

Older women using Wii Fit Plus™ to remain active

The benefits and challenges of exergaming as a physical activity

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Abstract

As a group, older women are among the least physically active North Americans. Exergames, or games that encourage physical activity, are proposed for all ages as a home- or school-based exercise system. Thirty women over 40 years of age were tracked for three to six months while they incorporated the exergame Wii Fit Plus into their overall program of physical activity. In a mixed methods research design, fitness tests were performed to assess changing abilities, while interviews were used to understand the process of exergame use. Among the eldest participants in the study, the use of Wii Fit Plus was most readily adopted as a group activity. For most participants in their '70s, additional support was required throughout the study to navigate the game's interface. Older participants, while enjoying the social aspects of exergaming, more frequently engaged in walking as a physical activity. Participants with less ability to stand on one leg at the onset of the study were able to retrain their balance by the conclusion. The least active participants reported that the moderate intensity activity offered by the game gave them the confidence to pursue additional physical activities.

Keywords: Wii Fit Plus, exergaming, balance, aging, moderate physical activity, women's health, active video games, exergame research design.

I. Introduction

Medical researchers have demonstrated that physical activity is associated with beneficial effects on human health. People who are physically active are less likely to develop chronic health conditions such as diabetes or cardiovascular disease [1, 2]. If such conditions are present, their mitigating effects could be lessened with regular physical activity. Physical activity can help to elevate one's mood, and has been shown to alleviate depression, one among many benefits discussed in a meta-review by [3].

Despite well-publicized public health campaigns extolling the benefits of regular exercise, fewer than half of all adults living in industrialized countries are active enough to meet their nation's minimum fitness guidelines [4]. Canadian adults are less fit today than their counterparts were 25 years ago [5]. For women, the most frequently cited barriers to fitness are a lack of time (due to work and caregiver obligations), a lack of resources (for gym membership or fitness supplies) and a shortage of companions to enjoy physical activities with [6]. Some researchers posit that exergames provide a pleasurable contemporary alternative to traditional physical activities [7, 8, 9].

Exergame is a term sometimes applied to games that encourage players to respond by being physically active or by exercising. A more precise but less compact expression might be 'games with an exertive interface'. Interactions between a digital device and human constitute an exergame when the exchange encourages the person to engage in any activity considered to be aerobic, or designed to improve balance, strength, agility, or other specialized forms of bodily control or movement.

II. Exergaming for Adults

Canadian Physical Activity guidelines suggest that adults undertake a minimum of 150 minutes of moderate (i.e. walking) to vigorous (i.e. brisk walking) intensity aerobic activities per week [10]. A majority of earlier exergaming studies looked at whether the games were

considered physical activity. A 2008 review of interactive game studies found that 11 out of 18 questioned whether exergames provided sufficient energy expenditure to be considered physical activity [7]. A more recent study measured Metabolic Equivalent of Task (MET) or energy expenditure for 68 activities in the console-based active titles *Wii Fit Plus* and *Wii Sports* [11]. Of these activities, 22 were considered moderate intensity with an MET rating of three to six [11]. None of the games and only one strength exercise was ranked higher than the minimum vigorous rating of six MET [11].

Several recent studies assessed physiological changes in adult women and the elderly who used *Wii Fit Plus*, a popular and commercially available software title manufactured by Nintendo for the *Wii* gaming console [12]. Players choose between activity categories such as Yoga, Strength, Aerobic, and Balance games, interacting with the game using a hand-held remote and a Balance Board. The Board is a rugged wireless sensor laden platform capable of measuring relative left-right and forward-back positions.

An Australian pilot study of 10 women aged between 30-58 years looked at the physiological effects of gameplay on women who played *Wii Fit* [8]. Researchers tracked the group for ten weeks, and asked participants to attend two 30-minute *Wii Fit* sessions per week. Participants were directed to choose from at least one game from each of the categories of activities available. The authors concluded that the system offered the possibility of measurable improvement in balance and lower body strength [8].

