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THE EFFECT OF REGULA EXERCISE FOR FUNTIONAL HEALTH OF THE ELDERLY

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The purpose of this study was to investigate the performance difference in walking, stair descent and ascent, sit-to-stand, and stand-to-sit, between elderlies who exercise regularly and those who don't. Twenty elderlies participated in this study (8 males and 12 females). All tests were assessed using a 10-camera Vicon system. The visual3D software was used to analyse data. A positive correlation exists between movement time of stair descent and anterior-posterior balance ability. The negative correlations exist between movement time of stair descent and ascent and balance ability in lateral-medial. A significant difference in balance ability of stair decent exists between those with regular exercise and those without. According to the ACSM principle, regular exercise can indeed reduce the chance of falling in the elderly.

KEY WORDS: elderly, balance, center of mass.

INTRODUCTION: With medical advance, the average human life expectancy is increasing, and more elderly population. According to the statistics, the percentage of elderly population in Taiwan has exceeded the figure defined by the World Health Organization (more than 7% of the population over the age of 65). With increasing age, elderly's muscles, vision, proprioception and cardiopulmonary function declines (Startzell, Owens, Mulfinger, & Cavanagh, 2000), which means society will be spending huge amount of resources to take care of the elderly's health. Keeping the health of the elderly efficiently is the problem we have to solve. One of the problems in the functional health of the elderly is falling, and poor balance ability is one of the reasons for falling. Vaillant et al. (2006) reported that exercise can improve physical activity ability, as well as reduce the fear of falling. Also, many studies discuss the factors of postural balance and control in the elderly (Lee & Chou, 2007; Mian, Narici, Minetti, & Baltzopoulos, 2007), and the training to improve balance ability of the elderly in postural control (Lord, Ward, & Williams, 1996). Previous studies indicated that regular exercise can improve balance ability and reduce the chance of falling, but no study to show the effect of regular exercise to functional health. Study indicated that elderly make movements slow after receiving signal, causing them not be able to quickly keep postural balance and stability (Brauer, Woollacott, & Shumway-Cook, 2002), which means the elderly with balance problem would take longer to make movement, reducing the functional health. Most cases of falling involve taking a stride or changing a direction, such as ascending stairs, or standing up from seated position. Balance can be divided into static and dynamic balance, and dynamic balance can explain balance of the elderly in functional health more clearly. Therefore, the purpose of this study was to investigate the performance difference in walking, stair descent and ascent, sit-to-stand, and stand-to-sit, between elderlies who exercise regularly and those who don't.

METHODS: Twenty the elderly participated in this study (8 males and 12 females). The subjects were divided into regular exercise (RE, age: 65.3±1.6 years, Height: 159.7±8.7 cm, Weight: 60.9±12.9 kg) and non-exercise group (NE, age: 67.0±1.7 years, Height: 159.2±8.4 cm, Weight: 57.8±10.5 kg), according to the ACSM principle (three times a week, every 30 minutes, up to 6 months or more, close chain exercise). All subjects are free of neuromuscular or orthopedic problems and signed the informed consent before test. A 10-camera Vicon system (Vicon MX13+, Oxford, UK, 200 Hz) was used to capture the motion of walking, stair descending and ascending, sit-to-stand and stand-to-sit, and the segments of body were defined by plugingait template in Vicon Nexus software (Vicon Inc., Oxford, UK). The procedures evaluated movement time and dynamic balance ability during walking, stair descent and ascent, sit-to-stand and stand-to-sit. In walking, the subjects were instructed to go forward 6 meters, and step on two adjacent force plates on the floor. The subjects had to descend or ascend step by step on the artificial 3-steps stair (one step: 28 cm x 100 cm x 18 cm) during stair descent and ascent. The subjects were instructed to fold arms crossed in front of the chest and stand up or sit down during sit-to-stand and stand-to-sit tests. Movement time was defined as the time of gait cycle or the time between center of mass (COM) changes dramatically. The range of COM sway in anterior-posterior and lateral-medial directions represent balance ability. The visual3D software (v4.0, C-motion Inc, USA) was used to analyse data, and filter using a fourth order Butterworth low-pass, and cut-off frequency was 8 Hz. All statistical analyses were performed using SPSS 20.0 (SPSS Inc.,Chicago,IL). The relationships between movement time and balance ability were examined using Pearson correlation coefficients. One-way ANOCVA was used to examine that variables have correlation between RE and NE. Independent t-test was used to examine balance ability between RE and NE. Statistical significance was set at $p<.05$.

