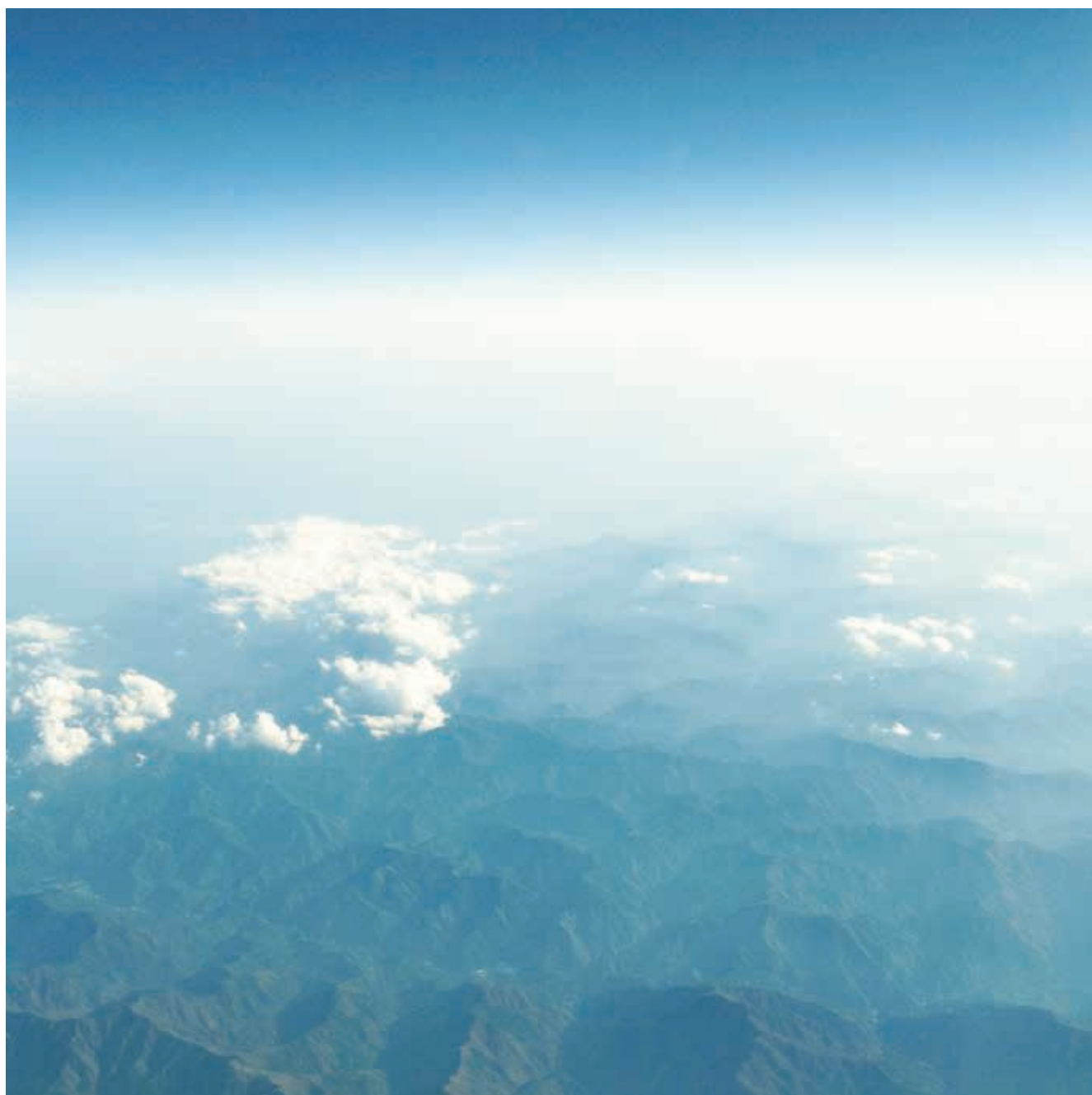


Asian Journal of  
**HUMAN  
SERVICES**

Printed 2012.1030 ISSN2186-3350  
Published by Asian Society of Human Services

*October 2012*  
**VOL. 3**



## REVIEW ARTICLE

# The Review of the Studies on the Fall Prevention Exercise Programs for Elderly Persons

Jaejong BYUN <sup>1)</sup>

- 1) School of Health & Fitness Management WOOSONG University,  
17-2, Jayang-Dong, Dong-Gu, Daejeon City, Korea.  
Bjj1236@wsu.ac.kr

## ABSTRACT

This study aimed to provide basic information for the prevention program for lumbar pain and falls of elderly people by comprehensively exploring the studies on the diverse exercise programs for fall prevention of elderly people. For the health management of elderly people, whether to keep physical strength through exercise is important, but it is true that common aerobic exercise and muscular exercise are not helpful for it. Therefore, this study analyzed and explored the researches for activity programs for fall prevention of elderly people and particularly it was found that the whole-body vibration and constant isokinetic exercise are effective for the fall prevention of elderly people from the results of the analysis of activity program for fall prevention through whole-body vibration and isokinetic exercise, which is not they are not traditional exercise program though. In conclusion, those results of researches are expected to be fairly helpful for the structure and operation of fall prevention program for elderly people in the future.

### <Key-words>

elderly people, fall prevention, isokinetic exercise

Asian J Human Services, 2012, 3:16-31. © 2012 Asian Society of Human Services

## Introduction

In modern society, the health of elderly persons has attracted attention due to the rapid aging. The development of science and medicine has prolonged the life expectancy and the prolonged life expectancy has caused to rapidly increase the proportion of elderly

population. In South Korea, due to the rapid aging, the life expectancy of 55 years old in 1960 has increased to 77 years old in 2020 through 73 years old in 1995, which means the increase of the proportion of elderly people of 60 and over; in South Korea, the proportion of elderly population of 60 and over has increased to 5.7% from 4.7% in 1990 and is expected to increase to 12.5% in 2010, which means to become an aging society (Ministry of Health and Welfare, 1995).

