วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 14 ฉบับที่ 2, ธันวาคม 2557
Journal of Sports Science and Technology Volume 14, No. 2, December 2014

นิพนธ์ต้นฉบับ (Original article)
สรีรวิทยาการออกกำลังกายและกีฬา (Sports and Exercise Physiology)

EFFECTS OF INTERACTIVE VIDEO GAMES ON PSYCHOMOTOR AND CARDIOVASCULAR RESPONSES IN ELDERLY

Kewalee WIRIYAWEERAWAT, Waree WIDJAJA, Metta PINTHONG, Thyon CHENTANEZ,
College of Sports Science and Technology, Mahidol University, Thailand, 73170

ABSTRACT

Objective: 1) to investigate the effects of exercise training with interactive video games, on psychomotor and physiological responses in elderly. 2) to compare the physiological effects in older people with high blood pressure in the control group (CG), and training group.

Method: Thirty elderly female with 68.4 ± 6.3 years were participated in this study. They were divided into two groups: training (TG) and control (CG) groups. The TG were trained by interactive video games (30 min, 3 days per week for 8 weeks) and the CG was provided with normal activity for 8 weeks. Ankle brachial pressure index (ABPI),resting heart rate, tapping speed testing ,percentage of fat (%FAT) ,hip circumference ,waist circumference, hand grip strength, six minute walk test (6MWT) were measured 3 times, at the baseline, 4th and 8th weeks, respectively. One-way repeated ANOVA and paired t-test were used to analyze. Significantly differences were considered at the $p < 0.05$ level.

Results: There were no significant change in the hip circumference, waist circumference, grip strength, ABPI, heart rate at rest and finger tapping test the right and left index fingers. The results showed significantly decreased in body weight, percentage of fat and BMI. After training for 8 weeks six minute walk test (6MWT) increased in training group and after training with interactive video game ABPI, muscle strength, systolic, diastolic blood pressure did not change.

Conclusion: The body composition, six minute walk test (6MWT) increased in training group. No difference in body composition and tapping speed testing was found. Moreover, interactive video game exercise training relate to quality of life. Interactive video game to help the elderly and the cardiovascular by six minute walk test changes body weight reduced but no effect on psychomotor.

(Journal of Sports Science and Technology 2014;14(2): 75-89)

KEYWORDS: PSYCHOMOTOR/CARDIOVASCULAR PHYSIOLOGICAL/ INTERACTIVE VIDEO GAMES

วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 14 ฉบับที่ 2, ธันวาคม 2557
Journal of Sports Science and Technology Volume 14, No. 2, December 2014

INTRODUCTION

According to National Statistical Office of Thailand (NSOT), the number and proportion of the elderly population has been increasing. The number of elderly people aged over 60 years old and above were 6.8 percent of the total population and increased to 9.4 percent and 10.7 percent in 1994 and 2003, respectively (1). As a person gets older, many systems of the body, such as musculoskeletal, neurological and cardiopulmonary systems change are deteriorate. These are the main causes that make the elderly having risk of health problems and often limit their capacity to fulfill functional activities of daily living and decreased quality of life (2). From aging process, many reports showed that the elderly has declined in the structure of the body including posture, and physiological changes such as the circulatory system, respiratory system, kidneys, endocrine system, transmission of the nervous system and the nervous of light to eyes other senses organs (3).

Hypertension was defined as systolic blood pressure $\geq$140 mmHg or diastolic blood pressure $\geq$ 90 mm Hg or self-reported use of hypertension medications. (4).Hypertension is a major public health problem (National Institute for Clinical Excellence (NICE) 2004; World Health Organisation, 2002; World Health Organization and International Society of Hypertension Writing Group, 2003) and a major risk factor for cerebrovascular and ischaemic heart diseases (5).

The principle of ABPI determination is to obtain a systolic blood pressure reading at the brachial artery of the right and left arms and at the right and left ankles. At the ankles, either or both the dorsalis pedis and tibialis posterior artery is used. The perforating peroneal artery is sometimes used when a signal is not detected from the dorsalis pedis artery.Current practice advocates that the systolic ankle reading is then divided by the brachial reading to give the ABPI. There are problems with this formula though because the ABPI can be obtained using different methods/equations as well as different cut-off values indicating the presence of peripheral artery disease (PAD). (6) Systolic pressure was measured on the right brachial artery and in both posterior tibial arteries. The ABPI was calculated for each leg and was defined as posterior tibial systolic pressure divided by brachial systolic pressure. Three ABPI groups were defined: low (ABPI<0.90), normal (0.90 $\leq$ABPI $\leq$ 1.40), and high (ABPI > 1.40). (7) If both ABPI measures were in the same category (low, normal, or high), then the APBI farthest from 1.0 was used. (4) A high ABPI (greater than 1.30) is also associated with increased CV risk. (8)

