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EFFECT OF LOW FREQUENCY WHOLE BODY VIBRATION FOR ELDERLY LIVING IN NURSING HOMES, BODY COMPOSITION AND PHYSICAL FITNESS

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Abbreviations

ACSM- American College of Sports and Medicine

ADL- Activities of Daily Living

ANOVA- Analysis of variance

BMC- Bone mineral content

BMD- Bone mineral density

BMI- Body mass index

CDC- Center for Disease Control

cm- centimeter

CON- Control group

DEXA- Dual energy X-ray absorptiometry

FDA- Food and Drug Administration

g- gram

G-gravity

GmbH- Gesellschaft mit beschränkter Haftung

HDL- High-density lipoprotein

HRmax- Heart rate maximum

HR reserve- Heart rate reserve

Ho- Null Hypothesis

Hz- Hertz

Kcal- Kilo calorie

Kg-Kilogram

m- meter

mm- millimeter

NHANES- National Health and Nutrition Examination Survey

P- Level of significance

QOL- Quality of Life

RES- Resistance

RM- Repetition maximum

RPE- Rated perceived exertion

SC- Satellite cell content

SD- standard deviation

SFT- Senior Fitness test

SV- Sinusoidal vibration

TOBEC- Total body electrical conductivity

TVR- Tonic vibration reflex

VO2- maximum oxygen uptake

VV- vertical synchronous vibration

WBV- Whole body vibration

WHO- World Health Organization

Resumo- Efeito de Exercício vibratório de baixa frequência de corpo inteiro para idosas institucionalizadas, Composição corporal e Aptidão fisica

As populações idosas institucionalizadas são propensas a doenças e invalidez. Estes são cuidados por profissionais de saúde que lhes permitem melhorar a realizar as atividades no dia-a-dia. Fisiologicamente, os idosos à medida que envelheciam, diminuem a densidade mineral óssea (BMD), força muscular e aptidão física. Neste estudo, o objetivo foi o de determinar o efeito de um programa de exercício vibratório de baixa frequência de três meses.

Oito sujeitos institucionalizados foram distribuídos de forma não aleatória pelo grupo de exercício (GE) vibratório (5 indivíduos; 82,80 ± 5,07 anos) e no grupo de controlo (CON) grupo (3 indivíduos; 85,33 ± 10,97 anos). O GE vibratório efetuou ao longo de três meses um programa exercício vibratório recíproco, numa posição ereta com os joelhos semi-flexionados, com uma frequência de12,6 Hz, amplitude 3mm, efetuando 6 séries por sessão, com um período de descanso de um minuto de intervalo, e com a frequência semanal de 3 vezes. O grupo CON não alterou a sua rotina diária. As variáveis estudadas foram: a densidade mineral óssea (DMO) no quadril direito e corpo total utilizando um densitómetro de duplo feixe de raios-X (DEXA); força máxima e potência média em ação muscular concêntrica na extensão e flexão do joelho com velocidades angulares de 60 ° / s e 180 ° / s, utilizando um dinamômetro isocinético; aptidão física, mais em concreto a distância percorrida em 6 minutos a andar, flexão de braço, sentar e alcançar, alcançar atrás das costas, levantar caminhar e sentar.

No início do estudo, verificou-se diferenças estatisticamente significativas entre o GE e o COM na variável peso (P = 0,043). Após os 3 meses de intervenção, o grupo exercício vibratório diminuiu significativamente (6%) a DMO no triângulo de wards comparativamente com o grupo CON que aumentou 4% (P <0,05). Não se verificaram alterações significativas na força máxima e potência média em ambos os grupos. Verificaram-se efeitos induzidos pelo treino no teste da caminhada de 6 minutos, e no teste de alcançar atrás das costas, tendo sido melhor no GE em relação ao grupo CON (P = 0,024 para o teste de caminhada de 6 minutos e P = 0,043 para alcançar atrás das costas). Não se verificaram mais alterações significativas nas outras variáveis estudadas em qualquer um dos grupos.

No sujeitos idosos institucionalizados, três meses de um programa de exercício vibratório de baixa frequência, obteve efeito sobre a aptidão física.

Palavra-chave: vibrações de corpo inteiro, a densidade mineral óssea, força muscular, aptidão física.

Abstract- Effect of Low Frequency Whole Body Vibration for elderly living in Nursing homes, Body Composition and Physical Fitness

Elderly population in nursing rehabilitation center is prone to diseases and disability even if they are well taken cared-off by health professionals to help function in daily activities. Physiologically, elderly as they aged there bone mineral density (BMD), muscle strength and physical fitness will normally decline. In this study, the objective is to determine the effect of 3-month Low frequency Whole Body Vibration (WBV) after the intervention was withdrawn for 3 months.