RESULTS: The relationships between movement time and balance ability were shown in Table 1. Positive correlation between movement time of stair descent and balance ability in anterior-posterior direction ($r=0.72$, $p<0.001$) was found. The negative correlations between movement time of stair descent ($r= -0.73$, $p<0.001$) and ascent ($r= -0.50$, $p<0.05$) and balance ability in lateral-medial direction were noted. No correlations between balance ability and movement time in walking, sit-to-stand and stand-to-sit were found. Balance ability between regular exercise and non-exercise were shown in Table 2. Significant difference of balance ability of stair descent in anterior-posterior ($p<0.05$) and lateral-medial ($p<0.05$) directions were noted between those with regular exercise and those who don't. No significant differences were also found between those with regular exercise and those who don't in walking, stair ascent, sit-to-stand and stand-to-sit.

DISCUSSION: No significant difference between RE and NE in balance ability of walking was noted. A change in stride length and cadence affects stride velocity. Stride length, stride velocity and cadence reduced to increase the stability of one's own balances in difficult movements (Hausdorff, Balash, & Giladi, 2003; Hollman, Kovash, Kubik, & Linbo, 2007); Protopapadaki et al. (2007) reported walking faster, the ground reaction force was greater, and the balance was more unstable. Therefore, regular exercise has no effect on balance ability of the elderly in walking, maybe this is one of reasons is that two groups have similar performance in walking.

No significant differences between RE and NE in balance ability of stair descent and ascent were found. Andriacchi et al (1980) pointed out that moment of joint in stair descent was larger than ascent, resulting the stability of lower extremity being unstable and larger displacement of centre of mass, which means balance control of stair descent was more difficult than ascent. Macfadyen & Winter (1988) pointed out it requires knee extension and plantar flexion to absorb the impact force in stair descent, which means the direction of motion is anterior-posterior in stair descent and ascent. Maybe this is the reason that a positive correlation exists between movement time and balance ability of anterior-posterior in stair descent. Thus, regular exercise can reduce the sway of lateral-medial in stair descent and ascent, and improve the efficiency of stair decent in anterior-posterior direction.

No significant difference between RE and NE in movement time and balance ability of sit-to-stand and stand-to-sit. Sit-to-stand and stand-to-sit tests were used to examine lower extremity function. Moxley Scarborough et al. (1999) pointed out that stronger thigh muscle strength correlates to better stability in sit-to-stand; Takayoshi & Shinichi (2010) reported that the elderly with poor muscle function in the lower extremity, which makes up for different characteristics in movements, have more unstable center of mass. Maybe the duration of movement is short and not difficult in test, which makes movement time and balance ability in sit-to-stand and stand-to-sit similar. Previous studies divided sit-to-stand into several phases (trunk flexion, hip-lift off and knee-hip extension phases), and the center of mass transfers upward in the hip-lift off phase, and forward in the trunk flexion phase, and change of the centre of mass is caused by multi-joint and multi-muscle (Vander Linden, Brunt, & McCulloch, 1994). Maybe a difference exists in some phases between RE and NE, but no significant difference in the entire of sit-to-stand and stand-to-sit. Therefore, regular exercise has no effect on movement time and balance ability of the elderly in sit-to-stand and stand-to-sit.

CONCLUSION: This study found that the regular exercise can reduce the sway of body in lateral-medial direction, and improve the efficiency in stair descent. However, no differences between regular exercise and non-exercise group were found in walking, stair ascent, sit-to-stand, and stand-to-sit. According to the ACSM principle, regular exercise can indeed reduce the chance of falling in the elderly, but intensity of exercise is lower in regular exercise group, such as walking, jogging and swimming. It seems some intense exercise can increase muscle strength to improve functional health in the elderly.

Table 1
The relationships between Movement time and balance ability in the elderly

	Anterior-posterior		Lateral-medial	
	r	p-value	r	p-value
Walking	-0.11	0.64	0.36	0.12
Stair descent	0.72	<0.001*	-0.73	<0.001*
Stair ascent	0.22	0.36	-0.50	0.03*
Sit-to-stand	0.35	0.14	0.43	0.07
Stand-to-sit	0.87	0.72	-0.13	0.59

*p<.05

Table 2
Balance ability between regular exercise and non-exercise

	Regular exercise	Non-exercise	p-value
Walking			
AP (cm)	1.15(0.09)	1.12(0.14)	0.57
ML (cm)	0.04(0.02)	0.03(0.01)	0.29
Stair descent			
AP (cm)	0.06(0.02)	0.05(0.01)	0.01*
ML (cm)	0.71(0.10)	0.62(0.03)	0.02*
Stair ascent			
AP (cm)	0.04(0.02)	0.04(0.01)	0.25
ML (cm)	0.70(0.08)	0.64(0.04)	0.06
Sit-to-stand			
AP (cm)	0.01(0.01)	0.02(0.01)	0.62
ML (cm)	0.20(0.05)	0.17(0.05)	0.16
Stand-to-sit			
AP (cm)	0.02(0.01)	0.02(0.01)	0.66
ML (cm)	0.13(0.03)	0.11(0.03)	0.25

*p<.05

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