Effect of Exergaming on Wellbeing of Residents in A Nursing Home: A Single Blinded Intervention Study

Hannah Willems
KU Leuven
Marlies Gunst
KU Leuven
Isabelle Demeyere
KU Leuven
Birgitte Schoenmakers (birgitte.schoenmakers@kuleuven.be)
KU Leuven

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Abstract

Background

To improve quality of life in nursing homes, meaningful activities and social contact are indispensable. Exergames can play a role addressing these needs.

Methods

In a randomized single blinded controlled intervention study, we investigated the effect of playing exergames on general well-being, fun and on social interaction.

Results

Eighteen residents took part in the intervention group and 17 in the control group. The median mental well-being score of the intervention group increased from 42/50 to 45. The median sleep score of the intervention increased from 23/30 to 28. The median pain score of the intervention group improved from18/20 to 20. The median score on subjective cognition increased from 24/30 to 26 while the mean scores on the objective assessment decreased from 1.8/2 to 1.7. Coaches gave an average fun score of 8.9/10 and an average intensity of exercise score of 11.6/20. Residents and coaches appreciated the social contact. Coaches reported a high feasibility (average of 4.1/5) but a low accessibility and a high intensity of supervision.

Conclusions

Exergaming is a feasibly complement to the usual activities. Future research should focus on vulnerable groups and aim to develop a study in an implementation design.

1. Introduction

The society is dealing with an enormous aging of the population. According to a report by the Federal Service of Care and Health, 1.2% of the Flemish population lived in residential care in the period from 2009–2016 (Gezondheid 2017). In Belgium, the current share of the age group 65–79 will increase from 13 per 1000 inhabitants to 179 per 1000 inhabitants by 2030. In December 2017, the Flemish Minister of Welfare, Public Health and Family published a report in which more than 20,000 residents in Flemish residential care centres gave their opinion on various aspects that contribute to quality of life (Gezondheid 2015). The main point of action turned out to be providing a meaningful daily activity and maintaining interpersonal emotional relationships.

Beside the traditional activities, exergames could fulfil both working points (Karahan, Tok et al. 2015, Dove and Astell 2019). Exergames are video games that are played by moving the body, combining physical and cognitive activity with social interaction. Movements are registered via a camera and an avatar will imitate the movements on a screen. It appears to the person who is moving, as if he is practicing that particular sport.

Exercise programs have already shown in the past that they have a beneficial effect on falls, allowing the elderly to be autonomous and independent for a longer period (Sato, Kuroki et al. 2015, Nagano, Ishida et al. 2016). These authors found that muscle strength, balance, walking and reaction time improved significantly after several weeks of exergaming. An internal report from a residential care centre shows that self-reliance improved in half of the participants playing exergames (Verhoeven 2015).

A meta-analysis compared 17 RCTs examining the effect of exergames on memory and cognition and concluded that exergames have a positive effect on global cognition (Stanmore, Stubbs et al. 2017). Other research showed that when physical activity was combined with cognitive exercise, additional effects occurred on different cognitive domains (Ben-Sadoun, Sacco et al. 2016, Stanmore, Stubbs et al. 2017, Wang, Yin et al. 2019). In 2010, Kemperman et al. suggested that the combination of physical and cognitive activity positively impacted memory through a process called “brain plasticity” (Kempermann, Fabel et al. 2010). Due to the virtual character of exergames and the direct feedback on movements performed by the gaming person, a positive effect is observed in the visual memory and reaction time (Stanmore, Stubbs et al. 2017).

Above, the psychosocial well-being of elderly people with dementia improved after playing exergames (Karahan, Tok et al. 2015, Ning, Li et al. 2020). In particular, quality of life, feelings of autonomy and competence increased. Sleep is considered an important prerequisite for promoting health and general well-being. The process of “brain plasticity” described above takes place during deep sleep. In a review the beneficial effect of sleep on long-term memory was confirmed (Pace-Schott and Spencer 2015). Both physical activity and cognitive exercise have proven positive effects on sleep (Hartescu, Morgan et al. 2016, Wilckens, Erickson et al. 2018).

In a randomized controlled single blinded intervention study, we investigated the effect of playing exergames on four domains of well-being in elderly people living in a residential care centre: mental well-being, sleep quality, pain complaints and cognitive functioning. In the secondary research question, we investigated if the elderly enjoyed playing the exergames and if social interaction improved through gaming. Finally, we investigated the feasibility of integrating these games into the regular animation activities of the residential care centre.