Eight nursing home residents were non-randomly assigned to WBV group (5 subjects; 82.80±5.07 years) and Control (CON) group (3 subjects; 85.33±10.97 years). The WBV group underwent 3 months of semi-flexed standing exercise in reciprocal vibratory machine at 12.6 Hz, 3mm amplitude, 6 sets per session with 1 minute interval rest period for 3 times a week while the CON group continues to their daily routine with no vibration. Outcome measures were right hip and whole body BMD ($g.cm^{-2}$) using Dual-energy X-ray Absorptiometry (DEXA), maximal strength and average power concentric isokinetic knee extension and flexion at 60°/s and 180°/s by isokinetic dynamometer and physical fitness measures such as 6 minute walk test, arm curl test, chair sit and reach, back scratch and 8 foot up and go.

At baseline, WBV and CON group were statistically significant difference on their weight status (P=0.043). After vibration was withdrawn for 3 months, WBV group significantly decreased (6%) in BMD wards triangle compared to CON group increased by 4% (P<0.05). No significant changes in maximal strength and average power on both groups. There are training-induced changes in 6 minute walk test and Back scratch were better compared to CON group (P=0.024 for 6 minute walk test and P= 0.043 for back scratch). No other significant changes were observed in both groups.

In nursing rehabilitation center residents, 3 months low frequency WBV exercise has effect on physical fitness.

Keyword: Whole body vibration, bone mineral density, muscle strength, fitness

Introduction

Elderly population is one of the cores in the health aspect as they are mainly at risk for diseases and disabilities. According to world health organization (WHO, 2012) population is rapidly ageing between 2000 and 2050; the proportion of the world´s population over 60 years will double from 11% to 22%. The absolute number of people aged 60 years and over is expected to increase from 605 million to 2 billion over the same period. Older people have the highest risk of death or serious injury arising from a fall and the risk increases with age. For example, in the United States of America, 20-30% of older people who fall suffer moderate to severe injuries such as bruises, hip fractures, or head traumas. Moreover, according to Center for Disease Control (CDC, 2006) that as patient age, they are at increased risk for sedentary lifestyle. This risk level may be in part due to physical, sensory, and cognitive changes associated with aging, in combination with environments that are not adapted for an aging population (WHO, 2012). In community-dwelling elderly people, falls and fall-related injuries appear to be independent determinants of functional decline. At least 30% of people over the age of 65 years fall each year, and this proportion increases to 40% after age 75 (Bruyere et al., 2005). The most common risk factors for falls and hip fractures in older adults is the muscle weakness in lower extremity muscles (Roelants, Delecluse, & Verschueren, 2004) which decrease in the ability to generate force (Daubney & Culham, 1999). However, there are misconceptions to physical exercise that some believe that it is detrimental to health that they may injure themselves. This may leads to apprehension of elderly population to engage in sports and exercise activities (WHO, 2012).

On the other hand, osteoporosis remains a public health issue (Bemben, Palmer, Bemben, & Knehans, 2010; Liu, Brummel-Smith, & Ilich, 2010; Verschueren et al., 2004). Bone is not an inanimate anatomic entity but a dynamic, living tissue liable to damage and resorption as well as capable of healing and growth. Extensive research in this area has lead to the understanding of the negative effects of unloading on the skeleton. Astronauts lose both trabecular and cortical bone at the rate of 1.5% per month and more in some instances (Kasturi & Adler, 2010). It has been estimated that with increasing age, BMD in women decreases 1-2% per year at the femoral neck and spine (Liu et al., 2010). Furthermore, femoral neck BMD appears to be an equally important risk factor in both genders, and is especially related to hip fractures (Schuit et al., 2004). By any measure, proximal femoral fracture is the most devastating complication of osteoporosis. The mortality rate in patients with hip fracture is 12-20% higher than in persons of similar age and gender who have not suffered a fracture (Verschueren et al., 2004).

Despite the non-modifiable risk factors for rapidly aging population, there are various ways to cope this problem by engaging through recreational activities, active lifestyle, sports and exercise. The several dimensions of exercise that gives impact to improvements in physical fitness such as aerobic exercise training, resistance exercise training, flexibility and balance exercises. According to (Chodzko-Zajko et al., 2009) affirms that regular physical activity reduces risk of many adverse health outcomes. All adults should avoid inactivity. Some physical activity is better than none, and that adults who participate in any amount of physical activity gain some health benefits. Increased physical activity protects against functional decline, heart disease, diabetes, bone fracture, and falling. Physical activity also improves sleep and quality of life (QOL) for older adults (Purath, Buchholz, & Kark, 2009).