Physical activity that promotes health and prevents diseases is recommended to all adult age 50 years up. Exercise in elderly people can improve maximal and submaximal aerobic capacities, augment cardiac output and reduce resting heart rate and blood pressure.(9) While the American College of Sports Medicine (ACSM) recommends that elderly people should accumulate 30 minutes or more of moderate-intensity physical activity for 5 days/week and vigorous-intensity physical activity for 3 day/week.(10) The Nintendo Wii is a recently released gaming system that features a motion sensing remote controller. The controller responds to a player's body movements and players can participate in games by interacting with

on-screen environments and objects using their own body movements. The Wii offers multiple interactive games, which provide players with more choice and opportunity to select games according to their preferences. Wii Fit Plus is one of the Nintendo Wii games that is played using a special Wii balance board in order to perform activities like yoga, jogging and aerobics.(11) Saposnik G. et al 2010(12) have studied about effectiveness of virtual reality by using Wii game technology in stroke patients for rehabilitation. The result showed that in training group by Nintendo Wii was significant improvement in motor function and virtual reality gaming was safe, feasible and potentially effective options to assisted rehabilitation therapy. (13) New research showed that exergames have significant benefits for older adults by providing cognitive stimulation and a source of social interaction, exercise, and fun (Science Daily, 2012.)(14). The research on exergames has confirm their significant contribution in increasing the participation of individuals in exercise programs (Chin et al., 2008; Patsi et al., 2011). (15)

In the studies of effects of interactive video game in adults it was found that energy expenditures during playing interactive video game were sufficient for the daily amount of exercise according to the guidelines from ACSM and the American Heart Association (AHA) (16). The oxygen consumption and heart rate after playing interactive video game such as Wii sports boxing increased significantly when compared with those of the treadmill walking (17).

Lamoth et al., 2012 reported that the combinations of active video gaming and exercise (exergaming) could improve elderly people's balance, and decreased the risk of fall. Exergaming has been shown to increase motivation during exercise therapy (17), such as Novel, 2006 used the interactive video games for rehabilitation therapy to improve physical fitness in healthy populations while Kho et.al ,2012(18) reported that the video game activities could improve the motor learning, cardiovascular, musculoskeletal, and balance systems.(19)

Many research have focused on the physiological responses of a video game or interactive play in children and adolescents, but a few studies in elderly. This study is to investigate the effects of long term exercise training using the interactive video games on psychomotor, physiological responses in the elderly with hypertension.

METHODS

Participants

Thirty elderly people with age range 60-75 years old from Baan-Salawan Hospital (Salaya, Nakhon Pathom) participated in this study. All participants will be screened and excluded using a specific-modified questionnaire. The plan of research was approved by, Mahidol Ethical committee for Human Research The anthropomorphic parametric such as age, weight, height and BMI were measured. They were divided into two groups as follows. Group 1: Control group (CG, n = 15), Group 2: Training group (TG; n = 15)

Inclusion criteria : females with aged range 60-75 years old. Blood pressure was not greater than 140/80 mm Hg. After a blood pressure medication to lower blood pressure.

Procedure

In TG group, participants trained by using the interactive game for 30 minutes, 3 days/week for 8 weeks and divided the intensity of training into 2 phases as follows.

1. Phase 1 (0th – 4th wk.): the intensity of exercise training is 55% maximum heart rate.
2. Phase 2 (5th – 8th wk.): the intensity of exercise training is 65% maximum heart rate.

Prior to participation, each subject will be clearly explained about the purpose, the experimental process, the benefit and possible risks in this study. Physical activity questionnaires will be used to assess a physical examination and exercise activity. This information will be recorded and kept confidentially. Warm up and training durations are 10 minutes and 20 minutes, respectively. The ABPI index is calculated through measuring the maximum systolic pressure at the ankle of dorsalis pedis artery then divided by the systolic pressure of the brachial artery. The ABPI was calculated for each leg and was defined as posterior tibial systolic pressure divided by brachial systolic pressure. Three ABPI groups were defined: low (ABPI<0.90), normal (0.90 $\leq$ABPI $\leq$ 1.40), and high (ABPI > 1.40). The tapping speed testing was using a dominator The participants are instructed to tap the denominator as fast as possible for 10 seconds. Three repetitions are determined for the right index finger (RI), left index finger (LI), right big toe (RBT), and left big toe (LBT). The tapping speed test recorded maximum tapping speed and the average of three sessions of tapping for 10 seconds. The six-minute walk test is used as a tool to evaluate the functional exercise level of patients with moderate to severe heart or lung disease. The walk is done on a flat surface with a staff member measuring the distance walked. The subject walked at his own pace as far as he can in a six-minute period. The distance walk and any symptoms or pain were recorded. The blood pressure, pulse rate and oxygen saturation were be measured before and after the walk.