2. Materials And Methods

We included residents living in a residential care centre. Inclusion criteria were: able to stand up independently and walk at least 3 meters, speaking and understanding Dutch, do not have a serious

medical condition that could pose a danger while playing exergames (eg epilepsy), performing a score of more than 20 on the Mini Mental State Examination.

With the aid of the staff members, we recruited and informed residents for participation. The GPs were informed about inclusion of their patients and a refusal of the GP to participate led to exclusion of the resident. For convenience reasons, the residents were included by unit where they resided. These units were randomly (supported by randomization software) allocated to the intervention arm and the control arm. The staff members were blinded for the intervention.

The primary research question also used hetero-anamneses taken from nine staff members: nurses, care assistants and occupational therapists. To supervise the exergames and to complete the questionnaires related to the secondary research question we engaged eleven coaches: physiotherapists, occupational therapists and animators.

The intervention took place during 13 weeks where exergames (boxing, bowling, football, …) with an Xbox 360 Kinect Sport were played in three residential care centers in Flanders. The intervention group played exergames twice a week for 13 weeks in sessions of one hour per four people. These intervention group residents also had the opportunity to participate in other planned activities. The control group only participated in the planned activities (usual care). Before the start of the study, an introduction moment with hands on training was organized for the coaches in each residential care center. Residents were informed by the staff members and through flyers. Before each game session, the coaches explained and demonstrated the game and the gear.

The primary research question was investigated via a questionnaire composed by merging selected questions from validated questionnaires with statements assessing sleep, mental well-being, pain complaints and cognitive functioning (Table 1). The questionnaire was taken before the start (time point 0), after the completion of the exergames (3 months) and 6 months after the start of the study in the residents from the intervention and control groups. Statements assessing mental well-being addressed the subdomains psychosocial wellbeing, and autonomy. To assess sleep quality, the different stages of sleep such as falling asleep, staying asleep and daytime energy levels were questioned. To assess pain complaints, the statements addressed the frequency of the pain complaints and the impact of pain on general well-being. In total, 26 statements were submitted and scored on a Likert scale (0 = fully disagree; 5 = fully agree). To assess cognitive functioning memory 6 subjective statements, 2 recall questions, the clock drawing test and the Stroop colour-word test were performed (Van der Elst, Van Boxtel et al. 2006, Pinto and Peters 2009).

A nurse, care provider or occupational therapist (staff members) completed a similar questionnaire with ten statements about the sleep quality, cognition, pain complaints and mental well-being of the residents (scored on a Likert scale from 0 to 5 ranging from ‘very bad’ to ‘very good’). To compile this questionnaire, the same sources were used as for the questionnaire of the residents.

In answer to the secondary research question, a staff member kept a diary per participant during the three-month test period for both the intervention and control groups. The fun factor was scored on the VAS scale (from 0–10)(Voutilainen, Pitkaaho et al. 2016). The intensity of exercise was measured by the Borg scale (from six, very light effort to twenty, or maximum effort)(Borg 1974). This diary also registered individual participation to the exergame session and the reason for any absence. In both the intervention and control group, participation in planned animation or regular activities was registered. In addition to this diary, a residents' questionnaire assessed at the end of the three months the fun factor, social interaction, advantages and disadvantages and if the participant would still participate in the exergames in the future. All these outcomes were measured with a 5-point likert scale ranging from 'fully disagree' to fully agree'. Finally, a similar questionnaire for coaches assessed their experiences with playing exergames in residential care centers: was this feasible, what was the fun factor for coaches and what are the benefits and drawbacks?

Data analysis was limited to simple descriptive analysis since the study sample was expected to be small.

Ethical approval

The staff informed residents about the intervention. If residents showed interest and allowed being approached for inclusion, the researchers further explained the study. For this purpose, the researchers used an informative flyer and a comprehensive information letter. If residents agreed to participate, they signed an informed consent. All methods were carried out in accordance with relevant guidelines and regulations and prepared in discussion with scientific and field experts. The Medical Ethical Board of the University Hospitals of KU Leuven approved the study (MP004468).