Recently, mechanical stimulation in a form of whole body vibration has aroused a great deal of interest in the fields of exercise physiology and bone research (Liu et al., 2010; Stewart, Cochrane, & Morton, 2009). Ancestors were exposed to many forms of vibration while hunting, fighting, and chopping down trees, for example. Nowadays, humans are exposed to vibration while travelling, working and performing leisure and domestic activities (Cardinale & Rittweger, 2006). Vibration stimulus is widely used among athletes (Delecluse, Roelants, Diels, Koninckx, & Verschueren, 2005; Fagnani, Giombini, Di Cesare, Pigozzi, & Di Salvo, 2006) for their training regimen to enhance muscle and bone characteristics, some experimental and clinical studies have investigated its actual effects (Torvinen et al., 2002). There are several studies both in animals (Prisby, Lafage-Proust, Malaval, Belli, & Vico, 2008; Wenger et al., 2009) and humans that showed positive effects in endurance capacity (A. C. Bogaerts et al., 2009), Body composition (Vissers et al.), Hip Bone mineral density (Gusi, Raimundo, & Leal, 2006; Iwamoto, Takeda, & Ichimura, 2001; Liu, Brummel-Smith, & Ilich, ; Verschueren et al., 2004), muscle performance in upper extremities (Mikhael, Orr, Amsen, Greene, & Singh), lower extremities (Mikhael et al., ; Raimundo, Gusi, & Tomas-Carus, 2009; S. S. Rees, Murphy, & Watsford, 2008; Roelants, Delecluse, & Verschueren, 2004; Torvinen et al., 2002), Balance (Bautmans, Van Hees, Lemper, & Mets, 2005; A. Bogaerts et al., ; Bruyere et al., 2005; Cheung et al., 2007; Ebersbach, Edler, Kaufhold, & Wissel, 2008; Gusi et al., 2006; Torvinen et al., 2002), Flexibility (Bautmans et al., 2005) and improved QOL for elderly (Bruyere et al., 2005). Notwithstanding the positive effects of whole body vibration (WBV), there was also no effect after the intervention in lumbar spine bone mineral density (Bemben et al., 2010; Verschueren et al., 2004). Many researchers have studied the effects of WBV for elderly either high frequency (Runge, Rehfeld, & Resnicek, 2000) or low frequency (Bruyere et al., 2005) that had significant effects. These studies differ in protocols and exercise parameters in terms of frequency, amplitude, duration, posture, type of exercise and vibratory machine. To date, there is no definite to which protocol is safe and effective for the elderly population. Food and Drug Administration (FDA) has not approved whole body vibration for medical purposes (Wysocki, Butler, Shamliyan, & Kane, 2011). The authors has suggested (Mikhael et al.) whether improvements from WBV are retained once the vibration stimulus is withdrawn and whether any meaningful clinical benefits ensue.

In lieu to the non-modifiable factors in elderly, this pilot study conducted a non-randomized 3 months training of low frequency (12.6Hz) WBV for the reciprocal vibratory machine (Galileo 2000, Novotec GmbH, Pfrozheim, Germany) in Santa Casa da Misericodia de Evora, nursing rehabilitation center. Consequently, the purpose of this study is to evaluate the effects of low frequency WBV exercise training program and to compare the effects of Body composition, Physical fitness and Quality of life (QOL) among experimental group (WBV) and control group (CON) after the vibration was withdrawn for 3months in nursing rehabilitation center**.**

I. Review and Related Literature

1.1 Physiological function and changes in Elderly

Disability, frailty, loss of independence and increased risks of falling and fractures are the risk factors of skeletal muscle changes with Aging. In general, muscle strength remains steady at approximately 50 years. Later years (70 years of age) starts the strength to decrease by 15% per decade (Rogers & Jarrot, 2008). Elderly persons muscle strength (Bautmans et al., 2005; Roelants, Delecluse, Goris, & Verschueren, 2004; Roelants, Delecluse, & Verschueren, 2004) and peak muscle power (Roelants, Delecluse, & Verschueren, 2004) can deteriorate that becomes critical for independence and have a strong influence on how older adults function in activities of daily living such as walking, climbing stairs, and rising chair. Moreover, advancing age is associated with physiologic changes that result in reductions in functional capacity and altered body composition. It is also associated with declines in physical activity volume and intensity; refer on Table 1 the typical changes in physiological function in terms of muscular, balance and mobility, motor performance and control, flexibility and joint Range of Motion (Rehn, Lidstrom, Skoglund, & Lindstrom), and Body composition or metabolism (Chodzko-Zajko et al., 2009).