RESULTS

1. **Physical characteristics**

Subjects in this study were divided into two groups. One was control group. (CG, n = 15) and the other was training group (TG, n = 15). Descriptive characteristics of subjects were presented in Table 1 as mean and standard deviation (SD) in age, weight, height, hip and waist circumference, resting HR, resting systolic blood pressure, resting diastolic blood pressure, body composition (% fat, BMI). Thirty people were recruited to participate in this study with age between 64-79 years. There were no significantly differences between 2 groups.

วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 14 ฉบับที่ 2, ธันวาคม 2557

Journal of Sports Science and Technology Volume 14, No. 2, December 2014

Table 1 Physical characteristics of the subjects. Data were mean ± SD

Physical characteristics	C group (n=15)		T group (n=15)		*p*-value
	Mean	SD	mean	SD	
Age (year)	68.40	5.33	69.60	5.06	0.585
Height (cm)	151.0	5.0	150.0	4.0	0.346
Weight (kg)	58.83	6.48	55.65	8.73	0.343
BMI (kg/m²)	25.68	3.09	24.61	3.34	0.429
Percentage of fat (%)	37.35	2.08	34.12	5.76	0.061
Resting HR (bpm)	70.53	11.51	68.2	8.9	0.358
Resting systolic blood pressure (mmHg)	119.56	15.11	123.73	12.98	0.415
Resting diastolic blood pressure (mmHg)	66.26	7.23	69.13	5.9	0.651
Hip circumference (cm)	87.30	5.90	84.93	7.00	0.427
Waist circumference (cm)	98.50	7.27	95.40	6.44	0.263

CG: Control group, TG: Training group - No Significant difference between groups.

Table 2 Body composition. Data were mean ± SEM

	Group	Baseline	week 4	week 8
		mean ± SEM	mean ± SEM	mean ± SEM
Body weight (Kg)	CG	58.83±1.73	59.19±1.73[a]	59.47±1.74[a]
	TG	55.65±2.33	55.10±2.34[a]	54.55±2.33[a]
Hip circumference (cm)	CG	87.30±1.57	87.73±1.56	88.10±1.56
	TG	84.93±1.87	84.57±1.89	80.23±1.91
Waist circumference (cm)	CG	98.50±1.94	98.73±1.93	98.73±1.93
	TG	95.40±1.72	95.40±1.72	95.33±1.71
Percentage of fat (%)	CG	37.35±0.55	37.78±0.46[e]	37.82±0.49[f]
	TG	34.12±0.95	33.44±0.96[ae]	34.03±0.98[af]
BMI (kg/m²)	CG	25.68±0.82	25.84±0.83[a]	25.96±0.82[a]
	TG	24.61±0.89	24.37±0.89[a]	24.12±0.88[a]

CG: Control group, TG: Training group

a = $p < 0.05$ compared within group at baseline

e = $p < 0.05$ compared between CG and TG at 4^{th} week

f = $p < 0.05$ compared between CG and TG at 8^{th} week

The body weight of TG and CG were significantly difference at the 4cth week and 8th week when they compared with baseline. Percent changes of body weights in TG was decreased 0.99±0.21 %, 1.99±0 %, respectively. While that in CG was different between baseline at the 4th week and 8th week was 0.60±0.13 %, 1.08±0.30 %.

Hip and waist circumference of TG were lower than CG at the 4th week and 8th week, respectively but they were not significantly difference within group and between groups.

The percentage of fat (%FAT) and BMI of TG and CG were significantly different at the 4th week and 8th week when they compared with baseline as shown in Table 2.

2. **Muscle strength**

Table 3.Hand grip strength (right arm and left arm) Data were mean ± SEM

Hand grip strength (kg)		Baseline		week 4		week 8	
Control group		Mean	SEM	mean	SEM	mean	SEM
	Right arm	0.32	0.10	0.33	0.09	0.34	0.08
	Left arm	0.33	0.07	0.32	0.07	0.33	0.07
Training group							
	Right arm	0.39	0.05	0.39	0.05	0.39	0.05
	Left arm	0.37	0.06	0.36	0.06	0.36	0.06

Hand grip strength right and left arms were of TG was not significantly lower than CG at the 4th and 8th week, respectively. There were no significant difference within group of TG and CG at the 4th week and 8th week, respectively, when compared with baseline as shown in Table 3

วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 14 ฉบับที่ 2, ธันวาคม 2557
Journal of Sports Science and Technology Volume 14, No. 2, December 2014

4. Cardiovascular parameters

Table 4 Cardiovascular parameters. Data were mean ± SEM

Parameters		Baseline	week 4	week 8
		mean±SEM	mean±SEM	mean±SEM
ABPI (Rt)	CG	1.12±0.01	1.15±0.02	1.14±0.03
	TG	1.10±0.03	1.09±0.02	1.15±0.03
ABPI (Lt)	CG	1.09±0.02	1.09±0.02	1.12±0.02
	TG	1.00±0.02	1.08±0.02	1.08±0.03
6MWT (meter)	CG	311.60±16.29	306.87±16.33^{ae}	305.80±17.67^{af}
	TG	333.80±13.44	357.33±15.38^{ae}	367.00±16.09^{abf}
Systolic blood pressures (mmHg)	CG	119.56±4.01	118.11±3.26	116.33±2.64
	TG	123.73±3.47	124.33±4.18	122.14±4.61
Diastolic blood pressures (mmHg)	CG	66.26±1.86	65.46±1.58	67.33±2.20
	TG	69.13±1.52	68.13±1.55	67.60±1.75
Resting heart rate (beat/min)	CG	70.89±2.97	69.56±2.61	67.89±2.53
	TG	64.93±2.32	67.93±2.15	68.57±2.15

CG: Control group, TG: Training group.

a = $p < 0.05$ compared within group at baseline

b = $p < 0.05$ compared within group at 4th week

e = $p < 0.05$ compared between CG and TG at 4th week

f = $p < 0.05$ compared between CG and TG at 8th week

Right and left of ABPI of TG was not significantly lower than CG at the 4th and 8th week. ABPI was no significant difference between the 2 groups at baseline, 4th and 8th week, respectively as shown in Table 4.

Six minute walk test (6 MWT) of TG was significantly higher than that in CG at the 4th week and 8th week, respectively. There was significant difference within group of TG at the 4th week and 8th week, respectively as shown in Table 4.

Systolic blood pressures of TG were not significantly lower than CG at the 4th week and 8th week, respectively. There was no significant difference between the 2 groups at baseline, 4th week and 8th week, respectively. Systolic blood pressures of TG were 123.73±3.47 mmHg, 124.33±4.18 mmHg, and 122.14±4.61 mmHg at baseline, 4th week and 8th week, respectively. While that in CG was 119.56±4.01 mmHg, 118.11±3.26 mmHg, and 116.33±2.64 mmHg at baseline, 4th week and 8th week, respectively as shown in Table 4.

Diastolic blood pressures of TG were not significantly lower than CG at the 4th week and 8th week, respectively. There no significant difference between 2 groups at baseline, 4th week and 8th week, respectively. Diastolic blood pressures of TG were 69.13±1.52 mmHg, 68.13±1.55 mmHg, and 67.6±1.75 mmHg at baseline, 4th week and 8th week, respectively. While that in CG was 66.26±1.86 mmHg, 65.46±1.58 mmHg, and 67.33±2.2 mmHg at baseline, 4th week and 8th week, respectively as shown in Table 4.

Resting heart rate of TG was not significantly lower than CG at the 4th and 8th week, respectively. There was no significant difference between the 2 groups at baseline, 4th week and 8th week, respectively as shown in Table 4.

5. Psychomotor performances

Table 5 Tapping speed testing (taps/10sec). Data were mean ± SEM

Tapping speed testing (taps/10 sec)		Baseline mean±SEM	week 4 mean±SEM	week 8 mean±SEM
right index finger (RI)	CG	39.67±1.91	44.11±2.13	43.67±2.14
	TG	41.27±2.36	44.27±1.84	45.87±1.91
left index finger (LI)	CG	38.33±1.94	38.33±1.85	40.56±1.7
	TG	41.27±1.56	41.53±1.48	41.40±1.32

CG: Control group, TG: Training group

c = $p < 0.05$ compared between CG and TG at baseline

f = $p < 0.05$ compared between CG and TG at 8th week

Tapping speed testing right and left index finger of TG was not significantly higher than CG at the 4th week and 8th week, respectively. There was no significant difference between the 2 groups at baseline, 4th week and 8th week, respectively as shown in Table 5.

