
2005	78,2	74,8	81,3
2006	78,5	75,2	81,6
2007	78,7	75,5	81,8
2008	78,9	75,8	81,9
2009	79,3	76,2	82,2
2010	79,6	76,5	82,4
2011	79,8	76,7	82,6
2012	80,0	76,9	82,8
2013	80,2	77,2	83,0
2014	80,4	77,4	83,2
2015	80,6	77,6	83,3
2016	80,8	77,7	83,4
2017	80,8	77,8	83,4
2018	80,9	78,0	83,5

Fontes/Entidades: INE, PORDATA
Última actualização: 2020-05-28

Figure 55: Life expectancy at birth: total and by gender, Portugal (age average) (Esperança de vida à nascença: total e por sexo (base: triénio a partir de 2001), 2020)



Figure 56: Ageing Index, Portugal (*Indicadores de envelhecimento, 2020*)

(A) Rácio - % (B) Proporção - % (C) Rácio

Anos	Índice de envelhecimento (A)	Índice de dependência total (A)	Índice de dependência jovens (A)	Índice de dependência idosos (A)	Índice de longevidade (B)	Índice de sustentabilidade potencial (C)
2002	103,3	48,8	24,0	24,8	42,3	4,0
2003	104,7	49,1	24,0	25,1	42,7	4,0
2004	106,6	49,4	23,9	25,5	43,2	3,9
2005	108,5	49,7	23,8	25,9	43,8	3,9
2006	110,4	49,8	23,7	26,1	44,6	3,8
2007	112,6	49,9	23,5	26,4	45,6	3,8
2008	115,1	50,1	23,3	26,8	46,4	3,7
2009	117,8	50,3	23,1	27,2	46,9	3,7
2010	121,6	50,8	22,9	27,9	47,6	3,6
2011	125,8	51,2	22,7	28,5	48,3	3,5
2012	129,4	51,7	22,5	29,1	48,7	3,4
2013	133,5	52,2	22,4	29,9	48,9	3,3
2014	138,6	52,8	22,1	30,7	49,0	3,3
2015	143,9	53,2	21,8	31,4	49,0	3,2
2016	148,7	53,8	21,6	32,1	48,8	3,1
2017	153,2	54,4	21,5	32,9	48,6	3,0
2018	157,4	54,9	21,3	33,6	48,4	3,0
2019	161,3	55,3	21,2	34,2	48,5	2,9

Fontes/Entidades: INE, PORDATA
Última actualização: 2020-06-15

Figure 57: Ageing indicators, Portugal (Indicadores de envelhecimento, 2020)

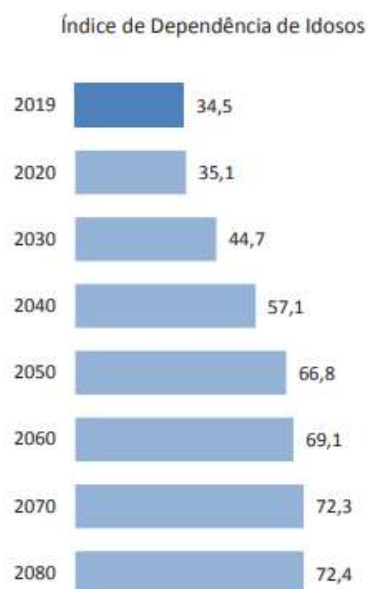


Figure 58: Elderly dependency levels, annual estimates, Portugal (Estatísticas Demográficas 2019, 2020)