3. Results

The intervention group started with 18 and the control group with 17 residents with an unequal distribution of gender (10 male versus 22 female) (table 2). After three months there was a drop-out of three residents in the intervention group due to not interested anymore, back pain and too burdened.

3.1 Primary research questions (table 3)

The median mental well-being score (of maximum 50) for the residents of the intervention group at time points 0, 3 and 6 months was 42, 45 and 45, respectively. For the residents of the control group, this score was 41 at all three time points. The median score (of maximum 20) of the staff member questionnaire on the mental well-being of the residents was 18, 18 and 16 in the intervention group at the respective time points of 0, 3 and 6 months. The scores of the control group at the same time points were 14, 17 and 16, respectively

The median sleep score (of maximum 30) for the residents of the intervention group at time points 0, 3 and 6 months was 23, 24 and 28 respectively. For the residents of the control group this was 24, 25 and

25, respectively. The median score (of maximum 10) of the staff member questionnaire on the sleep quality of the residents was of 7, 7.5 and 8 in the intervention group at the respective time points of 0, 3 and 6 months. The scores of the control group remained equal to seven over the full 6 months.

The median pain score (of maximum 20) among the residents of the intervention group at time point 0, 3 months and 6 months, respectively, was 18, 18.5 and 20. For the residents of the control group this was 17, 14 and 16 respectively. The median score (maximum of 5) of the staff member questionnaire about the pain complaints of the residents was four at all time points in both the intervention and control groups.

In the intervention group, the median score (maximum of 30) on subjective cognition was 24, 26 and 26 at the respective time points. In the control group, this score was 23, 26 and 27. The mean scores (maximum of 2) on the two open questions assessing cognitive functioning of the residents evolved from 1.8 at the start to 1.9 and to 1.7 after 3 and 6 months respectively in the intervention group. In the control group, these scores were 1.2, 1.6 and 1.5 at the same time points. The mean scores (maximum of 5) on the clock-drawing test, evolved from 3.1 at the start to 2.9 and to 3.5 after 3 and 6 months, respectively. In the control group, these scores were 2; 1.8 and 2.5 at the same times.

In the stroop-color-word test, the median time difference between correctly naming the colors of column 2 and column 3 in the intervention group was 28s, 29.5s and 28s at time points 0, 3 and 6 months. In the control group, these median time differences were 37s; 30.5s and 30.5s at the same times.

3.2 Secondary research questions

On average, 23.3 exergame sessions were organized in the three residential care centers. As registered by the coaches, there was an average participation rate of 88%. The main reasons for not showing up were other animation, visits of relatives and physical complaints. Coaches gave an average fun score of 8.9/10 and an average intensity of exercise score of 11.6/20 over the three months of playing (table 4).

After three months, residents were asked if they had fun, if they made new friends and if they would continue to play it in the future. On a 5-point likert scale, the average of these responses were 4.4, respectively; 2.8 and 4.4. Residents particularly liked being together and playing the games. Residents mentioned that feeling fitter and upgrading their social contacts were the major advantages of the exergames. For future exergame sessions, residents suggest offering more different games, organizing a weekly session and playing together with several people (table 5).

According to the coaches, the feasibility of the exergames and the positive effect both scored on average 4.1 on a 5-item Likert-scale. The average score on ‘continue playing in the future’ was 4.3 and on ‘fun factor for the coaches’ 4.7. The major advantages according to the coaches were maintaining mobility, the fun factor and the sportive, competitive ambience. Major disadvantages were the low accessibility for more physically disabled residents, the intensive coaching and the limited offer of games. The coaches advised to develop games specifically serving elderly (table 6).

4. Discussion

In this study, we observed an improvement of self-reported mental wellbeing, sleep pain complaints and cognition during exergaming and at six months follow up. An objective assessment of cognition however, did not reveal a sign of improvement. Staff members reported an improved mental wellbeing in the control group.

The fun factor and the intensity of exercise reported by the coaches were high. They also appreciated the feasibility of exergaming and the positive impact on the residents although they regretted the limited accessibility for disabled residents and the intensity of supervision. Residents also mentioned feeling, fitter, having fun playing and they would like to continue playing if organised on a structural base. They did not claim meeting new friends but they appreciated the social aspect of exergaming.