An American four-week pilot study reported on therapeutic use of the *Wii Fit* Balance Board by 22 elderly patients [13]. Occupational therapists prescribed *Wii Fit* sessions three times a week for 20 minutes [13]. Based on a Berg Balance Scale (BBS) assessment [14], 10 of 22 participants initially needed intervention to improve their balance. After a month of treatment playing *Wii Fit* balance games, only five still needed intervention [13]. Among the Berg balance measures to improve the most was participants' ability to stand on one leg.

Older adults can help to prevent falls by engaging in aerobic activities like walking and through strength, balance, agility and mobility training. Physical inactivity is associated with a decline in lower body strength and associated balance. The co-director, Centre for Successful Aging at California State University (Fullerton), writes, “Maintaining a high level of balance and mobility is essential to aging successfully” [15:vii].

An Australian team studied 316 healthy women (aged 20-80) and found that as the participants aged, changes in their strength and somatosensation contributed to poorer balancing ability [16]. The research was designed to inform health-intervention strategies, so that age-related declines in balance and mobility could be addressed before they affected older women’s quality of life.

III. The Wii Fitness Study

A. Study Design

Researchers have found that exergaming systems like *Wii Fit Plus* (WFP) can provide effective balance and lower body strength training. In addition, exergames provide moderate intensity aerobic activities. Building on these earlier findings, our *Wii Fitness Study* addressed the following questions: How did being part of a group influence women’s approach to exergaming? Were there physiological benefits to participants who used *Wii Fit Plus*? How and why did research participants adopt or reject *Wii Fit Plus* as part of their approach to physical activity?

Prior to the study, the field researcher and fitness trainer assessed commercially available exergames. WFP was considered the safest for our study – the chances of injury were small and a variety of activities were available in the package.

The *Wii Fitness Study* took place from February to December 2011 in a Vancouver-area community centre. Participants enrolled in the study from 3 to 6 months. Thirty women,

ranging in age from forty to seventy-nine, joined the study. Half the participants had home access to WFP, while the other half used the game exclusively at the study site on Saturday mornings.

All participants were encouraged to attend the Saturday morning drop-in. At that time, the field researcher and fitness trainer were available to give instructions in WFP use, guide workout strategies, conduct interviews, and do the fitness testing. Although one system at the drop-in site was available during the week, almost everyone found it more convenient to attend on Saturday mornings when assistance was available.

During the study, 97 semi-structured interviews were recorded, transcribed, summarized, and analyzed. Codes were developed based on iterative versions of interview data. Examination and re-examination of the codes led to conceptual development of categories and themes. Participants also charted a week of physical activity at the testing points.

Each participant was tested at the beginning, mid-point, and end of the study using previously validated fitness tests for aerobic endurance (Six Minute Walking Test), lower body strength (Chair Stand – rising from seated position), and balance (Standing on One Leg) [14,15,16,17]. Participants set up their own personalized avatars one of the WFP stations at the study site. The information recorded on the *Wii* console was unique to each avatar/participant, and so, the research team could assess which games were most frequently used and the total number of minutes on the console for each participant. Together, the data constitutes a Participant Profile, and was analyzed using a constructivist grounded theory approach [19].

Participants did not use exergames in isolation from other physical activities. WFP use was considered to be one among other activities. Participants chose how frequently they used WFP so that researchers could learn how readily the system was adopted or rejected.

Physiological changes over time were tracked and participants were asked about the process of change, if any, during the study period.

B. Results

1) Participants Aged 70-79: Fitness Test Results

As the fitness trainers who worked with the study noted, people sometimes misrepresent their own fitness level. Standardized fitness tests give a clearer indication of the effectiveness of one's physical activities.

Table 1 shows the fastest test score for each participant in her seventies while walking for 6 minutes. In the furthest right column, the equivalent percentile rank from the *Senior Fitness Test Manual* (SFTM) tables is shown [17:127]. The comparison gives an indication of the relative fitness level for each participant, when compared to others of the same age and gender who performed the Six Minute Walking Test with a larger cohort. Participant 5 (P5) and P6 were least able to walk quickly, while P1, P2, P3, and P7 were quicker most women their age.