The structural change of population has increasingly necessitated the attention to the social phenomena related to elderly population; especially the prolonged life expectancy has made the quality of prolonged old age life an important issue after retirement.

According to the U.S. National Center for Health Statistics in 1993, people spend 15% of their whole life unhealthily and it is mainly caused by the functional disorder, injuries and diseases due to the prolonged life expectancy. What elderly people hope most is to live their healthy old age and most of all they are extremely concerned about whether they can maintain the ability to perform ADL without other's assistance. One of the ways to live an independent life during old age is the regular and active physical activity.

Particularly whether elderly persons have the postural control ability through the maintenance of equilibrium is very important for fall prevention and their lumbar strength and flexibility play great roles for the postural control. The best way for fall prevention is to maintain healthy body functions; and among them, the coordination of diverse sensory functions including the strength of lower extremities, the flexibility of joints and equilibrium is the most important factor (Lord et al., 1994a).

Keeping the balance of body requires very complicated mechanism of nervous system, sensory system, musculoskeletal system, etc. Especially equilibrium goes through the process of recognizing the body movements through sensory organs, integrating the information through the central nervous system and finally responding to them with musculoskeletal system (Ho-Gyeong Seong, Gi-Whan Kim, 1996).

The weakening of muscle strength and abnormal tension of muscle cause the loss of equilibrium and the problems with walking and ADL (Jae-Suk Kim, 2004)

Daily life is associated with a lot of tasks to control postures and balance and the ability to keep balance is basic and essential for the daily life or intended activities of human beings (Cohen et al, 1993; Shumway-Cook & Woollacott, 1995)

Patients who have a stroke that causes the imbalance of body, asymmetry posture and impairment of weight-shift ability as well as people without health problems have great difficulty in keeping balance while standing up and in walking (Hyeok-Cheol Kwon, 1987; Carr et al., 1985). In particular, when the stability through the postural control of truncus is not secured fully, the functions of upper and lower extremities may be limited. Therefore, the stability of truncus plays important roles to enable human beings to stand up and perform functional activities (Dae-Jin Kim, 2006; Kisner & Colby, 2002)

Lumbar region is the core part to produce strength for the movements of human beings. In recent, the rapid development of economy has increased the time to spend in sedentary

lifestyle, which has caused the decrease and deficiency of physical activities and the lowered physical strength and has eventually increased the injuries of lumbar region (Sang-Ho Kim, Seong-Su Kim and Myeong-Gi Kim, 2007).

McGill (2002) argued that the muscles around lumbar to maintain the functional stability of body and Brill (2001) asserted that the core program to stabilize lumbar region is useful for the reinforcement of muscle strength, the increase of equilibrium and the maintenance of balanced posture (McGill, S. M. 2002).

Equilibrium, which is the ability to enable human body to control balance even in the abnormal situation, is the indispensable ability for the smooth physical activities as skill related physical component of When keeping a certain posture without moving during a certain period, very weak vibration that cannot be seen with the naked eyes is detected and the posture can be shaken even by a very low level of power from a certain direction; to keep balance steadily, symmetry posture needs to be maintained by situating the center of gravity of body around the center of transverse plane and the contraction of flexor and extensor muscles needs to be harmoniously kept to minimize the movement of joints. The equilibrium of body can be kept when comprehensively combining balanced posture with strong muscular force, sensitive static sense and precise reflex function (Gyeong-Suk Hwang et al., 1984).

Namely, equilibrium is the ability to keep the center of gravity of body within the base of support by minimizing motion (Nichols et al., 1996). It is also a critical factor for the functional activities (Berg, 1989).

The equilibrium of human body is the comprehensive function based on the sensory information that has been input through visual system, somatosensory system and vestibular system. Together with the prolonged life expectancy, the decrease of function and muscle strength of elderly people has lowered the degree of equilibrium and increased the frequency of falls (Wolfson et al., 2001; Horak et al., 1989)

To keep balance in daily life, the interaction of central and peripheral factors is indispensable. Peripheral factors are composed of visual system and vestibular system; visual system provides information on joint, muscle, tension of tendon, kidney pain and joint location; vestibular system provides information on gravity, speed and the location of head for linear accelerator (Alexander and LaPier, 1998).

Central factors choose the most appropriate muscle response to control the location of truncus and posture by integrating the information that is input through peripheral factors (McCollum et al., 1996).

Even one defect among those factors makes body difficult to keep balance, cause falls and limit functional activities (Kauffman, 1990).

The damage of lumbar area causes disequilibrium as the result of the cut-off of two kinds of basic physiological mechanism that control balance; first, somatosensory system can be impaired due to the change of proprioception; and second, the decline of muscle strength, motor coordination and somatosensory may cause abnormal postural patterns,

the postponement of reaction time and the impairment of stability (Boucher et al., 1995).

The first stage to assess the control of posture is to do the musculoskeletal system; the limitation of range of motion due to pains, muscle strength and endurance may affect the exercise strategy and balanced posture to keep the balance (Horak, 1987).

In the studies for elderly people, it was reported that the muscle strength is a critical factor for equilibrium and the improvement of muscle strength prevented falls and heightened the quality of life. Based on the analysis of precedent studies, one of the factors to affect the health of elderly people is the ability to control the posture and the posture is importantly affected by equilibrium. Equilibrium is affected by many factors; the modern people who lack physical activities and generally work sitting down have insufficient flexibility and have difficulty in keeping the balance of muscle strength.

However, it was found that the studies on the interrelation between equilibrium and lumbar muscle strength and flexibility are deficient. Therefore, this study aimed to provide basic information for the prevention program for lumbar pain and falls of elderly people by comprehensively exploring the studies on the diverse exercise programs for fall prevention of elderly people.

## Body

### 1. The Guideline of the Level of Physical Strength of Elderly People (WHO, 1997)

#### 1) Group III: Physically Fit-Healthy

These individuals regularly engage in appropriate physical activity, they can be described as physically fit and can participate in all activities of daily living. The elderly people in this Group may be able to participate in the activities with young people for more several years.

