BENEFITS OF EXERCISE TRAINING WITH NINTENDO® WII FOR HEALTHY ELDERLY POPULATION: LITERATURE REVIEW

Benefícios do treinamento de exercícios com o Nintendo® Wii na população de idosos saudáveis: revisão de literatura

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ABSTRACT

The present study aims to evaluate possible benefits of exercises performance by elderly population using Nintendo® Wii. The literature was reviewed through the indexed databases: Medical Literature Analysis and Retrieval System Online, PubMed, SciELO, The Cochrane Library, and Physiotherapy Evidence Database. Between 2010 and 2013 ten articles were selected: five articles methodologically classified as semi-experimental or interventional type and the other five as a randomized controlled trial. After literature review, we could identify six categories related to the outcomes investigated, which were static balance, dynamic balance, subjective measures of balance, functional capacity, muscle strength and motivation and/or fun. These results suggest that the Nintendo® Wii is a valuable tool for physical therapy practice, bringing potential benefits to the elderly population. Further research is needed to define a more appropriate protocol regarding games chosen, supervision, monitoring and that the duration and frequency of therapy would be more beneficial for these patients to better clinical applicability.

KEYWORDS: Virtual Reality Exposure Therapy; Postural Balance; Health of the Elderly; Rehabilitation; Physical Therapy Modalities.

INTRODUCTION

The population aging is a world phenomenon and Brazil withholds almost 13 million elderlies, which stands for about 7.4% of the total Brazilian population[1]. With aging, the systems responsible for balance are altered, causing elderlies to be vulnerable to functional deficits[2], so much that falls and unstable balance lead the ranking of the most serious clinical problems faced by the elderly[3]. Falls are the greatest contributors to immobility and early institutionalization, besides raising death rates among this group[3]. This is a multifactorial problem among the elderly and the risks are increased with the presence of factors such as poor balance, difficulty to walk, lower limbs deficits and the use of sedatives[4]. Adding to these, the experience of aging is different for different populations, even between men and women[5].

Programs of physical exercises that significantly enhance muscle power, maintaining body weight and composition, and improving balance, may diminish falls among elderly, being therefore an effective way of prevention[6,7]. Besides these, physical exercises improve social life, reduce the risks of chronic diseases, and improve physical and mental health and functional performance, assuring independence and autonomy for a longer period of time[8]. Technological advances has significantly contributed to the development of virtual games designed for the practice of physical activities, developed to make use of human movements as

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the entry element, aiming at a higher caloric expenditure[9]. In addition, the virtual environment has been showing to be a promising technology, since, through games, it promotes interaction and favors the use of balance-oriented reactions as it creates sensations resulting from experiencing a different reality[10].

The benefits of using Nintendo® Wii in rehabilitation science as a therapeutic tool in literature include correction of the body's posture, balance training, enhancement of locomotion ability and higher and lower limbs movement extent, besides motivating patients towards the practice of exercises[11]. Thus, the relation between virtual practice of physical activities and the true gain of motor skills is being studied, since interfaces such as Nintendo® Wii demand abilities necessary to perform everyday activities[12].

Based on these considerations, regarding the virtual practice of physical activities, the objective of the present research was to evaluate the benefits for healthy elderly populations of training with Nintendo® Wii.

METHODS

A bibliographic review was carried out through the analysis and integration of the literature regarding the possible benefits of the usage of Nintendo® Wii games for healthy elderly population. The bibliographic survey was done in January, 2014, in the indexed databases: *Medical Literature Analysis and Retrieval System Online (MEDLINE), PubMed, SciELO, The Cochrane Library*, and *Physiotherapy Evidence Database (PEDro)*, without any restrictions as to its publishing year and language, and using the descriptors *"Nintendo® Wii"*, *"balance"* and *"elderly"* with the Boolean operator *"and"*. The inclusion criteria taken into account were: electronically available complete articles; papers whose target population was the elderly (60 to 95 years old) of both genders and healthy; experimental or semi-experimental studies; quantitative and/or qualitative studies; studies that used Nintendo® Wii as a means of treatment or intervention. As for the exclusion criteria, they were: papers in which the studied individuals had any disease that could influence their balance (such as Parkinson's disease, cerebrovascular accident, vestibulopathies); individuals of either male or female gender, alone; individuals whose age was under 60; observational studies; case reports or series; and studies whose objectives were not to assess the use of Wii as a therapeutic resource, but as a tool to evaluate balance.

