



# Positive Impact of Exergaming on Older Adults' Mental and Social Well-Being: In Search of Evidence

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**Abstract.** Exergames aim at stimulating healthy people or patients needing rehabilitation to do physical exercise to enhance their physical state (e.g., postural balance, muscle power). As older adults generally have more health problems than younger ones, such games could be beneficial to them. Since the introduction of the Wii gaming system by Nintendo in 2006, several literature reviews have been conducted that examine the impact of exergames on older adults' physical well-being. However, less attention has been paid to the potential impact on their mental and social well-being. Therefore, the aim of this paper is to explore what we can learn from previously conducted empirical studies about the impact of exergaming on these kinds of well-being. Although a limited number of literature reviews show that some empirical studies have been conducted around these issues it is not clear that the results are evidence-based. The question remains whether the results can be used by rehabilitation centers and associations for senior citizens to promote exergaming among older adults also for their mental and social well-being. The purpose of this state-of-the-art paper is to present an overview to address this question and to make recommendations about guidelines for the research design of future evidence-based empirical studies.

**Keywords:** Exergaming · Older adults · State of the art paper  
Literature review · Exergaming · Impact · Evidence based studies  
Mental and social well-being

## 1 Introduction

The older we get, the more we are at risk for having health problems. As our western society is ageing rapidly, older people are living longer [1] and consequently their health has become an important societal issue. On its website, the WHO states, "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." [2] We not only live in an ageing society but also in a digitizing one [3] in which older adults increasingly use new technologies [4] such as digital games available for exercising [5]. In 2006, Nintendo released the Wii gaming

system [6, 7], one year later Wii Fit games (with the Wii Balance Board interface) were launched, and in 2010 X-Box Kinect came on the market. See [8, 9] for the way older people experience playing Xbox 360 Kinect's exergame *Your Shape Fitness Evolved 2*. Exergames aim at stimulating healthy people or patients needing rehabilitation to do physical exercise to enhance their physical state (e.g., postural balance, muscle power). As older adults generally have more health problems than younger ones, such games could be beneficial to them.

Older adults are increasingly playing digital games, e.g., 26% of all gamers in the USA are aged 50 or older in 2016 [5], and the use of exergames in later life has become a research topic [10]. Empirical studies (see [11] for an overview) clearly show that many older adults are motivated and capable of playing exergames, also known as 'active video games', 'interactive video games', and 'activity promoting video games' [12, p. 10]. Such games include hardware and software that responds to movements of the player's body through the tracking of handheld controllers and movements of the lower extremities using floor-based hardware, and allows the player to get immediate digital performance feedback on a screen [13].

According to the WHO, regular physical activity can among other things, reduce the risk of diabetes, cardiovascular disease, depression, breast cancer, and colon cancer [14]. It can also improve bone and functional health [15] and have other important health benefits [16]. In recent years several literature reviews have been conducted (such as [17–22]), including empirical studies of the impact on older adults' physical well-being. Larsen et al. [19, p. 205] conclude that "exergames have a potential to improve physical health in the elderly. However, there is a need for additional and better designed studies that assess the effectiveness and long-term adherence of exergames designed specifically for the elderly". Kari [23, p. 59], who conducted a systematic review of systematic reviews on the impact of exergaming on physical fitness and physical activity, draws a similar conclusion:

The results indicate that exergaming is generally enjoyed and can evoke some benefits for physical fitness and physical activity, but the current evidence does not support the ability of exergaming to increase physical fitness or physical activity levels sufficiently for significant health benefits. This systematic review also revealed several gaps in previous research. Additional high-quality research and systematic reviews concerning exergaming are needed.

The question is whether this also applies to the impact of exergames for older adults' mental and social well-being. Therefore, the aim of this state-of-the-art paper is to explore what we can learn from previously conducted literature reviews discussing empirical studies about the impact of exergames on older adults' mental and social well-being. In particular, organizations such as rehabilitation centers and associations for senior citizens could use those insights to promote exergaming among older adults also for their mental and social well-being.