#### 2) Group II: Physically Unfit - Unhealthy Independent

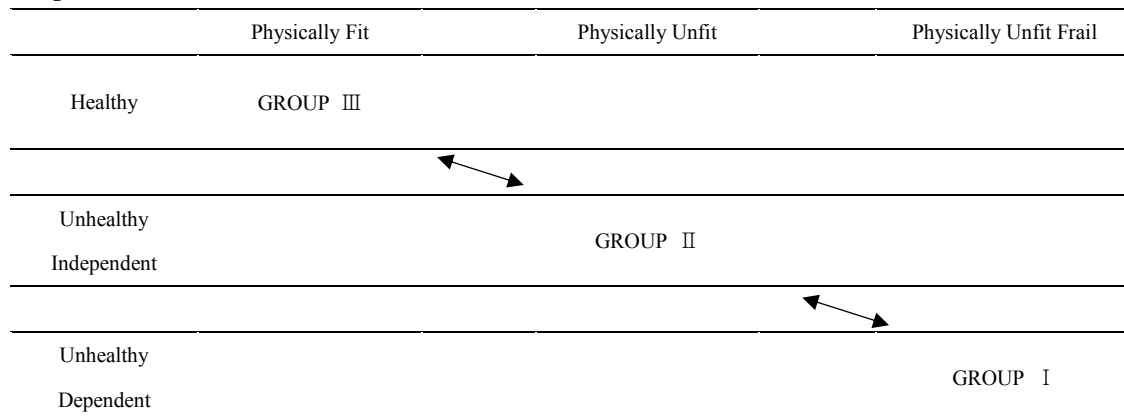
These individuals are not engaged in physical activity. While they are still living independently, they are beginning to develop multiple chronic medical conditions which threaten their independence. Regular physical activity can help improve functional capacity and prevent loss of independence. However, the physical activity program needs to be tailored according to their unique situations and the degree of impairment. According to the report of the American College of Surgeons (1996), 60% of elderly people belong to this group.

#### 3) Group I: Physically Unfit - Unhealthy Dependent

These individuals are no longer able to function independently in society due to a variety of physical and/or psychological reasons. Appropriate physical activity can significantly enhance the quality of life and restore independence in some areas of

functioning. Physical activity program has been developed to be utilized in long-term care hospitals or other residential facilities. The diverse activities to use chairs or bed may be helpful for elderly people of this group.

Figure 1. Health and Fitness Gradient (WHO, 1997)



**2. Physical Functions of Elderly People**

It is important to assess physical functions in daily living when assessing the degree of aging of elderly people. It is hard to evaluate the physical strength of elderly people only with their age. The guideline that enables to assess the level of physical functions for the health management of elderly people based on the accurate assessment of physical functions is useful. Therefore, the table that shows the levels of physical functions of elderly people based on the performance level of activities of daily living is presented with the intent to help elderly people assess the level of their physical strength.

	Physical Functions
Physically elite	<input type="checkbox"/> Sports competition, Senior Olympics <input type="checkbox"/> High-risk and power sports(e.g., hang-gliding, weight lifting)
Physically fit	<input type="checkbox"/> Moderate physical work <input type="checkbox"/> All endurance sports and games <input type="checkbox"/> Most hobbies
Physically independent	<input type="checkbox"/> Very light physical work <input type="checkbox"/> Hobbies (e.g. walking, gardening) <input type="checkbox"/> Low physical demand activities(e.g., golf, social dance, hand crafts, traveling, automobile driving) <input type="checkbox"/> Can pass all IADLs
Physically frail	<input type="checkbox"/> Light housekeeping <input type="checkbox"/> Food preparation, grocery shopping <input type="checkbox"/> Can pass some IADLs, all BADLs

Received July 15,2012

Accepted September 10,2012

Published October 31,2012

	<input type="checkbox"/> May be homebound
Physically Dependent	<input type="checkbox"/> Cannot pass some or all BADLs (e.g., walking, bathing, dressing, eating, transferring)
	<input type="checkbox"/> Needs home or institutional care
Disability	<input type="checkbox"/> Dependent in all BADLs

BADL = basic activity of daily living. IADL = instrumental activity of daily living.

from W. Spirduso, 1995, Physical dimensions of aging (Champaign, IL: Human Kinetics), 339.

### 3. The Analysis of the Studies on the Posture Control for the Fall Prevention

Balance that controls the posture of body on basal surface area is used interchangeably (Jeong-Byeong Chae, 2006), keeps the center of body within basal surface area while minimizing movements (Nichols et al, 1996) and is the state without location changes or motions (Jeong-Byeong Chae, 2006). The interaction of central and peripheral factors is critical to keep balance.

Peripheral factors are composed of somatosensory system, visual system and vestibular system; somatosensory system provides information on joint, muscle, tension of tendon, kidney, pain and joint location; visual system provides information on the change of environment; and vestibular system provides information on gravity, speed and the location of head for linear accelerator (Alexandrov et al., 2005).

Central factors choose the most appropriate muscle response to control the location of truncus and posture by integrating the information that is input through peripheral factors (McCollum et al., 1996). Even one defect among those factors makes body difficult to keep balance, cause falls and limit functional activities (Kauffman, 1990).

Keeping balanced posture is affected by pain, the range of motion, muscle strength and endurance and needs effective exercise strategy; when these functions are impaired, the stability of the center of body can be notably decreased (Jae-Sang Bak et al., 2001).

Normal posture control is to control the location of body by the musculoskeletal system according to the change of gravity or load (Jeong-Byeong Chae, 2006).

The impairment of musculoskeletal system affects the ability to control balance and obstructs the exercise strategy for when the balance is broken (Han-Suk Lee, 2001).

Lumbar pain provides inappropriate sensory information on the supporting surface and gravity as the nature or quantity of proprioceptive input from muscle spindles, Golgi tendon organs, joints and cutaneous receptor (Alexander & Lapier, 1998).