LITERATURE REVIEW

Fifty-nine articles were found, of which twenty were on *MEDLINE*, thirty-three on *PubMed*, three on *SciELO*, one on *The Cochrane Library* and two on *PEDro*. Of the total, twenty-one articles were in agreement with the inclusion and exclusion criteria, but eleven were in duplicity, that is, in more than one of the databases. Therefore, ten articles were included in the present study, which are represented in Table 1.

Table 1 – Description of studies that used Nintendo® Wii for balance improvement among healthy elderly.

Author/ Year	Methodology Employed	Ages / Sample	Measurements	Results
Rojas et al. (2010)	Semi-experimental and interventional study Single group with *Wii Fit* training Games: *Snowboard, Penguin Slide, Super Hula Hoop* and *Yoga* Duration: thrice a week, 20 minutes each session, for eight weeks	Average: 69 years old n= 20	Static posturographic platform.	Quantitative results: In the standing on two feet test and in the *Dantian* posture with eyes opened there was a significant reduction in the CoP displacement on the 3rd, 6th and 8th week, representing a reduction of 28% of the initial numbers; a significant reduction in average speed has also been found on the 3rd and 8th weeks.
Williams et al. (2010)	Longitudinal intervention study Wii Fit treatment group (n=15) Standard treatment group (n=6) Duration: total of 12 weeks Games: *Jogging, Tilt Table, Step Basics, Ski Slalom, Yoga, Heading, Ski Jump, Hula Hoop* Wii Fit treatment group: twice a week; Wii Fit aerobic and balance exercises Standard treatment group: exercises/instruction supervised by a physiotherapist	> 70 years old n=21	*Berg Balance Scale (BBS);* *14 activities of daily living (ADLs)* ; *Tinetti's Falls Efficacy Scale;* *Falls Efficacy Scale (FES-I);* Attitudes to Falls-Related Interventions Scale (AFRIS); *Wii Fit Age scores.*	Qualitative results: All participants in the Wii Fit group reported it as being a pleasant and acceptable practice; 77% reported that they would engage in such an exercise program if they were more widely available; 92% showed the desire to practice Wii Fit in the future; during interventions, negative aspects were identified, such as pain/discomfort, fatigue and difficulties, as well as positive aspects, such as the desire to practice Wii on their own. Quantitative results: Statistically significant improvement in the Wii Fit intervention group in the *BBS* (p=0.02) and in *Wii Fit Age score*s (p=0.03) in 12 weeks.
Agmon et al. (2011)	Interventional and semi-experimental study Single group with Nintendo® Wii Fit Games: *Basic Step, Soccer Heading, Ski Slalom,* and *Table Tilt* Participants were instructed individually and were followed-up through weekly phone calls Duration: average 30-minute sessions, thrice a week, in a total of three months	from 78 to 92 years old n=7	*"3 Activity Monitor";* *Berg Balance Scale (BBS);* *4MWT;* *Physical Activity Enjoyment Scale (PACES);* Monitoring through phone calls and semi-structured written records.	Qualitative results: All participants felt comfortable using Wii Fit after individualized training; initial technical difficulties were solved; alternatives were suggested for better safety; participants reported visible improvement through game scoring; all participants preferred *Table Tilt* and *Ski Slalom*; six participants reported pleasure in playing when visited by their grandchildren. Quantitative results: There was improvement in *BBS* after intervention (p<0.017), and in walking speed through the *4MWT* (p<0.018); there were no changes in the *PACES* scale (p=0.61)
Dougherty et al. (2011)	Interventional and semi-experimental study Single group with Wii Fit training Games: no description Duration: 10 minutes, thrice a week, for five weeks	Above 65 years old n= 9	*Berg Balance Scale (BBS)*; *Wii Fit Age*.	Quantitative results: It was indicated that the use of Wii may significantly improve balance and potentially reduce the risk of falls, as measured by *BBS*. Age was the only factor that significantly influenced balance (p=0.006).