DISSCUSSION

In this study, the physical characteristics of the age, weight, height, body mass index (BMI), waist circumference, hip circumference, resting heart rate, resting systolic blood pressure, resting diastolic blood pressure, percent of fat were measured. The results showed that the body weight, body mass index (BMI), and percent of fat (%FAT) in TG were reduced significantly after training for 8 weeks. The values of percent change were found that the weight of the body mass index (BMI) and percentage of fat (% FAT) decrease in TG. This may be because during the participants used the muscles in aerobic exercise training by continuing to step up and raise the legs for min. Evrim C.et.al., 2010 (20) found the significantly differences ($p < 0.05$) of the body weight, body mass index, body fat% after 8 weeks of exercise training. similar to in the research

conducted by Çolakoğlu & Karacan, 2006 (21) in order to investigate effects of aerobic exercises on some physiological parameters in young and middle aged females, body weight pre-test value of middle aged females which they found statistically significant. This was similar to our study. Maddison R, 2011 (22) concluded that the active intervention of the video game could changed in BMI and body composition in children with overweight and obesity.

Cardiovascular physiological system tests

Ankle brachial pressure index (ABPI)

The ABPI measurement is now used worldwide as an easy can be used to clinically assess the risk of future cardiovascular events.

This is study to evaluate the ABPI in hypertension. Several factors play an etiologic role, including the high prevalence of hypertension. The ABPI was a quick non-invasive method of measuring the effect the arterial disease. It developed as an indicator for peripheral vascular disease, such as atherosclerosis and can predict the risk of cardiovascular disease. (Resnick, 2004; Woo, 2005; McGee, 1998)(23,24,25). The ABPI was calculated for each leg and was defined as posterior tibial systolic pressure divided by brachial systolic pressure. Three ABPI groups were defined: low (ABPI<0.90), normal (0.90 ≤ABPI ≤ 1.40), and high (ABPI > 1.40).(7) Low ABPI was also independently associated with a high risk of all-cause and cardiovascular disease mortality (26). Furthermore, peripheral artery disease of the lower extremities is associated with an increased overall risk of mortality (27,28) related to an increased incidence of myocardial infarctions and other cardiovascular events. From this study are similar to Colakoglu and Karacan ,2006 (21) found that after training for walking and running 30min/d, 3d/wk for 12 weeks, there was no significantly difference between the tests of SBP and DBP. Gornik and co-woker, (2005) (29), stated that normally, the blood pressure in the ankles was the same or slightly higher than the blood pressure in the legs. This finding was supported by Virtanen and co-worker (1982) (30), demonstrated that the central action of clonidine inhibits peripheral release of norepinephrine, was insufficient to attenuate cardiac stimulation by physical exercise. Reduction of ABPI is a strong independent predictor of cardiovascular mortality in all patients with peripheral arterial disease. (31)

Six minute walk test (6MWT)

The result of this study found that six minute walk test (6MWT) of TG was significantly higher than that in CG at the 4th week and 8th week, respectively. There was significant difference within group of TG at the 4th week respectively, compared to the baseline. In accordance with Burr JF, 2001 (32), the 6MWT and correlated with health status indicated the severity of moderate to strong which were useful in the classification of exercise aerobics. Inclusion of further readily available variables, such as body weight, sex, resting heart rate, and age, greatly improved the discriminative ability of the 6MWT and allowed for the

creation of a useful prediction equation. Inclusion of further measures, such as exertional symptoms or body composition may have improved predictive abilities further, but were unavailable for the current investigation and may be cumbersome for inclusion by primary care physicians or other members of the health care team seeking a simple fitness estimation tool.

Although the six minute walk test has been used to detect changes following interventions to improve exercise tolerance for healthy older adults (33,34) as well as people with rheumatologic conditions such as knee or hip osteoarthritis (35) and fibromyalgia (36). The 6MWT has been used with a variety of other conditions such as heart failure (37,38), chronic obstructive pulmonary disease (COPD)(39) and stroke (40,41) It has also been used to predict hospitalization and mortality (42,43).

We found that elderly persons can safely perform the 6MWT to quickly measure their functional status. We may be the investigators to describe associations of 6MWT with training interactive video game, self-reported health, and education.

It is probable that the relationship between health status and 6MWT-distance reflects the influence of the status of the cardiovascular system on the general fitness. Studies of exercise physiology have revealed a direct relationship between muscle strength and physical exercise. Decreased physical activity (i.e., inactivity) usually leads to altered muscle metabolism, decreases in muscle mass and lower physical capacity.(40) This relation is more obvious among patients with comorbid conditions, in which the rate of inactivity correlates significantly with 6MWD.(45,46) Local data suggest there is a high prevalence of physical inactivity among Saudis, particularly those who are middle-aged.(47,48)

Zorba & et. al., 2000.(49) as a result of regularly conducted exercises, a decrease in thickness of subcutaneous fat and an increase in fat-free muscle mass can be expected similar to our study found that muscle strength exercises with interactive video game based on the test 6MWT.