Histological and biochemical examinations have revealed significant findings of age-related changes in muscle morphology. Atrophy and absolute loss fast twitch (type II) fibers have been described. Specifically, aging seemed to impose a preferential loss of type II fibers (Brown, 2000; Roelants, Delecluse, Goris et al., 2004). In their study (Verdijk et al., 2007) on satellite cell content (SC), they hypothesized that SC is specifically reduced in the type II fibers in the elderly. SC`s are essential for skeletal muscle growth and repair. This was the first study to show that type II fibers atrophy in elderly. This decline in SC content might be an important factor in the etiology of type II muscle fiber atrophy, which accompanies the loss of skeletal muscle with aging. Based on their review (Relaix & Zammit, 2012) that it is clear consensus for skeletal muscle does not regenerate without satellite cells.

In regards to performance changes in aging muscle that as per observations of age-related changes in muscle morphology mounted, research emphasis emerged related to assessment of the functional implications of these changes. Decreases of 10% per year after the age of 60 in endurance, velocity, and maximal voluntary contraction of the quadriceps have been reported (Brown, 2000).

Table 1: Typical changes in physiological function and body composition with advancing age in healthy humans

Variables	**Typical Changes**	**Functional Significance**
Muscular Function Muscle strength and power	Isometric, concentric, and eccentric decline from age 40 yr, accelerate after age 65-70 yr. Lower body strength declines at a faster rate than upper body strength. Power declines at a faster rate than strength.	Deficits in strength and power predict disability in old age and mortality risk.
Muscle endurance and fatigability	Endurance declines. Maintenance of force at a given relative intensity may increase with age. Age effects on mechanisms of fatigue are unclear and task-dependent.	Unclear but may impact recovery from repetitive daily tasks.
Balance and mobility	Sensory, motor, and cognitive changes alter biomechanics (sit, stand, locomotion). These changes + environment constraints can adversely	Impaired balance increases fear if falling and can reduce daily activity.

	affect balance and mobility.	
Motor performance and control	Reaction time increases. Speed of simple and repetitive movements slows. Altered control of precision movements. Complex tasks affected more than simple tasks.	Impacts many Activities of daily living (Kasturi & Adler) and increases risk of injury and task learning time.
Flexibility and joint ROM	Declines are significant for hip (20%-30%), spine (20%-30%), and ankle (30-40%) flexion by age 70 yr, especially in women. Muscle and tendon elasticity decreases.	Poor flexibility may increase risks of injury, falling, and back pain.
Body composition/metabolism Height	Height declines approximately 1cm per decade during the 40s and 50s, accelerated after age 60 yr (women > men). Vertebral disks compress; thoracic curve becomes more pronounced.	Vertebral changes can impair mobility and other daily tasks.
Weight	Weight steadily increases during the 30s, 40s and 50s, stabilizes until age 70 yr, then declines. Age-related changes in weight and BMI can mask fat gain/muscle loss.	Large rapid loss of weight in old age can indicate disease process.
Bone density	Bone mass peaks in the mid to late 20s. BMD declines 0.5% yr-1 or more after age 40 yr. Women have disproportionate loss of bone (2%-3% yr-1) after menopause.	Osteopenia (1-2.5 SD below young controls) elevated fracture risk.
Typical changes generally reflect age-associated differences on the basis of cross-sectional data, which can underestimate changes followed longitudinally.		

1.1.1 Body Composition

In aging, body composition changes, even in the absence of changes in body weight (St-Onge & Gallagher, 2010). In the evolution of age there are changes in weight, height, weight in relation to height (BMI) and body composition (Spirduso, Francis, & McRae, 2005). For most people, the weight declines in recent years is not due to loss of fat mass but lose of muscle mass and bone mass (R. Rikli & Jones, 2001). Body weight is a general description of the total body mass of an individual, whereas body composition includes information from several components (McArdle, Katch, & Kactch, 2008). The lean components such as total body water, skeletal muscle, organ mass, and bone mineral, tend to decrease, while total body fat increases and becomes redistributed more in the abdominal than in the peripheral adipose tissues (Figure 1). These changes seem to be associated primarily with a small positive imbalance between energy intake and expenditure due to an increasingly sedentary life style. Some changes could depend on age-related endocrine and metabolic alterations, however and may occur relatively rapidly (Coin, Sergi, Inelmen, & Enzi, 2006). The epidemic of sedentary lifestyle such as the bad habits and obesity increases the risk of developing chronic diseases and disabilities in older people (Hassinen, Komulainen, Lakka, Vaisanen, & Rauramaa, 2005). However, a minimum percentage of people treat themselves in a conscious and preventive in order to maintain their quality of life by good eating habits and physical exercise (Kohn, 2006). It has been increasingly recognized as modifiable factor in finding an optimal health, functionality and longevity with changes in body composition through age (Spirduso et al., 2005)