Author/ Year	Methodology Employed	Ages / Sample	Measurements	Results
Young et al. (2011)	Interventional and semi-experimental study Single group with Nintendo® Wii Games: Catch apples falling off the tree; handle a character moving inside a bubble Duration: 10 sessions of 20 minutes each, through a period of 4 weeks.	from 79 to 91 years old n= 6	Static balance test on a Wii platform; *Tinetti's Falls Efficacy Scale.*	Qualitative aspects: All participants said they would accept to continue training for a longer period of time, and all of them reported to be satisfied with the game experience. Quantitative results: Though the average oscillation had been reduced after the test, both in the anteroposterior and in the mid-lateral variations, in opened and closed eyes condition, only in anteroposterior stability with eyes closed was significance found (p=0.03); Through the *Tinetti's Falls Efficacy Scale* there was an 11% improvement, which reflected greater confidence in performing functional tasks.
Franco et al. (2012)	Randomized controlled trial G1 – Wii Fit Group (supervised Nintendo® Wii + home exercising) G2 – Matter of Balance group G3 – Control group (without interventions) Games: *Soccer Heading, Ski Jumping, Ski Slalom, Tightrope, Table Tilt, Balance Bubble* Duration: G1 – 10 to 15 minutes playing, twice a week, in a total of three weeks G2 – 30 to 45-minute group sessions, twice a week, for three weeks, with exercises provided by an exercise physiologist (protocol); they were not instructed as to home activities.	from 63 to 90 years old n= 32	*Berg Balance Scale (BBS);* *Tinetti's Falls Efficacy Scale*; *SF-36*.	Qualitative results: The results of a self-report demonstrated that Wii Fit is a pleasant form of exercise for the elderly population. Quantitative results: There were no statistically significant results *BBS* (p=0.837) *Tinetti's Falls Efficacy Scale* (p=0.913) *SF-36* (p=0.256)
Rendon et al. (2012)	Randomized controlled trial G1 – Virtual Reality Group (Nintendo® Wii Fit) G2 – Control group (without interventions) Games: *Lunges, Single Leg Extensions and Twists* (a physiotherapist was present during training sessions) Duration: G1 – three times a week for six weeks; G2 – without interventions	from 60 to 95 years old n= 40	*Eight-foot Up and Go Test (8ft UG);* *Activities-specific Balance Confidence scale (ABC);* *Geriatric Depression Scale (GDS).*	Quantitative results: Significant improvement in the *8ft UG* and *ABC* tests for G1, when compared to G2.

Author/ Year	Methodology Employed	Ages / Sample	Measurements	Results
Toulotte, Toursel and Olivier (2012)	Randomized controlled trial G1 – Adapted physical activities program G2 – Wii Fit® training G3 – a combination of both (physical activities + Wii Fit®) Games: *Heading Soccer, Ski Jumping, Yoga, Downhill Skiing, Game Balls* and *Tightrope Walker* (Supervised exercises) Duration: one hour, once a week, for 20 weeks	from 65 to 85 years old n= 36	*Tinetti's Falls Efficacy Scale;* *Timed unipedal stance test;* *Tests on Wii Fit®*	Quantitative results: After training, the scoring on *Tinetti's Scale* was significantly reduced ($p<0.05$) for G1, G2 and G3 in the static conditions and for G1 and G3 in dynamic conditions; after training, performances in the unipedal test significantly decreased ($p<0.05$) for G1 and G3; the position of the center of mass was significantly changed ($p<0.05$) for G2 and G3.
Bieryla and Dold (2013)	Randomized controlled trial G1 – Experimental group (Nintendo® Wii) G2 – Control group (continue with usual activities) Games: *Half-moon, Chair, Warrior, Torso Twists, Soccer Heading, Ski Jump* Duration: 35 to 45-minutes session, thrice a week, for three weeks	from 70 to 92 years old n=9	*Berg Balance Scale (BBS);* *Fullerton Advanced Balance (FAB);* *Functional Reach (FR);* *Timed Up and Go (TUG).*	Quantitative results: Improvement in the intervention group only in *BBS* ($p=0.037$); There was no significant increase in the scores of *FAB, FR* and *TUG*
Jorgensen et al. (2013)	Randomized controlled trial Training group with Nintendo® Wii (n=28) Control group (n=30) – use of ethylene-vinyl acetate copolymer insoles Games: *Leaning, Ski Slalom, Penguin Slide, Tightrope, Squatting* – all sessions were supervised by a trained physiotherapist Duration of Wii training: about 70 minutes, twice a week, in a total of 10 weeks Duration of the use of insoles by the control group: daily use for 10 weeks	75.9 ±5.7 years old n= 58	Muscle power through leg press; force platform; *Rapid Force Development (RFD);* *Timed Up and Go (TUG); Falls Efficacy Scale-International (short FES-I);* a test consisted of repeatedly standing up and sitting back again on a chair, taken for thirty seconds; *5-point Likert scale* with three structured phases regarding Wii; the participants were questioned regarding adverse effects	Qualitative results: No adverse effects were reported among participants; those of the Wii group strongly agreed with the statement that the training was fun and motivating, also demonstrating interest in continuing with training. Quantitative results: The Wii group presented greater maximum voluntary contraction force (18%) than the control group ($p=0.001$); the pressure center movement speed didn't differ (1%) between the groups ($p=0.92$). Results were better for Wii group in *RFD* ($p=0.03$), *TUG* ($p=0.01$), *short FES-I* ($p=0.03$), and in the *Thirty-Second Repetition Rise and Sit Test* ($p=0.01$).