Proprioceptive sense from muscles plays the role of the pain-gate that cuts or suppresses nociceptor to spinal cord and central nervous system. Therefore, the impairment of proprioceptive sense of patients with lumbar pain causes chronic pain, the limitation of the range of joint motions and the decrease of the ability to control posture (Comerford & Mottram, 2001).

The damage of lumbar region causes postural balance impairment in the results of the cut-off of two kinds of basic physiological mechanisms that control postural balance

Received  
July 15, 2012

Accepted  
September 10, 2012

Published  
October 31, 2012

(Deliagina et al, 2008); first, it may cause the impairment of somatosensory system due to the change of proprioceptive sense; second, it may cause the decrease of motor response due to the decrease of muscular force, motor coordination and somatosensory system.

The impairment of balance control may cause abnormal postural patterns, the postponement of reaction time and the impairment of stability (Boucher et al., 1995). That is to say, balance is affected by vestibular organ, visual organ, somatosensory, central nervous system, muscular force and the weight shift and postural control is affected by pain and damage, which changes postural control strategy (Harringe et al., 2007).

Louto et al. (1998) suggested that single leg stance balance of patients with lumbar pain in static condition is less stable than people without pain; single leg stance balance of patients with lumbar pain in static condition is obstructed because the muscular force of pelvis and motor coordination are damaged and muscles ineffectively interact with each other. For the control of static balance and dynamic balance and all the body movements, movements of body are produced both consciously and unconsciously.

Volpe et al. (2006) reported that the stability of truncus affects the control of posture balance in a standing posture.

Therefore, if central nervous system is damaged or joints and muscles fall ill or sensory organs are impaired, the stability of standing posture may be lost, the control of weight bearing and walking may be hindered and eventually the comeback to normal life may be difficult (Nurse & Nigg, 2001).

#### **4. The Analysis of the Studies on the Fall Prevention Program through Whole-Body Vibration**

Whole body vibration consists of two components; one is vibration stimulus and the other is non-weight bearing exercise using platform. Even though it is non-disputable that non-weight bearing exercise is helpful for the increase of muscular force of female elderly person, recent placebo studies have reported that the increase of muscular force of females who don't get trained has been caused by the vibration stimuli (Delecluse, Roelants, & Verschueren, 2003), which means that the vibration stimuli is the main factor to increase muscular force while exercising on vibration platform (Bosco et al, 1998; Torvinen, 2002; Cardinale , & Bosco, 2003).

As for elderly people, the amount of increase of muscular force of elderly people is less than that of young people after whole body vibration, which means that elderly people respond for vibration stimuli less than young people; it is assumed that the number of muscle spindle decreases with aging (Swash & Fox, 1972). As for female elderly people, because they are likely to weigh more (10.0%) and to have the lower ability to produce isometric strength, for the identical training program of whole body vibration, the



relative weight bearing of elderly people tends to be higher than that of young people. Therefore, the effects of whole body vibration between young and elderly people can be compared only when the intensity of vibration is determined individually.

Whole body vibration is effective to improve knee extension velocity of female elderly people, even though it is not more effective than traditional resistance exercise. Significant chronic effects of whole body vibration for relative force and velocity of knee extension is associated with the hypothesis that tonic vibration reflex affect the ability to mobilize the high-threshold motor unit (Bongiovanni, Hagbarth, & Stjernberg, 1990). During whole body vibration, threshold value of motor unit is low for voluntary contraction (Romaiguere, Vedel, & Pagni, 1993), which causes to activate faster motor units and to train the motor unit of high-threshold (Rittweger, Beller,& Felsenberg, 2002). Considering that the rapid muscle fiber of high-threshold decreases with aging, whole body vibration expands the area of average rapid muscle fiber and positively affects the velocity of movements (Lexell, Taylor, & Sjostrom, 1988).

\*\*\*

Maximal explosive power is the strong pathological predicting factor of functional limitation and disabilities of elderly people (Janssen, Heymsfield, & Ross, 2002; Runge, Rehfeld, & Resnicek, 2000). Explosive power is the product of force and velocity and the variable of maximal muscular force can explain 65-75% of the factors of maximal explosive power of knee extensor of elderly people. The velocity of movement nullifies the effect of maximal muscular force, because resistance is determined by the percentage of maximal muscular force of isometric exercise of each individual. Therefore, the increase of movement velocity means that the velocity of knee extensor of elderly people gets to be quickened due to high resistance.

Table 3. The Example of Whole Body Vibration Program

	start	week12	end
Duration(minutes)	3	20	30
Number of different exercises	2	6	9
Longest duration of vibration without rest(sec)	30	60	60
Rest between exercises	60	5	5
Amplitude(low/high)	low	high	high
Frequency(Hz)	35	40	40

Whole body vibration is the exercise method to minimize conscious efforts and the necessity of stress of musculoskeletal system, respiratory system and cardiovascular system. It was reported that most of participants in whole body vibration enjoyed it, didn't consider it as difficult and felt only moderate fatigue after the exercise.

It was found that whole body vibration has contributed to improve the posture control of

elderly people who are 60 and over and live in Seoul. The adaptability to perturbed surface was evaluated while toeing up and down; particularly the results of evaluation in the toes-down posture showed that the group that participated in whole body exercise has been significantly improved comparing with other experimental groups, which means that whole body vibration is useful for the fall prevention of elderly people as well as for the improvement of muscular force. The posture control ability that is helpful to decreases falls that may cause physical injuries including joint injury and fractures can be improved by whole body vibration (Bogaerts, Sabine, Christophe, Albrecht, & Steven, 2007).

Fatigue or the lack of concern may increasingly prohibit nursing home residents from actively participating in exercise. If even small quantity of certain exercise can create bigger effects, that can be a significant alternative. The study by Ivan Bautmans, Ellen Van Hees, Jean-Claude Lemper, & Tony Mets (2005) intended to understand the possibility that elderly people who are accustomed with living in residential facilities can participate in whole body vibration and the effects of whole body vibration to the functional ability and muscular force. For the 24 residents at nursing home, exercise compliance, timed up-and-go, Tinetti-test, back scratch, chair sit-and-reach, grasping power and isotonic leg extension were evaluated. In results, the group of whole body vibration showed significant differences in the tests of timed up-and-go and balance comparing with the group of static exercise.