Indivíduo - Milhares

Anos	Grupos etários						
	Total	Menos de 25	25-34	35-44	45-54	55-64	65 ou mais
2002	5.414,3	668,5	1.414,1	1.321,2	1.080,3	601,2	328,9
2003	5.433,8	612,9	1.434,1	1.345,2	1.097,6	614,8	329,3
2004	5.421,4	570,2	1.435,7	1.362,1	1.117,8	614,7	320,8
2005	5.461,4	541,3	1.446,2	1.367,0	1.150,7	631,1	325,1
2006	5.499,6	521,3	1.438,1	1.390,4	1.179,6	641,5	328,7
2007	5.533,1	505,7	1.420,1	1.408,4	1.191,1	670,9	337,1
2008	5.534,6	490,1	1.400,0	1.414,2	1.219,0	680,0	331,4
2009	5.486,1	455,4	1.366,6	1.420,5	1.235,6	683,0	324,9
2010	5.489,7	418,2	1.325,4	1.450,0	1.273,1	699,3	323,6
2011	↓ 5.428,3	↓ 436,7	↓ 1.280,6	↓ 1.460,2	↓ 1.262,5	↓ 698,4	↓ 289,8
2012	5.382,6	419,1	1.223,5	1.460,2	1.280,5	703,6	295,7
2013	5.284,6	389,5	1.162,5	1.448,4	1.285,8	723,7	274,8
2014	5.225,6	378,0	1.118,7	1.454,2	1.285,1	740,1	249,4
2015	5.195,2	369,5	1.083,6	1.443,3	1.284,3	768,7	245,8
2016	5.178,3	364,2	1.054,8	1.429,3	1.295,6	795,6	238,7
2017	5.219,4	371,3	1.033,4	1.407,5	1.314,3	845,6	247,3
2018	5.232,6	371,9	1.016,4	1.384,2	1.322,5	881,2	256,3
2019	5.252,6	373,6	1.006,2	1.359,8	1.341,2	906,4	265,4
2020	5.165,1	330,7	991,4	1.303,2	1.361,0	918,2	260,6

Fontes/Entidades: INE, PORDATA
Última actualização: 2021-02-10

Figure 59: Active population: total and by age group, Portugal (in thousands) (População activa: total e por grupo etário, 2021)

Appendix F – Card Sorting Guide

This appendix replicates what the participants saw inside the Miro link. The activity was conducted in Portuguese thus the link's content is in Portuguese.

Miro link: https://miro.com/app/board/o9J_l5UxMmo=/?invite_link_id=769831409935

Introduction

Hello!

Thank you for taking part in this card sorting activity. Card sorting is a easy and simple way of helping us understand how our app should be organized. The goal is to place the cards into the existing groups.

Tasks

1. Group cards. Look at the cards and, one at a time, drag them into the groups that make the most sense to you.
2. If you think a card can belong to one or more groups, you may copy the card (CTRL+C) and copy (CTRL+V) in another group.
3. There is a group named "I am not sure" if you are not sure where to place certain cards.

Time and rules

There are no right nor wrong answers

There is no time limit however, we recommend you do it in 15-25 minutes

Your answer will help us organize our app.

Thank you!

Appendix G – Expert Evaluation Guide

Introduction

Dissertation title:

Enhancing the Elderly's Self-esteem through an interactive product

Dissertation

O objetivo desta dissertação é, através de uma revisão de literatura, identificar uma oportunidade de design e, através de uma metodologia centrada no utilizador, chegar a um conceito de solução.

Esta dissertação explora o envelhecimento e envelhecimento ativo e discute os vários fatores que influenciam a autoestima e a extensão dos efeitos de *gameplay* no aumento da autoestima do idoso.

Tendo em consideração que a saúde física e cognitiva do indivíduo afeta a sua autoestima, este estudo aborda brevemente os efeitos de videojogos no desempenho cognitivo dos idosos e mais aprofundadamente os efeitos de *exergames* (ex: Wii fit) no desempenho físico e cognitivo dos idosos. Apesar de serem tema de muitos artigos na comunidade científica e oferecerem alguns benefícios, os *exergames* não fornecem a intensidade de exercício recomendada por especialistas e oferecem baixos benefícios cognitivos. Além disso, outros estudos indicam que há uma baixa utilização de *exergames* nas faixas etárias mais velhas, principalmente devido a falta de interesse.

Para criar uma solução que contribua para a autoestima do idoso através de estímulo físico e cognitivo, que seja aceite pelo público-alvo, sugerimos uma abordagem de design centrada no utilizador com foco na experiência do mesmo.

Este estudo resultou também numa ideia de produto, um produto interativo que oferece exercício físico e estímulos cognitivos de forma divertida e desafiante.

Além da revisão de literatura, também foram realizados: análise de competidores, pesquisa de mercado, *expert interviews*, questionário (a 150 pessoas com mais de 56 anos) e *cardsorting*.