Table I. SIX MINUTE WALKING TIME: WOMEN IN '70s

P#	Age	Fastest test (yards)	SFTM percentile
1	79	559.7	65
2	77	539	60
3	76	586.3	75
4	75	511.7	50
5	74	461.5	20
6	74	443.5	15
7	72	578.7	65
Average	75	526	50
Median	75	539	60
Standard Deviation	2	56	23

When performing the Six Minute Walking Test and the Chair Standing test, participants in the *Wii Fitness Study* improved their scores only slightly. Table 2 shows results from the One Leg Standing Test for women in their seventies. In addition to walking the most quickly, P3 demonstrated the greatest ability to stand one-legged. She considered herself a fast walker,

and was able to maintain her balance for at least thirty seconds during each of the three tests. P2 was able to improve her ability to stand onelegged from four seconds to thirty during the three months of the study. In addition to using WFP at home, she was a yoga practitioner who appreciated the WFP's reminder to correct her posture.

Table II. ONE LEG STANDING TEST: WOMEN IN '70s

P#	Age	Balance Start	Balance Mid-	Balance End
1	79	27	24	15
2	77	4	15	30
3	76	30	30	30
4	75	30	7	5
5	74	3	9.5	10
6	74	1	3.5	0
7	72	5	4	9
Average	75	14	13	14
Median	75	5	10	10
Standard Deviation	2	14	10	12

Several women in their seventies discussed adopting a regular fitness routine after retirement. All were living independently; two lived with a daughter and her partner. Four of the women in this group were affected by memory loss; one had been diagnosed with Alzheimer's disease. Six of the seven frequently attended the community centre hosting the study, and considered other participants as either close friends or acquaintances. The women who knew each other stated that the opportunity to socialize was part of the appeal of attending the Saturday morning dropin. Women in this group tended to interact with each other while playing by shouting out hints to improve game play and laughing frequently at poor performances or narrow escapes while playing the WFP balance games. They complained that their balance was poorer now than when they were younger.

P7 was both the youngest and the most frequent WFP user in this age group. She reported walking an hour daily at a moderate intensity and logged between 154 and 406 minutes weekly playing WFP at home. She was the only one in this group who owned a Wii console

prior to the start of the study. She explained that her grandson played WFP and she wanted to remain competitive with him.

Previously, P5 had played *Wii Sports* – the others could not navigate the menus without assistance from the research team.

For women in their seventies, social interaction with old friends, and the opportunity to play using a novel exergame system were factors in attending the weekly exergaming sessions. Several participants mentioned that they could not afford to own a *Wii* system, so the opportunity to share was invaluable. Women used the balance games most often in WFP, and mentioned that they were beginning to retrain their balance.

The eldest three participants (P1, P2, P3) were relatively fit in terms of aerobic endurance, as was P7. Among these four participants, the idea of having a daily routine of physical activity was common; two of the women walked a dog several times daily. Rather than making an effort to be more active, this more active sub-group tended stay fit because they were physically active when performing routine daily activities.

2) Participants Aged 60-69: Fitness Test Results Women in this age group were making a transition from full-time or part-time paid work into their retirement years. One was still working full-time, one was looking for paid work, and the rest were either partially or fully retired. Most participants in their sixties were developing strategies to counter chronic health conditions such as diabetes, high blood pressure, knee or hip replacement, osteoarthritis and osteoporosis. In Table 3, the fastest performances during the Six Minute Walking Test are compared with their counterparts from the SFTM tables [17:127].

P13 and P14 gave the strongest performance in this group with top scores in their aerobic endurance and balance tests. Both achieved a Six Minute Walk that put them into the 85th percentile, in comparison with others their age [17:127]. Both were committed to being

physically active, but they adopted different routines. P13 introduced crosstraining principles, learned from a younger relative. When walking the dogs twice daily with her family, they sprinted to vary the pace of their movements. P14 preferred co-ed competitive sports, playing ball hockey or indoor soccer several times a week.