It was found that whole body vibration for nursing home residents with functional disabilities for six weeks improved balance and movements and the additional studies on whether whole body vibration is additionally useful for the muscle functions comparing with traditional exercise are needed.

The weakening of muscular force of elderly people due to muscle contraction causes physical weakness and disabilities (Fried, Tangen, Walston, Newman, Hirsch, Gottdiener, Seeman, Tracy, Kop, Burke, & McBurnie, 2001; Bartz, 2002; Morley, Perry, & Miller, 2002). In particular, the weakening of muscular force may pose a critical threat to the independent activities or walking of elderly people living in residential facilities.

Healthy elderly people can improve considerable quantity of muscles through resistance exercise (Latham, Benntt, Stretton, & Anderson, 2004). Even physically weak elderly people living in residential facilities can participate in resistance exercise and may improve muscular force and movements (Rydwik, Frandin, & Akner, 2004; Thomas, & Hageman, 2003; Fiatarone, Marks, Ryan, Meredith, Lipsitz, & Evans, 1990; Fiatarone, O'Neill, Ryan, Clements, Solares, Nelson, Roberts, Kehayias, Lipsitz, & Evans, 1994). However, the intensive resistance exercise of the major muscles that are used for mobility and walking requires considerable quantity of motions that is calculated with exercise time, exercise intensity(70-80% of maximal muscular force) and the frequency of repetition(three sets at 10 times), which may give fatigue to 98% of elderly residents of nursing home (Lias, & Ferrell, 2000), but the lack of motivation may weaken the

Received  
July 15,2012

Accepted  
September 10,2012

Published  
October 31,2012

possibility that physically weak elderly people participate in exercise. However, it has been reported that even small quantity of whole body vibration may significantly improve muscle functions of healthy elderly people (Roelants, Delecluse, & Verschueren, 2004) as well as young people (Delecluse, Roelants, & Verschueren, 2003; de Ruiter, Van Raak, Schilperoort, Hollander, & de Haan, 2003).

Exercise compliance of physically weak elderly people living in residential facilities for whole body vibration is similar with that of healthy elderly people for whole body vibration (Roelants, Delecluse, & Verschueren, 2004; Bruyere, Wuidart, Di Palma, Gourlay, Ethgen, Richy & Reginster, 2005; Russo, Laurentani, Bartali, Cavazzini, Guralnik, & Ferrucci, 2003) and that for traditional resistance exercise (Bautmans, Njemini, Vasseur, Chabert, Demanet, & Mets, 2005), which shows the possibility that whole body vibration may be taken advantage of for physically weak elderly people.

##### **5. The Analysis of Studies on the Fall Prevention Program through Isokinetic Exercise**

Just like the weakening of Lumbar muscular force, chronic functional overload due to long-term, epidemiological and orthopedic disease that is found through a lot of activities of sports and daily living is deeply associated with lumbar pain (Nachemson, & Lindh, 1969; Berkson, Nachemson, & Shultz, 1979; Holmstrom, Lindell, Moritz, 1992). lumbar pain can be generally treated by the well-balanced strengthening of lumbar muscular force (Brady, Mayer, & Gatchel). Quantification of the function of lumbar area turned out to be critical to determine the process of the strengthening of muscular force and rehabilitation to help sport players or sitting-down job workers return to their workplace (Langrana, & Lee, 1984; Ganzit, Chisotti, Albertini, Martore, & Gribaudo, 1984; Ganzit, Chisotti, Albertini, Martore, & Gribaudo, 1998; Bayramoglu, Akman, Kilinc, Cetin, Yavuz, Ozker, 2001; Grabiner, Jeziorowski, & Divekar; Hakkinen, Kuukkanen, Tarvainen, & Ylinen, 2003).

Until now, the postures to examine the functions of lumbar area have been selected by the preference of therapists. Lumbar muscle function test in sitting-down posture stimulates the functional needs more and it has been regarded to ease the postural discomfort of people who mainly live in sitting-down (Cartas, Nordin, Frankel, Malgady & Sheikhzadeh, 1993; Langrana et al, 1984; Kumar, Dufresne, Van, 1995; Akebi, Saeki, Hieda & Goto, 1998). The test in standing posture stimulates functional obstructive kinetic chain more while preserving the lordotic curve of lumbar spine (Marras, King, Joint, 1984; Mayer, Smith, Keeley, & Mooney, 1985; Smith et al, 1985; Delitto et al, 1991; Jerome et al, 1991; Madsen, 1996). The test in standing posture means the high-participations of hip-joint flexor in flexion exercises and gluteus maximus and hamstrings in extension. These participations of muscles add proper muscles to spine and abdominal muscles and induce the broad participations of hip joints (Akebi, Saeki, Hieda & Goto, 1998).

For the functional test of muscle functions, the posture of body and the direction of

movement are a very important factor. Especially the selection of postures that reduce the burden of spine is important (Findley et al, 2000; Wessel, Ford, & van Driesum, 1992). Based on the several studies, researchers measured the torque of lumbar area by the equipment of isokinetic exercise and reported that the posture for the standard materials means unusual things. In conclusion, important clinical determinations have been made based on the wrong reading.

To determine isokinetic lumbar curve in standing and sitting-down posture and functional differences in extension, movements including exclusive muscular force of lumbar area that is not affected by the changes of posture need to be investigated; the preparation posture and the angle of physique region in the exercise of maximal deviation have been analyzed. In results when comparing two postures before exercising, the angles of hip, trunk and lumbar showed significant differences; this means that moderate curve of trunk as well as retroflexion of pelvis in sitting-down posture appeared. When comparing the movements in two postures, while the significant difference of the range of motion (ROM) was found when high participation of hip point was done, the minimal difference was found in the angle related to trunk.