Psychomotor performances

Tapping speed testing

Tapping speed testing of TG and CG were not significant. In this study, it was anticipated that the training will have the effect of increasing the number of times the tap. However, the results of this study showed that right index finger tapping and left index finger tapping were not significantly different between the two groups.

This may imply that, the psychomotor performances including speed of tapping (TST) in time were limited. These tests compose of various physiological components; the time of integration of signals and decision making plus time spent in motor pathways and muscle contractions. The psychomotor speeds data have been shown to reflect quite well with physical fitness. Reilly and Smith, 1986 (50) suggested that the implications for activities where psychomotor task were superimposed on a requirement for high muscular power out levels. Beverly and co-worker, 2006 (51) found that the reaction time was not merely an indicator of

age-related physiological deteriorations but rather an indicator of the brain's basic information processing ability. Chentanez and co-worker,1990 (52) suggested that the measurement of reaction time could be used in confirming the location of lesion in the patient with neuronal circuit damaged in brain, spinal cord or peripheral nerve pathways (6). The tapping test has been originally developed as part of neuropsychological tests, is a simple measurement of motor speed and motor control and is used in neuropsychology as a sensitive test for brain damage. Mitrushina et al.,1999(53), Penteado and co-workers (1993)(54) reported that patients with sensorineural hearing loss may be caused by vertebrobasilar arterial obstructive disease. Spirduso,1980 (55) suggested that measurement of the tapping speed test data had been shown to reflect quite well with the degree of physical fitness, in which people who exercise regularly usually had greater psychomotor speeds of several tests than sedentary subjects. Furthermore the age and gender also affect to psychomotor. (56,57)

CONCLUSION

The present study found that 8th weeks of aerobic training with interactive video game decreased the body composition such as body weight, percentage of fat (%) and BMI. While six minute walk test (6MWT) was increased after training. However, there was no significant difference in hip and waist circumference, muscle strength, ankle brachial pressure index (ABPI), resting blood pressures , resting heart rate (HR) (beat/min) and tapping speed testing such as at the right index finger (RI),and left index finger (LI) between groups.

Exercise training by using interactive video games for 8 weeks affects the cardiovascular, and body composition in the elderly. Therefore, it can help to improve health in elderly.

References

1. The National Statistics Office of Thailand (NSOT). The results of the Survey of the Elderly in 2550, (2551): 20 September.
2. Panrampai Thaitrong, Six-Minute Walk Test in Healthy Thai Elderly Aged 60-80 Years. Respectively. University 6th Conference
3. O'Hara-Deveraux M. Eldercare : a practical guide to clinical geriatrics. New York: Grune & Stratton; 1981.
4. DWJ Armstrong, C Tobin, MF Matangi. The accuracy of the physical examination for the detection of lower extremity peripheral arterial disease:Can J Cardiol 2010;26(10):e346-e350.
5. Lee LL, Watson MC, Mulvaney CA, Tsai CC, Lo SF. The effect of walking intervention on blood pressure control:A systematic review. International Journal of Nursing Studies 47 (2010):1545–1561 .

6. Helaine E. Resnick.Prevalence of elevated ankle-brachial index in the United States 1999 to 2002:The American Journal of Medicine (2005) 118, 676–679
7. Available: http://www.sciencedail.com/releases/2012/04/120423143126.htm
8. McDermott. Ankle brachial index as a predictor of outcomes in peripheral arterial disease: J Lab Clin Med 1999;133:33-40
9. Jonathan F. Bean, MD, MS, Ariana Vora, MD, Walter R. Frontera, MD, PhD.Benefits of exercise for community dwekking older adults.Arch Phys Med Rehabil.2004;85(3):31-42.
10. Nelson ME, Rejeski WJ ,et.al Nelson ME,Rejeski WJ,Blair SN,Duncan PW,Judge JO,King AC,et al.Physical activity and public health in older adults:recommendation from the American College of Sports Medicine and the American Heart Association.Med Sci Sports Exerc.2007 Aug;39(8):1435-45
11. J.E. Sharman, M. Stowasser. Australian Association for Exercise and Sports Science Position Statement on Exercise and Hypertension; Journal of Science and Medicine in Sport (2009) 12, 252—257
12. Saposnik G TR, Mamdani M, Hall J, McIlroy W, Cheung D, et al. . Effectiveness of virtual reality using Wii gaming technology in stroke rehabilitation : a pilot randomized clinical trial and proof of principle. Stroke. 2010 july;41(1):1477-84.
13. Tony Pigford DWA,A..Feasibility and Benefit of Using the Nintendo Wii Fit for Balance Rehabilitation in an Elderly Patient Experiencing Recurrent Falls.Journal of Student Physical Therapy Research.2010;2(1):12-20.
14. Nikolaos Vernadakis, Asimenia Gioftsidou, Panagiotis Antoniou, Dionysis Ioannidis, Maria Giannousi. The impact of Nintendo Wii to physical education students' balance compared to the traditional approaches / Computers & Education 59 (2012):196–205
15. Barkeley JE.PA.Physiologic Responses,Perceived Exertion,and Hedonics of Playing a Physical Interactive Video Game Relative to a Sedentary Alternative and Treadmill Walking in Adults.JEP 2009;12:12(3):12-22.
16. Lamoth et al. (2012).Available from: http://www.ncbi.nlm.nih.gov
17. 1Michelle E.Kho, Abdulla Damluji, Jennifer M.Zanni, Dale M.Needham. Feasibility and observed safety of interactive video games for physical rehabilitation in the intensive care unit:a case series; Journal of Critical Care (2012) 27, 219.e1–219.e6
18. N. Vernadakis et al. The impact of Nintendo Wii to physical education students' balance compared to the traditional approaches;Computers & Education 59(2012):196–205