Residents reported a positive effect of gaming on their mental health better but staff members did not notice this change. The improvement in mental wellbeing of the gaming residents was in accordance with findings in comparable research [4]. It is unclear if this effect is due to exergaming or to the mere impact of a new activity [12]. Indeed, the gaming residents particularly appreciated the social contacts and the grind breaking impact of this very new game. The Xbox and games remained available to the residential care centre for an additional 3 months after ending the study, residents from the intervention group were able to game on a voluntary basis which might also explain the lasting positive effect.

Physical activity during the day is a known sleep-promoting factor what might explain the improvement of sleep quality [14, 20]. After six months, we see an additional increase in the sleep score among the residents of the intervention group. These residents were still able to exergame which may explain the lasting positive effect on sleep, despite playing less intensively and without supervision.

As in other studies, there was an overall improvement in the pain complaints in the intervention group compared to the control group [21]. Physical exercise has a beneficial effect on various pain complaints [22]. Pain complaints are also very variable over time and context dependent. It is assumable that musculoskeletal pain emerges when sedentary residents suddenly start exercising [5, 23].

The results did not show a convincing influence of exergames on the cognitive functioning of the residents. These experiences contrast with results from other research [8, 9, 23, 24]. A meta-analysis showed that exergaming positively affected attention, the visuospatial ability and executive functions [8]. A 2016 systematic review also showed promising results in terms of cognition after playing exergames [25]. In our study, residents were free to participate any time and they did not play on a scheduled base. Second, the games were in particularly focussing on physical exercise. Finally, we included a sample of cognitively well-functioning residents. A structured schedule of playing, with games focussing on cognitive competences and applied to a cognitively frail group, might have a more positive effect on cognition [10, 25].

Coaches and participants appreciated the fun factor and the social interaction during exergaming. Similar results were reported in other research [4, 9, 23]. Mental and physical wellbeing are linked to feelings of pleasure and to social contact and we can assume that this should be the major goal of exergaming or any other activity in a residential care centre. Beside, to maximize the positive effects of exergaming and to remain attractable over time, coaches should consider to schedule playtime and to offer more gaming variation. To increase accessibility, an offer of less physically demanding exergames should be available wherefore also more disabled residents can participate [3, 26].

The main limitation of this study was the small study population, obstructing in depth statistical analyses. Any inclusion bias cannot be ruled out: to play exergames residents needed to be fit and mentally resilient. However, even with this relatively competent group of participants we observed improvements in wellbeing. Second, the blinding was not always successful since residents shared their participation in the study to the blinded staff. Third, to control the time spent to complete the questionnaires, we compiled a short version of validated instruments. Due to the small study sample, a validation of these questionnaires was impossible.

A strength of the study is that implementation of the exergames fitted in the usual offer of activities which facilitates transfer of the procedure and the results ta daily practice. Second, the exergames were easy and intuitive to use, lowering the time investment and threshold for playing and coaching. Third, the study sample was larger than reported in most other studies in this domain and context.

5. Conclusions

This randomized study in three Flemish residential care centers showed that playing exergames positively affected general well-being defined as sleep quality, mental well-being and pain complaints Cognitive functioning did not improve after the introduction of exergames but this might be related to the cognitively strong group of participants. Over time, the residents enjoyed the exergames and the social contact while they also felt fitter. The coaches appreciated the feasibility of the exergames and they believed implementation in the usual care of a residential care center requires variation in games and a scheduled program. Exergaming is an attractive and feasibly complement to the usual activities offered in a residential care setting. Future research should focus on more physically and mentally vulnerable groups and should aim to develop a study in an implementation design.

Declarations

Ethics approval and consent to participate: The staff informed residents about the intervention. If residents showed interest and allowed being approached for inclusion, the researchers further explained the study. For this purpose, the researchers used an informative flyer and a comprehensive information letter. If residents agreed to participate, they signed an informed consent. All methods were carried out in accordance with relevant guidelines and regulations and prepared in discussion with scientific and field

experts. The Medical Ethical Board of the University Hospitals of KU Leuven approved the study (MP004468).

Consent for publication: all authors explicitly consent for publication

The datasets generated and/or analysed during the current study are available in the link: https://drive.google.com/drive/folders/10clsG3acKRJr3m8LvD0L4FxVOwr5I0R_?usp=sharing

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Authors' contributions

o Conception and design of the research: MG, HW, IDM, BS

o Acquisition of data: MG, HW, IDM

o Analysis of data: MG, HW, IDM, BS

o Drafting the article: MG, HW, IDM

o Revision the article: MG, HW, IDM, BS

o All authors read and approved the final manuscript.