In the results of the observation, the information that has been produced based on the equipment of isokinetic exercise and surface EMG becomes the basis to read the muscle functions. When comparing various angles of trunk in the contraction of different speeds, the fact that it is difficult to set up the relationship between the results of electromyogram and muscular force has been already known. There are complex and important factors including signal control in EMG that is produced from electrode related to muscle fibers, the effects of force length related to muscles and the effects of dynamic activities related to the relationship between EMG and force (Gallagher, 1997; Redfem, 1992; Soderberg, & Knutson, 2000).

In fact, initial angle of sitting-down posture causes the contraction of iliopsoas muscle and straight muscle of thigh, which produces discomfort posture and prohibits the ability to produce muscular force. Therefore, the significant decrease of muscular force that is observed in sitting-down posture can be explained by the level of contribution for the decrease of flexor muscle of hip; it decreases to 1/3 of low speed and 2/3 of high speed comparing with the standing posture. These results coincide with the opinions of other scholars who argue that the effectiveness of muscle group that produces torque are affected by the arm that plays a role of lever as well as the muscular force of muscle (Poulsen, 1981; Smidt et al, 1983).

The level of contribution of iliopsoas muscle was measured as about 50% of torque curve of trunk, but the different levels of contribution were presented according to the speed of each movement; the high level of contribution was shown in low speed. These results support that torque curve test in high speed is not the valid method to measure muscle functions (Wessel et al, 1992). Moreover, the significance of the contribution of hip flexor muscle was confirmed as the indirect method that analyzes the signal of EMG. In this

Received  
July 15,2012

Accepted  
September 10,2012

Published  
October 31,2012

study, significant difference in the EMG results of abdominal muscles comparing with the muscle functions in sitting-down and standing postures was not found, but the effects of difference of motions to hip flexor was discovered. EMG signal of straight muscle of thigh has decreased about 15% in sitting-down posture comparing with the test result in standing posture. It is assumed that the decrease of EMG signal is due to the iliopsoas muscle, which is the strongest hip flexor. However, unfortunately EMG of iliopsoas muscle cannot be measured with surface EMG. Extensor muscles of spine and hip are used for extensor and these muscles become longer in sitting-down posture (Findley et al, 2000; Morini, Ciccarelli, Romano, & Ripani, 1994). The previous studies have reported that the torque of trunk extensor muscle is not affected by postures (Cartas, Nordin, Frankel, Malgady & Sheikhzadeh, 1993; Langrana et al, 1984). However, in the recent studies, the torque of trunk extensor muscle has decreased 13 to 15% when testing in sitting-down posture, even though it does not show the significant difference (Akebi et al, 1998).

The results that were mentioned above are supported by the analysis of EMG signal of hip extensor muscle that shows the decrease of electrical activities of gluteus maximus and biceps femoris in sitting-down posture. The difference in EMG activities of erector muscle of spine is small and insignificant and it is expected that similar muscle functions in both postures are shown. In spite of the rapid decrease of signals from hip extensor muscle, the small decrease of torque in sitting-down posture supports the hypothesis that the contribution of hip extensor muscle in entire motions is less likely to be related. The levels of contribution for the center of rotation of pelvis and total torque produced are varied according to the speed and postures (Thorstensson, & Nilsson). However, while exercising in standing posture, the level of contribution of flexor muscles is higher than that of extensor muscle.

Other motions of gluteus that is included to flexor and extensor of lumbar change the proportion of agonist and antagonist of lumbar in two test postures. In fact, the proportion of maximal torque of flexor and extensor muscles in standing posture varies 60 to 88%; in sitting-down posture, because the contribution of hip flexor muscle to trunk curve lacks, the proportion of maximal torque of extensor and flexor muscles is just 45%.

In clinical setting, the proportion of extensor muscle and flexor muscle in the test of spinal function has played an important role. As for people who suffer from lumbar pain or spinal diseases, the proportion of extensor muscle and flexor muscle has changed due to the low ability of flexor or extensor muscles (Bayramoglu, et al 2001; Langrana et al, 1984; Mayer, et al, 1985; Shirado, Ito, Kaneda, & Strax, 1995). The proportion of agonist and antagonist has been considered as the prevention factor from acute or chronic spinal injuries.

It has been known that spinal extensor and flexor muscles have contributed for the prevention of atrophy of the hip and the spinal flexion and lordosis of spine in the atrophied and fixed posture (Langrana et al, 1984).

Received  
July 15,2012

Accepted  
September 10,2012

Published  
October 31,2012

Considering all the information mentioned above, the test in sitting-down posture can be regarded that it is less likely to be affected by the participation of hip muscles and, therefore, it is more proper for not only the reasonable function test for examinees and but also the torque ratio among antagonists.

Additional supports for the test in sitting-down posture can be gained by the observation of the motions of lumbar in flex motions. In sitting-down posture, the angle of abdominal region proved less noticeable lordosis of spine through small quantity of motion. It has been known that the increase of lordosis of lumbar pulls the lumbar spine and is caused by the action of iliopsoas muscle that bends the hip. These studies have been conducted already. Iliopsoas muscle becomes shorter pathologically in sitting-down posture, which reduces its role rapidly. Based on those reasons, sitting-down posture has been regarded as the best method to protect lumbar spine from abnormal condition due to overload in motions; it is also supported by the research results that the motions in sitting-down posture have a better performance tolerance (Langrana et al, 1984).

In recent, functional recovery of patients with chronic lumbar pain has been done by whole body muscle exercise focusing on the extensor muscle of trunk. Even though the muscle rehabilitation has been utilized to reinforce the muscular system of upper and lower extremities for several years, it has not been done for the lumbar rehabilitation. Mayer et al (1985) used kinesitherapy as well as psychological support for the functional recovery of patients with lumbar pain. Hazard et al (1989) investigated the success of this kinesitherapy based on other compensation system.