Table III. SIX MINUTE WALKING TIME: WOMEN '60s

P#	Age	Best test (yards)	SFTM percentile
8	66	569	50
9	65	604	65
10	64	595	45
11	63	524	15
12	63	478	5
13	61	684	85
14	60	692	85
Average	63	592	50
Median	63	595	50
Standard Deviation	2	78	31

P9's test also indicated that she was more physically fit than many women her age. Although she had severe osteoarthritis, she was determined to remain active daily despite the pain. P9 and P13 were self-described fast walkers. Like P3 in the older group, P13 stopped attending the 55+ Walking Club because other group members walked too slowly for her quicker pace. She asserted that walking slowly was more difficult for her physically than walking quickly. P11 and P12 performed the Six Minute Walking Test more slowly than other women their age. P11 had hip replacement surgery, while P12 had double knee replacement surgery, and this may have slowed their pace. P12 noted that she was in pain if she walked too far during one day, while P11 reported a recurrent ankle injury.

The length of time that each woman in her sixties was able to stand on one leg at each testing point is shown in Table 4. Three participants were able to stand on one leg for at least 30 seconds during the entire study: P8 practiced yoga daily, P13 cross-trained daily while dog walking, and P14 played team sports several times weekly. P10 and P11 increased their ability to stand one-legged during the study.

P12 was the most inactive participant in this group and, although enthusiastic, seemed to lose her ability to stand one-legged as the study progressed.

Table IV. ONE LEG STANDING TEST: WOMEN '60s

P#	Age	Balance Start	Balance Mid-point	Balance End
8	66	30	30	30
9	65	20	30	30
10	64	6	30	23
11	63	10	13.5	30
12	63	13	8.5	0
13	61	30	30	30
14	60	30	30	30
Average	63	20	25	25
Median	63	20	30	30
Standard Deviation	2	10	9	11

Within this group of seven participants, five used the *Wii* system at the study site, while P8 and P14 were part of a home-based WFP group. Smaller home-based groups of three women tended to include one individual who was the most technically competent, initiated playing, and played most frequently. Neither P8 nor P14 initiated WFP play sessions, although they joined in. They were not comfortable setting up the equipment themselves; instead they played when the group played, and used the games more frequently earlier in the study. Several women who used the game at the study site discussed purchasing one, but were not sure if they had space or if would use it without the structure of the Saturday morning sessions. P9 discussed purchasing the system to use during rainy Vancouver weather, but worried that she would have less incentive to leave her home and to be social with others.

3) Most Frequent Wii Fit Users (aged 60-79)

One Leg Standing Test results from participants were arranged in order of their WFP use after identifying the most 15 frequent users. Test results from those with poor initial balance from ages 60-79 are shown in Table 5.

Table V. FREQUENT WFP USERS WITH POOR INITIAL BALANCE

P#	Age	On WFP Console hour:min	Balance Start	Balance End
9	65	7:28	20	30
7	72	6:39	5	9
10	64	5:20	6	23
11	63	4:42	10	30
6	74	4:30	1	0
12	63	4:27	13	0
5	74	2:56	3	10
Average	68	5:08	8	15
Median	65	4:42	6	10
Standard Deviation	5	1:30	7	13

While individual one-legged balance varied greatly among this group of users, the overall pattern shows that those with poor initial balance showed the greatest improvement in balancing ability. Among infrequent WFP users, the One Leg Standing Test Results remained consistent.

IV. Discussion

A. Playing *Wii Fit Plus* with a Group

The design of *Wii Fit Plus* allows only one player to use the unit at a time. In the WFP multi-player mode, turn taking prevents simultaneous play. When larger family and friend groupings used the game, the most technically astute player tended to initiate gameplay.

Away from the study site,

many older players reported difficulty, at least initially, in navigating through the game menus. Players with more willingness to engage with the technical set-up tended to be younger and reported the fewest barriers to frequent gameplay.