## 2 Method and Results

### 2.1 Literature Search

We present a state of the art paper by discussing the results of literature reviews that include *single* empirical studies on the impact of *exergames* on older adults' *mental* and *social* well-being. As we focus uniquely on the impact of exergames on these specific kinds of well-being for older adults, we did not include literature reviews on other game types such as video games without physical exercising, serious games and brain games. Literature reviews focusing on other generations or not differentiating between different generations have also been excluded in this position paper; we refer the reader to [23–32] for more information about this topic. We have also excluded intergenerational games (see for more information [33–35]).

In Sects. 2.2 and 2.3 literature reviews that have been published by the end of 2016, have been used to gain insight into the impact of exergaming on older adults' mental and social well-being. For the analysis of results from these literature reviews, we pay attention to those specific kinds of impacts within the empirical studies included and analyze the empirical evidence for the claims made by the authors of these reviews.

### 2.2 Impact on Older Adults' Mental Well-Being

As exergames are often played for exercise purposes, it is no surprise that a considerable number of literature reviews include empirical studies focusing on the physical impact of such games (see Introduction). The question is whether there are also empirical studies focusing on the mental impacts of exergames, which is especially important for older adults who are at risk for cognitive decline [5, 36]. Although the impact of cognitive decline varies, impaired executive function has the most significant impact [37]. “Executive function manages our ability to perform certain tasks related to perception, response, and maintenance of contextual information that is related to working memory, reasoning, and problem solving [38, 39].” [36, p. 137] For cognitive decline, an important point is that we become slower (e.g., our processing speed decreases) as we grow older [40, 41] so this should be considered while designing digital games for older people [35, 36, 42–45].

It would be interesting to know, of course, if digital games can enhance older adults' cognitive functioning in areas such as speed, reaction time, memory, attention, concentration, visual-spatial skills, hand eye coordination, reasoning, and problem solving. The field of *braingames* or brain-training interventions is characterized by the absence of scientific consensus about the impact on cognition. Simons et al. (2016) [46, p. 103] state the following about the impact of these kinds of games on the improvement of cognition:

In 2014, two groups of scientists published open letters on the efficacy of brain-training interventions, or “brain games,” for improving cognition. The first letter, a consensus statement from an international group of more than 70 scientists, claimed that brain games do not provide a scientifically grounded way to improve cognitive functioning or to stave off cognitive decline. Several months later, an international group of 133 scientists and practitioners countered that the literature is replete with demonstrations of the benefits of brain training for a wide variety of cognitive and everyday activities.”

To address the lack of scientific consensus about the impact of *braingames* on older adults’ mental well-being and to know if there is scientific consensus about the impact of *exergames* in this regard we used 4 literature reviews. Hall et al. [18], Maillot et al. [47], Bleakley et al. [21] and Chao et al. [22] discuss 9 empirical studies to gain insight into the extent to which the mental effects of playing an exergame by older adults can be considered as evidence-based. Table 1 shows that the included empirical studies [48–53] present evidence that playing exergames enhances older adults’ mental performance, but empirical study [54] does not specify the significance of their results, and empirical studies [55, 56] do not show any significant results in this domain.

Finally, we mention the main insights from 5 independent meta-analyses conducted in this field by Zhang and Kaufman (2015 [57, p. 1]) concluding that playing digital

**Table 1.** Impact of exergaming on older adults’ mental well-being: four literature reviews

	Number of empirical studies*	Impact	Evidence based?
Hall et al. (2012) [18]	7	Rosenberg et al. [48]: Better cognitive performance (global cognitive functioning, includes items tapping attention, memory, visuoconstructional skills, and aspects of expressive language) measured by the repeatable battery for assessment of neurocognitive status (RBANS)	after 6 weeks: $P = 0.333$ after 12 weeks: $P = 0.043$
		Studenski et al. [49]: improved health and mental condition, and better score on the Digit Symbol Substitution test	$P = 0.02$ Self-reported health $P = 0.0180$ Mental Component $P = 0.012$ Digit Symbol Substitution test
		Bainbridge [55]: no improved balance	Not evidence based
		Bell et al. [50]: improved balance	$P < 0.01$ Berg Balance Scale
		Hsu et al. [51]: improved physical enjoyment	$P = 0.014$ Physical Activity enjoyment Scale confidence
		Szturm et al. [52]: improved balance	$P = 0.02$ Activities-specific Balance Confidence Scale
		Yamaguchi et al. [53]: improvement on dementia	$P = 0.002$ Hasegawa’s Dementia Scale-revised