Short-term training for muscular force dramatically improves the muscular force of muscles of back and submaximal endurance (Graves, et al, 1990; Mayer, et al, 1985; Pollock, Leggett, Graves, & Jones, 1989). The three times of kinesitherapy per week focusing on endurance can improve sufficient endurance as much as the five times of functional recovery program per week. Exercise interval of the three times per week is generally used for the weight training rehabilitation (Fleck, & Kraemer, 1987). Isokinetic exercise for the training of patients with lumbar pain has a merit to provide proper centripetal resistance whenever to repeat it. Centripetal contraction is needed for the hypotrophy of fast muscle and the maximal isometric improvement of muscular force (Mayhew, Rothstein, Finucane, & Lamb, 1995). However, training without eccentric factors may cause patients to get injured due to the eccentric contraction (Ploutz-Snyder, Tesch, Dudley, 1998). In addition, isotonic contraction is excellent in the muscular force and explosive power of extensor muscle of knee joint comparing with isokinetic contraction.

Recent studies have shown that eccentric factors need to be included to exercises for the maximal results of dynamic strength (Kovaleski, Heitman, Trundle, & Gilley, 1995); because the most of lumbar motions include eccentricity and centripetal factors, they play critical roles in training for lumbar region.

The maintenance of factors of muscle endurance and muscular force importantly affects

Received  
July 15,2012

Accepted  
September 10,2012

Published  
October 31,2012

the rehabilitation of lumbar extensor muscles; for the training to maintain muscle endurance and muscular force, sporadic training may be useful for patients. This training enables patients with lumbar pain to maintain muscular force and muscle endurance (Tucci, Carpenter, Pollock, Graves, & Leggett, 1992) and to prevent them from being disabled due to lumbar pain when conducting three times a week for four weeks in a year. This strategy has the potential to simplify the prevention program in field (Mooney, Kron, Rummerfield, & Holmes, 1995).

In the group that participated exclusively in isokinetic exercise, the endurance that appeared just after training has not been maintained during the follow-up period.

### Conclusion

The concerns and importance of healthcare of elderly people have been increasingly given attention due to the rapid increase of elderly population and living an independent and healthy life has become the most important goal for the healthcare of elderly people; the pertinent factors to health and physical strength including cardio respiratory endurance, muscular force, muscular endurance, flexibility, body composition are important; as for elderly people, the secondary damage by falls may severely obstruct their independent life and put their life in danger.

Even though maintaining physical strength through exercise is important for the health management of elderly people, the aerobic exercise and weight lifting are not always effective due to the physical characteristics of elderly people. Therefore, this study analyzed and explored the researches on exercise programs for fall prevention of elderly people. In particular, in the results of the analysis on the effects of whole body vibration and fall prevention exercise program through isokinetic exercise, they are significantly effective for the fall prevention of elderly people, even though those exercises are not traditional ones. These results are expected to be helpful for the composition and operation of fall prevention exercise program for elderly people in the future.

### References

- 1) ACSM. (1995a). Guidelines for graded exercise testing and exercise prescription (5th ed.). Philadelphia, Lea & Febiger.
- 2) Bogaerts, Sabine V, Christophe D, Albrecht L, and Steven B. (2007). Effects of whole body vibration training on postural control in older individuals: A 1 year randomized controlled trial. *Gait & Posture*, 26:309-316.
- 3) Cardinale M, and Bosco C. (2003). The use of vibration as an exercise

Received  
July 15,2012

Accepted  
September 10,2012

Published  
October 31,2012

- intervention. *Exercise and Sport Sciences Reviews*, 31:3-7.
- 4) Chang-Gyu Kim (2000). *The Human Body*. Seoul: Daehan Media.
  - 5) Delecluse C, Roelants M, and Verschueren S. (2002). Strength increase following whole body vibration compared to resistance training. *Medicine and Science in Sports and Exercise*, 34:1523-1528.
  - 6) Donald, A. (2004). *Kinesiology of the musculoskeletal system*. Seoul: Jung-Dam Media.
  - 7) Gyeong-Suk Hwang, Jung Tae Kim and Sung Hyun Park (1984). Effect of Scapular Stabilization Exercise on EMG Change of Shoulder Girdle and Trunk Muscle during Archer's Shooting, *Journal of Sport and Leisure Studies*, 29-30.
  - 8) Hakkinen A, Kuukkanen T, Tarvainen U. and Ylinen J. (2003). Trunk muscle strength in flexion, extension, and axial rotation in patients managed with lumbar disc herniation surgery and in healthy control subjects. *Spine*, 28:1068-73.
  - 9) Han-Suk Lee (2001). Study of Standing Balance Control between Normal Subjects and Subjects with Low Back Pain. Ph.D. Dissertation, The Graduate School, Daegu University.
  - 10) Ivan B, Ellen Van H, Jean-Claude L. and Tony M. (2005). The feasibility of whole body vibration in institutionalized elderly persons and its influence on muscle performance, balance and mobility: a randomized controlled trial. *BMC Geriatrics*, 5(17).
  - 11) Jae-Suk Kim (2004). Assessment of Isometric Trunk Extension Strength in Post Stroke Hemiplegic Patients. Unpublished Master's Dissertation. Graduate School of Rehabilitation Science.
  - 12) Je-Sang Bak (2001). Effects of the Foot Position on Standing Balance in Patients with Hemiplegia. Master's Dissertation, Department of Physical Therapy, The Graduate School, Hanseo University.
  - 13) Jeong-Byeong Chae (2006). Effects of Proprioceptive Control Program on the Balance and Walking in the Person with Stroke. Ph.D. Dissertation, The Graduate School, Daegu University.
  - 14) Jessie Jones C, and Debra J. Rose. (2005). Physical activity instruction of older adults, *Human Kinetics*.
  - 15) Mayer T, Gatchel R, Mayer H, Kishino N, Keeley J, and Mooney V. (1987). A prospective two-year study of functional restoration in industrial low back injury. An objective assessment procedure. *JAMA*, 258: 1763-1767.
  - 16) McGill, S. (2002). *Low back disorders: evidence-based prevention and rehabilitation*. Champaign(IL):Human Kinematics.
  - 17) Morini S, Ciccarelli A, Romano M, and Ripani M. (1994). The knee flexor and extensor muscle force related to hip position. *Medicine and Sport*, 47:739-44.