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All methods were carried out in accordance with relevant guidelines and regulations and prepared in discussion with scientific and field experts.

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Tables

Table 1
composition of questionnaire by outcome and source

26 questions/statements	Source (n = number of questions)
6 statements on sleep quality	Domus Medica Guideline Sleep Disorders (9)
10 statements on mental wellbeing	Bel Rai (11) OPQOL-35 (12) RAND 36 (13)
4 statements on pain complaints	Bel Rai (10)
6 statements + 2 questions + 2 tasks to assess cognitive functioning	IQCODE-N (14) NHG Guidelines Dementia (15)

Table 2
characteristics of residents

Characteristics	Total (n = 32)	Intervention group (n = 15)	Control group (n = 17)
Gender	10	6	4
- Male	22	9	13
- Female			
Age	3	2	1
- < 76j	3	0	3
- 76-80j	26	13	13
- > 80j			
Education	13	7	6
- Opleiding tot 14j	7	4	3
- Opleiding tot 16j	8	3	5
- Opleiding tot 18j	3	1	2
- Opleiding tot > 18j			
Duration of stay	11	6	5
- 1j	14	6	8
- 1-3j	7	3	4
- > 3j			
Walking aid	8	3	5
- None	1	0	1
- Stick	21	12	9
- Walker	2	1	1
- Wheel chair			
Marital status	3	0	3
- Not married	9	4	5
- Married	2	2	0
- Divorced	18	9	9
- Widow(er)			

Characteristics	Total (n = 32)	Intervention group (n = 15)	Control group (n = 17)
Children	5	2	3
- 0	6	1	5
- 1	4	2	2
- 2	17	10	7
- > 2			
Earlier sport	17	7	10
- Yes	15	8	7
- No			
Earlier video games	4	1	3
- yes	28	14	14
- no			
Earlier exergames	2	1	1
- yes	30	14	16
- no			

Table 3
Effect of exergaming versus usual care on wellbeing, sleep, pain and cognition

Median score on questionnaire	Intervention group			Control group		
	Time point			Time point		
	0m	3m	6m	0m	3m	6m
Wellbeing rated by residents /50	42	44,5	45	41	41	41
Wellbeing rated by staff /20	18	18	16	14	17	16
Sleeping score rated by residents /30	23	24	28	24	25	25
Sleeping score rated by staff /10	7	7,5	8	7	7	7
Pain score rated by residents /20)	18	18,5	20	17	14	16
Pain score rated by staff /op5	4	4	4	4	4	4
Cognitive function rated by residents /30	24	26	26	23	27	26
Cognitive function rated by staff /30	13,5	13	13	12	11	11
(Mean) Cognitive function objective /2	1,8	1,9	1,7	1,2	1,6	1,5
(Mean) Clock drawing test /5)	3,1	2,9	3,5	2	1,8	2,5
Stroop colour word test in seconds	28	29,5	28	37	30,5	30,5

Table 4
average fun and intensity score in exergaming group

Average score	Intervention group/time points		
	0m	3m	6m
VAS (fun)	8,7	8,9	9
Borg (Intensity)	10,9	11,6	13,1

Table 5
Advantages and disadvantages of exergames reported by residents

Advantages	**Number of answers**
- Feeling fitter	5
- Social contact	2
- Being busy	2
- Other than usual activity	1
- Competition	1
- New sport	1
Disadvantages	**N**
- Pain arms or back	3
- Fear of falling	1

Table 6
positive effects, advantages, disadvantages and suggestions for future reported by coaches

Positive effect	Number of answers
- Fun	3
- Competition	3
- Motivated residents	3
- Innovative	2
- Ground-breaking	1
- Integration in care centre	1
- Recall of sports, memories	1
Advantages	
- Exercising	5
- No extra material investment, easy to aplly	3
- Social contacts	2
Bringing seniors in contact with ‘modern times’	1
- Playing with family/visitors	1
	1
Disadvantages	
- Low accessibility for disabled residents	3
- Coaching	3
- Limited variation in games	3
- Games not always intuitive	2
- Exclusion of residents	1
- English	1
Future	
- Games for seniors	4
- Lower frequency	3
- More inclusive	1
- Not playing in warm season	1