Product

App for several devices (mobile phone, iPad/tablet, laptop, TV) that offers:

- Follow-along exercise videos
- Follow-along physiotherapy videos
- Cognitive exercises and games
- Scheduling online sessions with professionals (personal trainers, physiotherapists, occupational therapists) to:
 - Get personalized plans
 - Follow-up sessions
 - Online training sessions

The app's content is personalized through CRM, which is based on a questionnaire they answer after their first log in (exercises will be tailored to their age, health, goals and availability) and on their patterns of use when logged on.

Target

- Older adults (56-64 years old)
- Youngest-old elderly (65-74 years old)

Test goals

Evaluate the interface's usability according to Nielsen's Heuristics. The interface to be evaluated is presented as wireframes (designed for an iPad Pro). Keep in mind that not all actions of the prototype are active.

Procedure

Each expert will receive a word document with the previous information, the prototype and project links, as well as an evaluation sheet with the assignment: one table with a list of tasks and questions and a table for the heuristic evaluation.

Evaluation sheet

Name:

Years of experience:

Date:

Prototype link: <https://www.figma.com/proto/bLLgRh2fooi6oHdJWkImne/Expert-review?page-id=1%3A2&node-id=4%3A239&viewport=241%2C48%2C0.14&scaling=scale-down&starting-point-node-id=4%3A239&show-proto-sidebar=1>

Project link: <https://www.figma.com/file/bLLgRh2fooi6oHdJWkImne/Expert-review?node-id=1%3A2>

1 – Task Analysis

Peço que realize as seguintes tarefas e, no final de cada tarefa, responda a 2 perguntas.

Tasks	Will the user know what to do at this step?	If he does the right thing, will he know he did the right thing and is progressing towards his goal?
1 - Agendar uma sessão de Exercício Físico para pedir um plano de treino personalizado, com o profissional João Gomes, no dia 18 de Dezembro às 10:30.		

Além disso quero ser contactado no dia anterior à sessão por chamada telefónica (para ser lembrado da sessão e confirmar a minha disponibilidade).		
2 – Quero ver o terceiro vídeo do dia 2 do meu plano personalizado de exercício físico. Quero vê-lo em tela cheia.		
3 - Hoje não me apetece fazer um vídeo do meu treino personalizado, em vez disso quero ver um vídeo na área de exercício físico: Quero abrir um vídeo de treino de força, recomendado para mim, com equipamento, nível principiante, intensidade média e de 20 minutos (não é para pôr em tela cheia)		

2 – Heuristic Evaluation

This evaluation should include a list of violated heuristics, their severity, and recommendations, if convenient. When describing the violation, it is important that you clearly identify where it is (e.g., by writing the name of the screen).

For this part, I ask that, besides navigating the prototype freely, you take a look at the screens in the project link since they include the sign-up flow, sign-in flow, the questionnaire the user answers on their first log in, empty states, and some notes to be considered for a possible implementation stage (see the black rectangles).

Project link: <https://www.figma.com/file/bLLgRh2fooi6oHdJWkImne/Expert-review?node-id=1%3A2>

Severity rating

0 = I don't agree that this is a usability problem at all

1 = Cosmetic problem only: fix if time is available

2 = Minor usability problem: fixing this should be given low priority

3 = Major usability problem: important to fix, given high priority

4 = Usability catastrophe: fix this before product can be released

Nielsen's Heuristics	Violation	Recommendation	Severity
1 - Visibility of system status Always keep users informed about what is going on, through appropriate feedback within reasonable time.			
2 - Match between system and the real world Use words, phrases, and concepts familiar to the user, rather than internal jargon. Follow real-world conventions, making information appear in a natural and logical order.			
3 - User control and freedom Users should leave the unwanted state without having to go through an extended dialogue. undo and redo.			
4 - Consistency and standards Users should not have to wonder whether different words, situations, or actions mean the same thing.			
5 - Error prevention			

Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.			
6 - Recognition rather than recall Minimize the user's memory load by making objects, actions, and options visible.			
7 - Flexibility and efficiency of use Accelerators. Shortcuts — hidden from novice users — may speed up the interaction for the expert user such that the design can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.			
8 - Aesthetic and minimalist design Dialogues should not contain information which is irrelevant or rarely needed.			
9 - Help users recognize, diagnose, and recover from errors			

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.			
10 - Help and documentation Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation.			

Help

If you need help, do not hesitate to contact me.

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