The articles included in the study criteria summed up to ten and were published between the years of 2010 and 2013. Of these, five were methodologically classified as semi-experimental or interventional with pre- and post-training analysis but without the methodological strictness of a randomized clinical trial[13-17], and the other five as randomized controlled trials[18-22].

Among the studies, interventions varied from a total of three to twenty weeks, the training frequency ranged from one to three times a week, and the training or session duration with Wii lasted from ten to seventy minutes. In relation to the types of games used, the studies oscillated from two to eight different games for training; in one of the studies there was no description. In six studies there was a protocol in order to perform the training with Wii Fit[13,14,16,17,21,22] and there was supervision throughout all sessions in four of the studies[17,19,20,22].

In the literature analysis and integration, it was possible to identify six categories related to the outcome which was investigated by means of the exercise training with Nintendo® Wii of the healthy elderly population; these were: static balance, dynamic balance, subjective balance measurements, functional capacity, muscle power and motivation and/or recreation.

Static balance:

In a study that used posturographic platform as an evaluation instrument, before and after eight weeks of training with Wii Fit, with twenty-minute sessions performed three times a week, it was possible to identify a significant improvement in the static balance of the participating elderly individuals, in which there was significant reduction both in the center of pressure (CoP) displacement area and in average speed from the third week on[13]. Such results points to the hypothesis that training with virtual reality can be used as a useful health strategy for the elderly[13].

In a randomized clinical trial, with the treatment group training twice a week with Wii in sessions that averaged seventy minutes long, during ten weeks, when compared to the control group, which only made daily use of insoles, there weren't found significant changes in the evaluation of static balance; the authors considered that this result may have reflected a potential ceiling effect in relation to the type of test that was used (opened eyes standing on both feet) for the evaluation of static balance[22].

In order to evaluate the static balance through the Wii platform, Young et al.[17] developed an interface that made possible to calculate the center of pressure (CoP) incorporating it in virtual reality, suggesting its use as a low cost evaluation instrument. In a four-week period training with Wii, totaling ten sessions of twenty minutes each, it was possible to achieve an important improvement in anteroposterior corporal balance in closed-eyes condition after training[17].

Another randomized clinical trial study used as an evaluation tool the timed unipedal stance test and tests in Wii Fit. This study took twenty weeks of training, with sessions that lasted one hour and occurred once a week. After the training, there was an improvement in the performances in the unipedal stance test for the adapted physical activity group and for the Wii group. In addition, the position of the center of mass was significantly changed in the Wii training groups and in the adapted physical activity group combined with Wii[20].