19. Evrim Çakmakçi, Ahmet Sanioglu, Hüsamettin Vatansev & Kamile Marakoglu, (2010). The Effects Of 8-Week Step-Aerobic Exercise On The Body Composition And Hematologic Parameters In The Obese And Overweight Females. Physical Education and Sport / Science,Movement and Health (2010) 2(1) 113-117
20. Çolakoðl FF. Khan, S. (2006). Young Women in the Middle Age Women in Aerobic Exercise Effects on Some Physiological Parameters, March 2006 Vol: 14, No: 1 Kastamonu Journal of Education 277-284.
21. Maddison R, Foley L, Ni Mhurchu C, Jiang Y, Jull A, Prapavessis H, Hohepa M, Rodgers A. Effects of active video games on body composition: a randomized controlled trial.: Am J Clin Nutr. 2011 Jul;94(1):156-63.doi:10.3945/ajcn.110.009142. Epub 2011 May 11.
22. McGee SR, Boyko EJ.Physical examination and chronic lower-extremity ischemia: a critical review. Arch Interm Med 1998;158;1357-64
23. Blaz Mlacak,Ales Blinc,Maja Pohar,and Janez.Peripheral arterial disease and Ankle-Brachial Pressure Index as predictors of mortality in resident of Metlika county,Slovenia.Croat Med J.2006 April;47(2);327-334
24. Resnick HE,Lindsay RS,McDermott MM.et al. Relationship of high and low ankle-brachial index to all-course and cardiovacular disease mortality: The Strong Heart Study. Circulation. 2004;109:733-738.
25. Li J, Luo Y, Xu Y, et al. Risk factors of peripheral arterial disease and relationship between low ankle-brachial index and mortality from all-cause and cardiovascular disease in Chinese patients with type 2 diabetes. Circ J 2007;71:377- 81.
26. Kannel WB, McGee DL: Update on some epidemiologic features of intermittent claudication: The Framingham Study. J Am Geriatr Sot 33:13-l& 1985
27. Criqui MH, Langer RD, Fronek A, Feigelson HS, Klauber MR. McCann TJ, Browner D: Mortality over a period of 10 years in patients with peripheral artery disease. N Engl J Med 326:381-386, 1992
28. Gornik L and Beckman A. Peripheral Arterial Disease. Circulation.2005; 111:e169-e172
29. Virtanen K, Janne J and Frick M.H. Response of blood pressure and plasma norepinephrine to propranolol, metoprolol and clonidine during isometric and dynamic exercise in hypertensive patients. European Journal of Clinical Pharmacolgy. 1982;21:275-279
30. Blaz Mlacak,Ales Blinc,Maja Pohar,and Janez.Peripheral arterial disease and Ankle-Brachial Pressure Index as predictors of mortality in resident of Metlika county,Slovenia.Croat Med J.2006 April;47(2);327-334