The body composition profile of an elderly person may be expected to be considerably different from that of the young adult used as the reference persons for body composition. The changes in the body composition that are characteristic of senescence are analogous to those occur with growth in the earlier years of life but are in the opposite direction, representing a catabolic rather than an anabolic change (Kuczmarski, 1989). However, the body composition is improved when there is decline of fat mass and corresponding increase in muscle mass and bone mass, thus resulting in an improvement in muscle strength, balance (Hakkinen et al., 1998), aerobic capacity (Galetta et al., 2006), physical activity (Kohn, 2006), functional capacity (Zoico et al., 2004) and a concomitant reduction in the risk of developing certain chronic diseases such as cardiovascular diseases and diabetes (Blew et al., 2002; Papadopoulou, Laparidis, & Hassapidou, 2005).

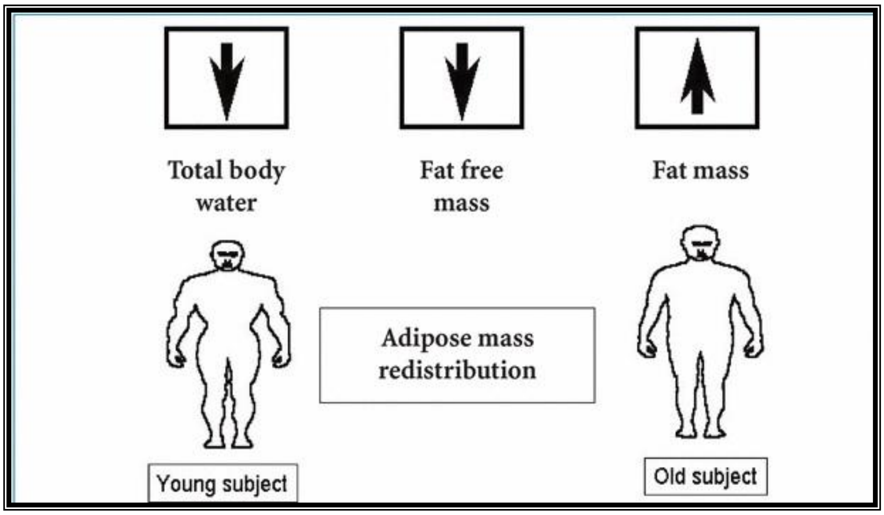
The body weight steadily increases during the 30s, 40s and 50s, stabilizes until age 70 years, and then declines. Age-related changes in weight and BMI can mask fat gain/muscle loss. The height declines approximately 1cm per decade during the 40s and 50s, accelerated after age 60 years (women > men). Vertebral disks compress; thoracic curve becomes more pronounced and the bone mass peaks in the mid to late 20s. BMD declines 0.5% yr-1 or more after age 40 years. Women have disproportionate loss of bone (2%-3% yr-1) after menopause (Chodzko-Zajko et al., 2009).

Health risks in elderly people cannot be evaluated simply in conventional terms of body fatness or fat distribution. Elderly people have less muscle and bone mass, expanded extracellular fluid volumes and reduced body cell mass compared to younger adults (Baumgartner, 2000). In addition, they are associated with a higher percentage of body fat and body fat redistribution. Redistribution of fat, predominantly from lower-body to subcutaneous fat in the abdominal and visceral section is quite frequent among the elderly despite an apparent decrease in the BMI. This phenomenon mainly occurs due to changes in total adiposity and changes in body weight (Milanovic, Pantelic, Trajkovic, & Sporis, 2011). The body composition changes are associated to various health problems (Moushira, Sanaa, Hala, Shams, & Mona, 2013). For example, excess of body fat increases the risk of diseases such as the metabolic syndrome, diabetes mellitus (type 2), stroke, hypertension, osteoarthritis, and cardiovascular disease (coronary artery disease and hyperlipidemia)(ACSM, 2009; Moushira et al., 2013).

According to (Raguso et al., 2006) that age-related change of body composition affect health status ; Of 213 subjects ≥ 65 years recruited for the study, lean tissues decreased in both genders ($p < 0.05$). Compared to subjects aged 65-74 years at baseline, those aged ≥ 75 years lost more body weight and fat free mass ($P < 0.05$). On the other hand, aged between 60-80 years, the body composition could be influenced by the following factors such as genetic potential, early growth and development, differences in socio-economic status, health status, as well as geographic region and ethnic group affiliation (Milanovic et al., 2011).