Dynamic balance:

The objective evaluation of the dynamic balance was taken into account in seven studies, in which the evaluation instrument was the *Berg Balance Scale (BBS)*[14-16,18,21]; *Tinetti's Falls Efficacy Scale*[14,17,18,20]; scores achieved at *Wii Fit Age*[14,16]; *Fullerton Advanced Balance (FAB)*[21] *scale*; *Functional Reach (FR)*[21].

Statistically significant improvement was achieved in the Wii Fit intervention group in the *BBS* (p=0.02) and in the Wii Fit scores (p=0.03), when compared to the standard treatment group, in twelve weeks of training being performed twice a week; improvement in the *BBS* began already in the fourth week[14].

In the studies carried out by Agmon et al.[15], with a three-month Wii training program, consisting of three sessions a week, each one lasting an average of thirty minutes, and in Dougherty et al.[16], with a five-week training program, which consisted of three ten-minute sessions a week, there was a significant improvement in the evaluation of the dynamic balance by means of *BBS* after the training[15,16].

Only two studies reported important improvement in balance evaluation through the *Tinetti's Falls Efficacy Scale*. One of these had only one Wii group, which performed ten sessions of twenty minutes each for the period of four weeks, obtaining an improvement of 11% in the total score[17]. The other one was a randomized controlled trial, which consisted of twenty weeks of training, with one session a week, each lasting one hour; this trial found significant reduction in the scores for the three groups in the static condition, and also in dynamic conditions, for the adapted physical activities program group and for the group of adapted physical activities program combined with Wii[20].

In a randomized controlled trial carried out through a three-week period, with two sessions a

week that lasted from ten to fifteen minutes each, no statistically significant results were found in any of the evaluated items; in this case, the authors conjectured that the intervention period may have been too short in order to detect changes in balance[18]. On the other hand, another randomized controlled trial carried out through a period of three weeks, but with each session lasting from thirty-five to forty-five minutes and a frequency of three sessions a week, obtained improvement in the Wii intervention group through the *BBS*, though there were no significant changes in the *FAB* and *FR* scores[21].

Subjective balance measurements:

Subjective measurements for the analysis of balance were taken into account in some articles through the *Falls Efficacy Scale-International (FES-I)*[14] and its shorter version, *Short FES-I*[22], and also the *Activities-specific Balance Confidence Scale (ABC)*[19].

In the study that made use of *FES-I*, no important changes occurred for the Wii intervention group from the beginning until the end of the study[14]. On the other hand, in a randomized clinical trial, which made use of the *Short FES-I*, statistically significant change was found for the Wii group in relation to the control group; the post-intervention difference between the Wii group and the control group was of 4.9%[22]. In addition, in the randomized controlled trial study that used the *ABC Scale* there was significant improvement for the Wii group when compared to the control group.

Functional capacity:

In addition to the balance measurements mentioned above, other aspects were taken into account. Among these, was the functional capacity measurement, taken by means of several tests, including *Timed Up and Go Test – TUG*[21,22]; *Four-Minute Walk Test (4MWT)*[15]; a test consisted of repeatedly standing up and sitting back again on a chair, taken for thirty seconds[22]; the *eight-foot Up and Go Test (8ft UG)*[19]; the fourteen *Activities of Daily Living (ADLs)*[14]; Three Activity Monitor[15].

There was significant improvement in *TUG* only in the randomized clinical trial study, which had a total of ten weeks of training, each session averaging 70 minutes, twice a week. In this study, a significant improvement was found in the Thirty-Second Repetition Rise and Sit Test, in favor of the Wii group[22].

In a three-month long interventional study, consisting of three weekly sessions, each lasting thirty minutes, there was significant improvement in walking speed in the Wii training group, assessed through the *4MWT*[15]. Besides this, in a randomized controlled trial, with a six-week Wii training, performed thrice a week, there was improvement in the *8ft UG Test*[19].

Muscle power:

As part of the evaluation procedure, a randomized controlled trial assessed the muscle power, by means of maximum voluntary contraction on the leg press (Leg Force, Newtest, Finland) and *Rapid Force Development (RFD)*[22]. In this study, the results were better for the Wii group, after ten weeks of training, with two weekly sessions, averaging seventy minutes each, in the maximum voluntary contraction force and in the *RFD* evaluation.