Older players tended to use WFP at the study site because they were provided with technical assistance and were able to socialize with old friends. Many of the older participants knew each other previously and were familiar with the study site, a seniors' lounge. Our three WFP stations allowed three participants to play at one time using their own television monitor. Participants who had just finished or were waiting their turn sat on couches within the space. Although WFP could be an ideal workout on a rainy afternoon, with a few exceptions, participants preferred to use WFP under the supportive conditions of the Saturday morning drop-in.

As [20]'s study of 947 older adults found, participants preferred to attend groups with adults close to their own age, not with those who were much younger or older. Those who were active with a group tended to adhere to their intention to be physically active [20]. In the *Wii Fitness Study*, participants preferred having individual and focused instruction within a social environment.

B. Improving Balance among Wii Fit Plus Users

A lessening of physical activity and a loss of balancing ability has been associated with aging. As [21:51] note: "older women have the lowest rates of physical activity in any demographic group". Study participants who walked more slowly also tended to have a relatively poorer ability to stand on one leg. Older participants with poor initial balance who were frequent WFP users were able to regain their balancing ability in some cases. The change over time can be attributed not only to WFP use, but also to increased awareness of the possibility to retrain one's balance.

C. Remembering the Importance of Walking Outdoors

In many parts of North America, winter weather can include snow, ice, and rain, conditions that make walking outdoors less appealing. Participants who walked a dog reported walking year-round. One woman said she had been for a walk every day of her life. Walking was the most frequent physical activity reported by participants aged 60 or older. Many older participants had either given up their car, or used it infrequently. When shopping or attending local events, they tended to walk, either alone or with a friend.

Several participants participated in a walking group immediately following after their Saturday morning WFP session. Originally, the group accommodated a variety of walking speeds by allowing the faster walkers to progress at their own pace, and then loop back to join the slower walkers. At one point, the group protocol changed, and the faster walkers were asked to walk at a slower pace. Instead, the faster walkers left the group and walked on their own. The most physically active participants were comfortable either working out solo or with a group. Inactive women, after overcoming a reluctance to be active while others were present, seemed to benefit from being part of a group who were active together.

D. Moderate Intensity Movements for Inactive Women

In a longitudinal American study of previously sedentary women aged 40-65, participants were divided into four groups, testing the retention and adherence to either a home-based or fitness centre-based program [22]. The researchers found greatest adherence among women attending a centre based six month long introduction to a moderate intensity program [22].

In our study, there were four older women who were relatively inactive, compared to others their age. The inactive study participants liked to have a scheduled WFP time on Saturdays and were encouraged to be active by their colleagues who were co-present. Their more active friends saw an opportunity to promote increased physical activity. Those who disliked being physically active enjoyed WFP because it was a form of 'exercise' they were able to perform

comfortably – something at their level of expertise. The WFP activities are rated at light to moderate intensity MET values [11], but it should be noted that an activity rated as light could produce shortness of breath and increased heart rate among very inactive participants, becoming a moderate intensity activity for those individuals.

V. Conclusion

The health benefits of physical activity are numerous, and participants were aware of the importance of remaining physically active as they aged. Responses of older women to the exergame *Wii Fit Plus* were positive, but the complexity of the interface prevented some from obtaining autonomous control of the game. The greatest physiological benefit was derived by those who were previously inactive and who had poor initial balance. By playing the WFP balance games, these women were able to improve their balance, in part by gaining confidence in their ability to play WFP balance games, and applying that insight outside the game. Inactive participants overcame their initial reluctance to be physically active in public by finding an activity that they could perform and improve on their performance, as their increased scores in the WFP balance games indicate. For older women, walking remains the most common physical activity, while WFP is seen as a technique to improve one's balancing ability and spend an enjoyable half-hour with friends.

The benefits offered by systems like the *Wii Fit Plus* result from the combination of an entertaining suite of balance games with a customized instrument capable of measuring movement. The challenge will be to design a simple, easily navigated exergaming system that can be customized to accommodate the multiple fitness requirements of diverse user groups.

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