Body composition is an integral component of total health and physical fitness. Body composition evaluation should be included as a fundamental aspect of all physical fitness appraisals (Kravitz & Heyward, 1992)

Figure 1. Body composition changes with advancing age



1.1.1.1 Lean Mass

Lean body mass represents the weight of the muscles, bones, ligaments, tendons, and internal organs. Lean body mass differs from fat-free mass. Since there is some essential fat in the marrow of the bones and internal organs, the lean body mass includes a small percentage of essential fat (Kravitz & Heyward, 1992).

The loss of lean mass and other important changes in body composition occur with sex hormone deficiency in women (Andreoli & Lello), associated with decreases in resting energy expenditure and oxidation of body fat (Hunter, McCarthy, & Bamman, 2004) and loss of skeletal muscle mass (Evans & Cyr-Campbell, 1997). Men had significantly greater lean mass than women (Bevier et al., 1989). In physical exercise, aging in males decreased in lean body mass

(Vermeulen, Goemaere, & Kaufman, 1999) and not in females (Raguso et al., 2006).

The authors believe that weight loss can be voluntary or involuntary, the latter is usually occurs in the elderly, thus maintaining a strong association with mortality risks (Zamboni et al., 2005). Moreover, a study showed that weight loss is not intentional. It usually occurs because of the certain types of diseases such as cancer, respiratory diseases, etc. (Wannamethee, Shaper, & Alberti, 2000). Thus, concluded that involuntary weight loss despite of bringing more prospective reductions of obesity has increased risk of morbidity and mortality; being voluntary weight loss is the most appropriate and healthy. This involves a balanced feeding and practice physical exercise regularly (Zamboni et al., 2005).

The strength training has been effective in improving functional capabilities as well as increased muscle mass (ACSM, 2002). In a study shown that higher muscle strength was observed with increasing lean body mass, and participants with higher muscle strength scored better in the physical performance and ADL (Lebrun, cvan der Schouw, de Jong, Grobbee, & Lamberts, 2006).

1.1.1.2 Fat Mass

There are two types of fats that are classified as essential fat and non essential fat. The essential fat is necessary for normal functioning of the central nervous system and other organs of the body while the latter are stored in adipose tissue, which if in excess is understood as obesities (Spirduso et al., 2005).

Adult men and women differ in their regional fat distribution. The distribution of fat is different between sexes after puberty as well as the size of fat cells and fat metabolism. A large amount of fat that is deposited in the body depends on the number and size of fat cells. In adulthood women still have a higher disposition fat contour, especially in the breasts, the hip and thigh. On the other hand, men tend to deposit excess fat in the abdominal regions such as subcutaneous, intra-abdominal or visceral, usually in larger amounts than women in pre-menopauses (Gooren, 2006). The distribution changes in body fat helps to better understand the relationship between obesity, morbidity and mortality in the elderly (Zamboni et al., 2005).

In men, fat mass play a mediating role between the determinants and BMD. They concluded that fat mass is a strong independent determinant of total hip BMD and that possibly plays a mediating role in the association of weight change, walking activity with hip BMD in women (Pluijm et al., 2001). Aging in males increased in fat mass (Vermeulen et al., 1999). Higher fat mass was significantly associated with lower physical performance score, lower physical activity and a higher frequency of disability. Increasing fat mass was associated with increasing lean mass and decreasing lean/fat ratio. It was concluded that the role of fat mass as the primary risk marker for disability (Lebrun et al., 2006). The studies have shown fat mass increases while the muscle declines. They concluded that reductions in the mass of individual organs/tissues and in tissue-specific organ metabolic rate contribute to a reduction in resting metabolic rate that in turn promotes changes in body composition favoring increased fat mass and reduced fat-free mass (St-Onge & Gallagher, 2010). According to (Going, Williams, & Lohman, 1995) that losses in muscle, protein, and bone mineral contribute to the decline in fat-free mass; however, the onset and rates of decline remain controversial. Moreover, In their longitudinal study of (Hughes, Frontera, Roubenoff, Evans, & Singh, 2002) that fat-free mass decreased in men (2.0% per decade) but not in women, whereas fat mass increased similarly in both sexes (7.5% per decade).