31. Jamie F. Burr, Shannon S. D. Bredin, Marc D. Faktor, Darren E. Warburton, The Six-Minute Walk Test as a Predictor of Objectively Measured Aerobic Fitness in Healthy Working-Aged Adults: The Physician and Sportsmedicine, Volume 39, Issue 2, May 2011, ISSN – 0091-3847
32. Troosters T, Gosselink R, Decramer M. Six minute walking distance in healthy elderly subjects. Eur Respir J. 1999 Aug;14(2):270-4
33. Harada ND, Chiu V, Stewart AL. Mobility-related function in older adults: assessment with a 6-minute walk test. Arch Phys Med Rehabil. 1999 Jul; 80(7):837-41.
34. Focht B, Rejeski WJ, Ambrosius W, Katula J, Messier S. Exercise, self-efficacy, and mobility performance in overweight and obese older adults with knee osteoarthritis. Arthritis and rheumatism. 2005;53(5):659-65.
35. King S, Wessel J, Bhambhani Y, Sholter D, Maksymowych W. The effects of exercise and education, individually or combined, in women with fibromyalgia. The Journal of rheumatology. 2002; 29(12):2620-7.
36. De Bock V, Mets T, Romagnoli M, Derde MP. Captopril treatment of chronic heart failure in the very old. Journal of Gerontology. 1994; 49(3):M148-52.
37. O'Keeffe ST, Lye M, Donnellan C, Carmichael DN. Reproducibility and responsiveness of quality of life assessment and six minute walk test in elderly heart failure patients. Heart. 1998; 80(4):377-82.
38. Hajiro T, Nishimura K, Tsukino M, Ikeda A, Koyama H, Izumi T. Analysis of clinical methods used to evaluate dyspnea in patients with chronic obstructive pulmonary disease. American Journal of Respiratory and Critical Care Medicine. 1998; 158(4):1185-9.
39. Mudge S, Stott NS. Timed walking tests correlate with daily step activity in persons with stroke. Archives of physical medicine and rehabilitation. 2009; 90(2):296-301.
40. Fulk G, Echternach J, Nof L, O'Sullivan S. Clinometric properties of the six-minute walk test in individuals undergoing rehabilitation post stroke. Physiotherapy theory and practice. 2008; 24(3):195-204.
41. Harada ND, Chiu V, Stewart AL. Mobility-related function in older adults: assessment with a 6-minute walk test. Arch Phys Med Rehabil. 1999 Jul; 80(7):837-41.
42. Lord S, Menz H. Physiologic, psychologic, and health predictors of 6-minute walk performance in older people. Archives of physical medicine and rehabilitation. 2002; 83(7):907-11.
43. A.R. Coggan, A.M. Abduljalil, S.C. Swanson, *et al*.Muscle metabolism during exercise in young and older untrained and endurance-trained men: J Appl Physiol, 75 (1993), pp. 2125–2133
44. F. Pitta, T. Troosters, M.A. Spruit, V.S. Probst, M. Decramer, R. Gosselink.Characteristics of physical activities in daily life in chronic obstructive pulmonary disease: Am J Respir Crit Care Med, 171 (2005), pp. 972–977

45. M. Hulens, G. Vansant, A.L. Claessens, R. Lysens, E. Muls.Predictors of 6-minute walk test results in lean, obese and morbidly obese women:Scand J Med Sci Sports, 13 (2003), pp. 98–105
46. H.M. Al-Hazzaa. Prevalence of physical inactivity in Saudi Arabia: a brief review:East Mediterr Health J, 10 (2004), pp. 663–670
47. H.M. Al-Hazzaa. Physical activity, fitness and fatness among Saudi children and adolescents: implications for cardiovascular health:Saudi Med J, 23 (2002), pp. 144–150
48. Zorba, E. (1999). Everyone's Sports and Physical Fitness, Meyer Press, Ankara.
49. Reilly T. and Smith D. Effect of work intensity on performance in a psychomotor task during exercise. Ergonomics. 1986: 29(4): 601-606
50. Beverly A. Shipley, Geoff Der, Michelle D. Taylor, and Ian J. Deary, Cognition and all-cause mortality across the entire adult age range: Health and Lifestyle Survey . Psychosomatic Medicine 2006; 68:17-24.
51. Chentanez T. Reaction time, impulse speed and number of synapses in reactionneuronal circuits of patients with damage in various locations in the nervoussystem . Mahidol Research. Faculty of Science . Mahidol University. 1990.
52. Mitrushina, M.N., Boone, K.B., D'Elia, L.F.Handbook of normative data forneuropsychological assessment; Oxford University Press: New York. 1999.ISBN 0-19-505675-2.
53. Penteado N, Isnard C, et al. Sudden sensorineural hearing loss and vertigo associated with arterial occlusive disease: three case reports and literature review. Sao Paulo Medical Journal. 1993; 1516-3180
54. Spirduso WW. Physical fitness, aging and psychomotor speed: a review. J. Gerontol. 1980;35:850-865.
55. Chaiwanichsiri Dootchai., E.L., Lerson Noomanoch Star Excurcion Balance Training : Effects on Ankle Functional Stability after Ankle Sprain. Jouranl Medicine Assoc Thai,2005.88(Suppl 4): p.S90-4
56. Chentanez T, Siriporn, Sasimontonkul, Pipat, Cherdrungsi, Patterns of Reaction time and Movement time of Various Athletes. Journal of Sports Science and Technology, 2004.4 (NO. 1 and 2): p.67-73