Received  
July 15,2012

Accepted  
September 10,2012

Published  
October 31,2012



- 18) Morini S, Ciccarelli C, Cerulli C, Giombini,A, Di Cesare A, and Ripani M. (2008). Functional anatomy of trunk flexion-extension in isokinetic exercise: muscle activity in standing and seated position ,*The Journal of Sports Medicine and Physical Fitness*, 48:17-23
- 19) Nurse M, and Nigg M. (2001). The effect of changes in foot sensation on plantar pressure and muscle activity. *Clinical Biomechanics*, 16: 719-727.
- 20) Pollock M, Leggett S, Graves J, Jones A, Fulton M, and Cirulli J. (1989). Effect of resistance training on lumbar extension strength. *The American Journal of Sports Medicine*, 17:624-628.
- 21) Poulsen E. (1981). Back muscle strength and weight limits in lifting burdens. *Spine*, 6:73-5.
- 22) Russo C, Lauretani F, Bandinelli S, Bartali B, Cavazzini C, Guralnik J, and Ferrucci L (2003). High-frequency vibration training increases muscle power in postmenopausal women. *Archives of Physical Medicine and Rehabilitation*, 84:1854-1857.
- 23) Seong-Ho Kim, Seong-Su Kim and Myeong-Gi Kim (2007). An Influence which Lumbar Stabilization Exercises by its Exercise Intensity Has on the Lumbar Stabilization and Pain. *Journal of Sport and Leisure Studies*, 31: 933-942.
- 24) Seong-Su Kim and Il-Gyu Jeong (1995). *Exercise Physiology*. Daegyeong Publishing Company.
- 25) Shirado O, Ito T, Kaneda K, and Strax TE (1995). Concentric and eccentric strength of trunk muscles: influence of test postures on strength and characteristics of patients with chronic low-back pain. *Archives of Physical Medicine and Rehabilitation*, 76:604-11.
- 26) Torvinen S, Kannus P, and Sievanen H. (2002). Effect of four-month vertical whole body vibration on performance and balance. *Medicine and Science in Sports and Exercise*, 34:1523-1528.
- 27) Vincent M. Ciriello, Raymond W. and McGorry. (2000). Effects of preloaded isokinetic versus pure isokinetic training on dynamic and static lumbar muscle strength and endurance. *Journal of Occupational Rehabilitation*, 10(4): 257-269.
- 28) Wolfson, L., Whipple, R, Derby C, Ameman P, Murphy T, Tobin J, and Nashner, L. (1992). A dynamic Posurography study of balance in healthy elderly. *Neurology*, 42(1): 2069-2075.
- 29) Yeong-Ho Choi (2002). *The Effect of Knee Joint Taping on Lower Extremity Muscle Fatigue and Postural Sway*. Department of Exercise Science, Graduate School of Bio-Medical Science, Korea University.

Received  
July 15,2012

Accepted  
September 10,2012

Published  
October 31,2012

## CONTENTS

### REVIEW ARTICLES

- How Did 'Difficult to Involve' Parents Emerge in Early Childhood Care and Education?  
-A Discussion of Research Trends on Family Support and Relationship with Guardians..... **Tetsuji KAMIYA** • 1
- The Review of the Studies on the Fall Prevention Exercise Programs for Elderly Persons..... **Jaejong BYUN** • 16
- Current issues in driver's license of people with intellectual disabilities..... **Atsushi TANAKA** • 32

### ORIGINAL ARTICLES

- The Changing Characteristics of In-home Care Service Providers in the U.S. and in the  
UK: Implications for South Korea ..... **Yongdeug KIM, et al.** • 38
- Assessing Training System for Social Service Workers in South  
Korea: Issues and Policy Agenda ..... **Jaewon LEE, et al.** • 60
- Relationship between depression and anger ..... **Noriko MITSUHASHI, et al.** • 77
- Workaholism Determinant Variables of Social Workers and Care Workers  
in Senior Welfare Centers in Korea ..... **Jungdon KWON, et al.** • 87
- The Exploration of Financial Resources of Financial Adjustment System  
and Social Welfare in Japan ..... **Haejin KWON, et al.** • 105
- Relation between the importance of school education and after-school activity programs  
and age, sex, and school type for school-aged children with disabilities..... **Hideyuki OKUZUMI, et al.** • 131
- A Study on the Vitalization of Silver Industry by Analyzing the Needs of Silver  
Industry in the Daejeon, South Korea ..... **Gowhan JIN** • 138
- A Comparative study on Factor Analysis of the Disabled Employment between  
Japan and Korea ..... **Moonjung KIM, et al.** • 153
- Relationship between Teacher Mental Health that Involved  
in Special Needs Education and Sence of Coherence ..... **Kohei MORI, et al.** • 167

### SHORT PAPERS

- The Analysis of Disaster Mitigation System and Research on  
Disaster Rehabilitation. .... **Keiko KITAGAWA, et al.** • 177
- The Trend of International Research on University Learning Outcome and  
Quality of Life and Mental Health of University Students  
..... **Changwan HAN, et al.** • 189
- The research trend and issue of hospital school in the education for the health impaired  
..... **Aiko KOHARA, et al.** • 198
- Bibliographical consideration about the current situation and the problem to be solved  
about cooperation between teachers in hospital classrooms and other staffs..... **Remi KAKUTANI, et al.** • 208
- The Current Status and Issues in Korean Barrier-Free General School  
..... **Eunae LEE, et al.** • 219

### CASE REPORT

- Approach for the problematic behaviors of autism complicated with severe and multiple disabilities  
~ a case study of a first year junior high school student in daily living ~  
..... **Kazumi SUGIO, et al.** • 229