(continued)

**Table 1.** (continued)

	Number of empirical studies*	Impact	Evidence based?
Maillot et al. (2012) [47]	1	Rosenberg et al. [48]: see above	See above Maillot et al. (2012, p. 590) [48] remark that “the critically important, untrained control group was not included”
Bleakley et al. (2015) [21]	3	Rosenberg et al.[48]: see above	see above
		De Bruin et al. [54]: Gaming elements can be used to take patients' attention away from any pain	not specified
		Studenski et al. [49]: see above	see above
Chao et al. (2015) [22]	2	Chao et al. [56]: no cognitive enhancement (measured by Bandura's self-efficacy theory)	No statistically significant differences were found in any of the outcomes after the intervention
		Rosenberg et al. [48]: see above	see above

\*Related to those empirical studies in the literature review that examined the impact on older adults' *mental* well-being

games (so not only exergames) is “effective in improving older adults' (...) executive function ( $g = 0.76$ ) and processing speed ( $g = 0.54$ ).”

### 2.3 Impact on Older Adults' Social Well-Being

In 2009, Nap et al. [58, p. 247] stated, “Digital games hold the potential to enhance seniors' leisure time and social connectedness, and provide a mental and even physical workout. However, most digital games that are currently on the market are targeted at the younger audience and contain content that generally does not resonate well with seniors. Senior gamers do exist, yet little is known about them.” As far as exergames being played by older adults is concerned, the situation has changed since 2009. As mentioned in the introduction, in recent years several empirical studies have been analyzed in literature reviews with respect to the impact of exergames on older adults' physical well-being. Section 2.2, though, showed there are not many exergame studies that focus on their impact on mental well-being. The question being addressed here is what is the state-of-the-art regarding the impact of exergames on the social well-being of older adults and whether there is any empirical evidence for the claims they make.

Although many exergames are designed to be played individually, older players sometimes like to play digital games with another person, in a social context [8, 9, 59]. There are no literature reviews, though, on empirical studies that focus uniquely on the social dimension of exergames (including social interaction, social relationships, social connectedness, emotion, mood). Table 2 shows 3 literature reviews, including 10

empirical studies, that note the impact of exergaming on older adults’ social well-being, *as well as* its physical and mental impact. From the 3 empirical studies included in Hall et al. (2012) [18] only 1 empirical study [53] shows the potential for improved social interaction by playing a digital game. Chao et al. [22, p. 393] conclude from the results of the 4 empirical studies included that Nintendo Wii exergames can serve as a mechanism to increase social interaction, but for 2 of the 4 empirical studies, evidence is not specified. Cota and Ishitani (2015) [60] refer to 3 empirical studies [65–67] that indicate the potential of digital exergames for social interaction, but for 2 of them [65, 66], evidence is not specified. Out of 10 empirical studies, it is not clear for 5 of them as to whether they are evidence-based, and for 1 empirical study there is no statistical evidence. So, the majority of these empirical studies (6 out of 10) do not suggest a positive, evidence-based impact on older adults’ social well-being.

**Table 2.** Impact of exergaming on older adults’ social well-being: three literature reviews

	Number of empirical studies*	Impact	Evidence based?
Hall et al. (2012) [18]	3	Halton [61]: Positive group interaction between clients	not specified
		Bell et al. (p. 220) [50]: For social relationships “no group-related significance was found, however there were isolated items that showed significance within the various groups. Owing to the small sample size, results of this study are not generalizable.” (Social Provisions Scale [SPA])	no statistical evidence
		Yamaguchi et al. [53]: Improved social interaction (Multidimensional Observation Scale for Elderly [MOSE])	$P = 0.054$
Chao et al. (2015) [22]	4	Wollersheim et al. [62]: Social connectedness with the group and family members	not specified
		Kahlbaugh et al. [63]: Participants report decreased loneliness and improved mood compared with the television group	not specified
		Albores et al. (p. 50) [64]: “Significant improvements were observed in (...) CRQ Emotion”	$P = 0.02$
		Rosenberg et al. [48]: mental health-related quality of life + decrease in anxiety level	$P = 0.04$ (after 6 weeks) $P = 0.01$ (after 12 weeks)