1.1.1.3 Bone Mineral Density

Bone mineral loss is major risk factors for bone fractures, which are a significant cause of morbidity, institutionalization in nursing homes, and mortality among the elderly (Coin et al., 2006). In the study investigated by (Hannan, Felson, & Anderson, 1992) found that increased age was significantly associated with decreased bone mass in a linear and equivalent fashion for both men and women through the elderly years in the proximal femur and proximal radius. Likewise, in a cohort study of ambulatory white adults aged (55-84 years) between BMD and eight measures of body size (total weight, body mass index, waist-hip ratio, lean mass, fat mass, percentage fat mass, and current and maximum adult height) showed that all measures of body size were associated with bone mineral density in both sexes and were better markers of BMD in the weight-bearing sites than in the non-weight bearing sites which implies a mechanical effect of weight on BMD (Edelstein & Barrett-Connor, 1993).

Prolonged bed rest has been shown to increase bone resorption and decrease bone formation in normal subjects, causing a bone mineral density (BMD) decrease of 3.8% at the greater trochanter in 11 weeks. This finding is significant because the normal rate of bone loss is about 3 % per decade for cortical bone; and 7%- 11% per decade for trabecular bone (Kasturi & Adler, 2010).

According to the author´s review that not all low bone mineral density is osteoporosis. There are several factors that could account for low bone density. It could be genetic or could be at the extreme end of the distribution curve for normal individuals. Furthermore, for some cases for excessive running could lead to lower estrogen activity and therefore lower bone mineral density for women (Licata, 2009).

1.1.1.3.1 Influenced of dietary supplementation for Bone Mineral Density

In the study of men and women age 65 years or older who are living in the community, dietary supplementation with calcium and vitamin D moderately reduced bone loss measured in the femoral neck, spine and total body over the three year study period and reduced the incidence of non-vertebral fractures

(Dawson-Hughes, Harris, Krall, & Dallal, 1997). Moreover, calcium supplements prevented a femoral BMD decrease and lowered vertebral fracture rate in the elderly (Chevalley et al., 1994). Potassium and Magnesium were significantly associated with greater BMD at all 4 sites for elderly men and at 3 sites for elderly women ($P < 0.05$) (Tucker et al., 1999). In the cohort study of elderly men and women that low vitamin k intakes were associated with an increased incidence of hip fractures and neither associated with low BMD (Booth et al., 2000). On the other hand, in women who had undergone menopause five or fewer years earlier, bone loss from the spine was rapid and was not affected by calcium supplementation but for those who had been postmenopausal for six years or more and had a higher calcium intake, maintained bone density at the hip and radius but loss in the spine (Dawson-Hughes et al., 1990).

1.1.2 Methods of Evaluating the Body Composition

Body composition can be estimated through various techniques from field-based tests to advanced tests conducted in a clinical or laboratory setting (Esmat, 2012) and vary in terms of complexity, cost, and accuracy (ACSM, 2009). Different assessment techniques are used in this study such as anthropometry, body mass index (R. Rikli & Jones, 1999) and dual energy x-ray absorptiometry (DEXA).

1.1.2.1 Anthropometric methods

Measurements of height, weight, circumferences, and skinfolds are used to estimate body composition. Although skinfold measurements are more difficult than other anthropometric procedures, they provide a better estimate of body fatness than those based only on height, weight, and circumferences (ACSM, 2009).

1.1.2.2 Body Mass Index (BMI)

The BMI is used to assess weight relative to height and is calculated by dividing body weight in kilograms by height in meters squared (kg·m-2) (ACSM, 2009). Here is the classification shown below (Table 2).

Table 2 Classification of Disease Risk Based on Body Mass Index (BMI) and Waist Circumference

	Disease Risk[a] Relative to Normal Weight and Waist Circumference		
	BMI (kg.m-2)	Men, ≤ 102 cm Women, ≤ 88 cm	Men, > 102 cm Women, > 88 cm
Underweight	< 18.5	-	-
Normal	18.5-24.9	-	-
Overweight	25.0-29.9	Increased	High
Obesity, class			
I	30.0-34.9	High	Very high
II	35.0-39.9	Very high	Very high
III	≥ 40	Extremely high	Extremely high

[a]Disease risk for type 2 diabetes, hypetension, and cardiovascular disease. Dashes (-) indicate that no additional risk at these levels of BMI was assigned. Increased waist circumference can also be a marker for increased risk even in persons of normal weight.
Modified from Expert Panel. Executive summary of the clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults. Arch Intern Med. 1998; 1855-67.