Motivation and recreation:

Finally, some questionnaires were used to complement the findings of some articles, such as the *Attitudes to Falls-Related Interventions Scale* (*AFRIS*) associated with a qualitative interview[14]; *Physical Activity Enjoyment Scale (PACES)* along with frequency, time duration, safety, difficulties in the games[15]; *SF-36* for quality of life[18]; *Geriatric Depression Scale (GDS)*[19]; *5-point Likert scale* with three structured phases regarding Wii along with a questionnaire about adverse effects[22].

In the great range found among the questionnaires, no change in the outcome of any of the studies was obtained. On the other hand, when the qualitative aspects were investigated, the findings were positive for training with Wii Fit, with reports referring to it as a pleasant, recreational and motivating activity[14,15,17,18,22].

General aspects:

Virtual reality has had an important role in health and, in the field of physiotherapy, Nintendo® Wii Fit has been used as a therapeutic resource for different populations, such as in the improvement in balance among hemiparetic patients[23], in the rehabilitation of children with cerebral palsy[24], and among cerebrovascular accident patients[25,26]. Recent studies have adopted Nintendo® technology with the intention of promoting health among healthy elderly people[13-22], specially as it represents a relatively low cost commercially available resource[24,25].

The results of the studies have shown static balance[13,17,20,22] and dynamic balance[14-17,20,21] to be primary benefits of the use of Nintendo® Wii Fit but, in addition to these, secondary benefits have been described, such as improvement in functional capacity[15,19,22], muscle power[22] and motivation and/or recreation[14,15,17,18,22]. These benefits may be explained by the fact that, as an interactive game is played, such as Nintendo® Wii, there are cognitive and sensorimotor inputs, resulting from the player's

need of an adequate postural control in order to perform the required tasks, besides understanding the notices, planning for strategies for better performance and responding adequately to stimuli[24,25]. Joo et al.[25] highlight that the use of Nintendo® Wii should not substitute conventional treatment, but that it favors motivation towards the treatment and adds an entertainment aspect to it, creating an opportunity for socializing and leisure when used with a partner or in group.

In spite of the possible benefits of Wii for healthy elderly populations, the analyzed studies present methodological differences, both in evaluating the results and in the training protocol, which makes difficult to standardize and better compare the outcomes.

FINAL CONSIDERATIONS

The results of this research suggest that Nintendo® Wii is a valuable instrument for physiotherapy practices, bringing about potential benefits for the elderly population. On the other hand, because of the great variance found in methodologies used in the studies and their suggested results, it's not yet possible to come to a clear conclusion regarding Wii for this population.

Thus, more studies are made necessary that propose to define a more adequate protocol comprehending selected games, supervision, monitoring and the most beneficial therapy duration and frequency for the healthy elderly population, as a means of promoting their health.

RESUMO

Este estudo tem como tema os exercícios realizados por meio do Nintendo® Wii e seus possíveis benefícios para população de idosos saudáveis. Foi realizada revisão bibliográfica por meio das bases de dados indexadas: Medical Literature Analysis and Retrieval System Online, PubMed, Scielo, The Cochrane Library, e Physiotherapy Evidence Database. Entraram no presente estudo 10 artigos, publicados entre os anos de 2010 a 2013, sendo cinco artigos classificados metodologicamente como semi-experimentais ou do tipo intervencional e os outros cinco como ensaio clínico controlado randomizado. Após a análise e integração da literatura, foi possível identificar seis categorias relacionadas aos desfechos investigados, sendo elas o equilíbrio estático, equilíbrio dinâmico, medidas subjetivas de equilíbrio, capacidade funcional, força muscular e motivação e/ou diversão. Os resultados desta pesquisa sugerem que o Nintendo® Wii é um valioso instrumento para a prática fisioterapêutica, trazendo potenciais benefícios para a população de idosos. São necessários mais estudos com a proposta de definir um protocolo mais adequado em relação aos jogos escolhidos, supervisão, monitorização e qual a duração e frequência de terapia seria mais vantajosa para esses pacientes, para melhor aplicabilidade clínica.

DESCRITORES*:* Terapia de Exposição à Realidade Virtual; Equilíbrio Postural; Saúde do Idoso; Reabilitação; Fisioterapia.

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