(continued)

**Table 2.** (continued)

	Number of empirical studies*	Impact	Evidence based?
Cota and Ishitani (2015) [60]	3	Mubin et al. [65] and Kow et al. [66]: improved social interaction	not specified
		Rice et al. [67]: a strong inter-relationship between the attributes under the constructs of Physical Engagement and Social Interaction - such that the more physically engaging they found the game, the more they perceived it to be socially interactive	correlation results between the two constructs: $P < .01$

\*Related to those empirical studies in the literature review that examined the impact on older adults' *social* well-being

### 3 Conclusions and Implications for Future Research

Most literature reviews in recent years have focused on the impact of exergames on older adults' physical health. This state-of-the-art paper aimed at examining the impact of exergames on an older adults player's mental and social well-being. Table 3 shows that impact on older adults player's mental well-being was discussed in 4 literature reviews [18, 21, 22, 47] including 10 empirical studies, and impact on older adults player's social well-being was discussed in 3 literature reviews [18, 22, 60] including 10 empirical studies.

**Table 3.** Overview of literature reviews including empirical studies related to the impact exergaming on older adults' physical, mental and social well-being

Impact on	Literature reviews	Empirical studies included
Mental well-being	[18, 21, 22, 47]	[48–56]
Social well-being	[18, 22, 60]	[48, 50, 53, 61–67]

The results in Sect. 2.2 showed that 6 out of 9 empirical studies [48–53] present evidence that playing exergames enhances older adults' mental performance, but 1 [54] does not specify the significance of the results, and 2 others [55, 56] do not show any significant results in this domain.

In Sect. 2.3, the results of the empirical studies showed that out of 10 empirical studies, only 4 studies show a positive impact on older adults' social well-being [48, 53, 64, 67] while 5 others [61–63, 65, 66] do not specify the significance of the results, and 1 [50] does not show any significant results in this domain. So, we can conclude from our state-of-the-art paper that though there are studies showing evidence that exergaming has a positive impact on older adults' mental and social well-being, others do not specify the significance of the results or do not find any significant results.

These results suggest that for future empirical research in this field to determine the impact of exergames on older people's well-being, it is necessary to take into account the following guidelines. This will allow organizations such as rehabilitation centers and associations for senior citizens to use evidence-based results to promote exergaming among older adults also for their mental and social well-being.

- (1) Conduct experiments comparing the effects of exergames with conventional approaches to exercise therapy. See also [68]. Of particular note, an empirical study conducted by Kahlbaugh, 2011 [63] was designed as an intervention with an experiment where the older adults who used Wii bowling "...had lower loneliness and a pattern of greater positive mood compared to the television group." (p. 331) Studies using a control group give us more insight into the impact of the exergame as a tool to enhance well-being in older adults than studies where this is not the case.
- (2) Empirical studies should be designed as experimental or quasi-experimental studies using pre- and post-tests. See also [22, 47].
- (3) Conduct longitudinal studies to determine if there is a long-term impact of exergames on older adults' mental and social well-being See also [19].
- (4) Conduct studies with larger sample sizes in a variety of settings. See also [18]. We agree with Chao et al. (2015) [22, p. 396] that, "The most common weaknesses among the reviewed studies were small sample sizes which lack the power to detect statistically significant differences."
- (5) Finally, we would like to repeat the following conclusion made in 2017 by Loos [11]. In his literature review focusing on the motivation and competence of older adults to play exergames, he asserted that: "Future research should give voice to the experiences of older adults playing exergames in natural settings, pay attention to differences in the group of older adults (e.g., age, gender, education) and compare the ways older adults make sense of exergames versus traditional approaches." [11, p. 261] The explorative study conducted by Quandt et al. (2009) [68, p. 27] based on interviews with older adults playing social games is an exception and a good example of how to gain insight into "the integration of gaming into their everyday life, and aspects of social interaction within real and virtual life".

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