1.1.2.3 Dual energy x-ray absorptiometry (DEXA)

Bone health will be evaluated in the current National Health and Nutrition Examination Survey (NHANES) by dual energy X-ray absorptiometry (DEXA, figure 2) scans of the femur and anterior-posterior (Chevalley et al.) spine. This method will be used to (1) monitor secular trends in overweight prevalence; (2) describe the prevalence of obesity; and (3) examine the relationship between overweight and obesity and other examination measures, including blood pressure, glucose intolerance, and a battery of indicators for cardiovascular disease. DEXA will be used to assess overall skeletal changes that often occur with age by measuring bone mineral content (BMC) and bone mineral density (BMD). DEXA measurements can also be used to provide information on early gender and ethnic changes in the rate of bone accretion and to determine the age when skeletal accretion ceases and when peak bone mass occurs

(NHANES, 2007). The criterion to diagnose osteoporosis is that T score ≤ -2.5 while osteopenia is T score of -1 to -2.49 (WHO, 1994).

Figure 2. Dual enery X-ray Absorptiometry (DEXA)

1.2 Physical Exercise and Activity

The Institute of Medicine´s definitions of physical activity and exercise and related concepts are adopted, where physical activity refers to body movement that is produced by the contraction of skeletal muscles and that increases energy expenditure. Exercise refers to planned, structured, and repetitive movement to improve or maintain one or more components of physical fitness (Chodzko-Zajko et al., 2009). Exercise interventions may be effective in preventing, delaying, or reversing the frailty process. It has therefore been argued that more intervention studies in frail populations are needed (Faber, Bosscher, Chin, & van Wieringen, 2006).

Despite the benefits of physical activity, a large proportion of older adults still lead a sedentary lifestyle (Chen, 2010). The residents of long term care institutions, ability and resources for practicing physical activity are more restricted than community-dwelling older adults. The study revealed that barriers to physical activity can be personal or environmental, including physical health problems and physical frailty, fear of resultant injury or falling, past sedentary lifestyle, insufficient understanding about physical activity and environmental restriction. These leads to low functional capacity, muscle weakness, and deconditioning are more common in older adults than in any other age group and contribute to loss of independence. However, age should not be a barrier to physical activity promotion because positive improvements are attainable at any age (Tiedemann, Sherrington, Close, & Lord, 2011).

1.2.1 Physical Fitness

Physical fitness is operationally defined as a state of well-being with a low risk of premature health problems and energy to participate in a variety of physical activities (ACSM, 2009; Chodzko-Zajko et al., 2009). The importance of functional fitness in older adults is that the performance has the physiologic capacity to perform normal everyday activities safely and independently without undue fatigue (R. Rikli & Jones, 1999). The data's shown below in table 3 on functional fitness framework which points out the everyday activities (e.g personal care, shopping, housework) requires the ability to perform functional movements, in turn, are dependent on having sufficient physiologic reserve such as strength, endurance, flexibility and balance (R. Rikli & Jones, 2001).

Table 3 A functional ability framework indicating the physiologic parameters associated with functions required for basic and advanced everyday activities (R. Rikli & Jones, 2001).

Physical Parameters	Functions	Activity Goals
Muscle strength/endurance	Walking	Personal Care
Aerobic endurance	Stair climbing	Shopping/errands
Flexibility	Standing up from chair	Housework
Motor Ability		
Power speed /agility	Lifting /reaching	Gardening

Balance Body composition	Bending/ kneeling Jogging /running	Sports Traveling
Physical impairment	Functional limitation	Reduced ability/Disability

1.2.2 Variables of training exercise

1.2.2.1 Mode

It refers to the type of exercise employed during the training session. The mode should be based on an individual´s functional capacity, interests, time and equipment availability, and personal goals and objectives (Balady et al., 2002; Speer, 2005). The different modes of exercise are aerobic and anaerobic exercise, strength and muscular endurance exercises, balance and flexibility.

1.2.2.2 Duration

The total amount of time spent in the exercise training. This is typically 20 to 60 minutes, but shorter durations of at least 10 minutes may be performed multiple times per day to achieve similar effects (e.g., three 10-min sessions vs. one 30-min session), which is especially appropriate for those who are deconditioned or symptomatic (e.g., cardiopulmonary patients) (Speer, 2005). Exercise duration is prescribed as a measure of amount of time physical activity is performed (i.e., per session, day, or week) or by the total caloric expenditure (ACSM, 2009).

1.2.2.3 Frequency

The total number of exercise sessions per week (e.g., 2-6 sessions per week) (ACSM, 2009). A deconditioned person may improve with only 2 sessions per week, while a higher-fit person may need 5 or more sessions per week to see further improvements (Speer, 2005). Health/fitness benefits occur in some people with as little as one to two exercise sessions per week performed at moderate to vigorous intensity (≥60% VO2 reserve). However, this minimal frequency of physical activity cannot be recommended for the general adult population because of the higher risk of musculoskeletal injury and adverse cardiovascular events in persons who are not physically active on a regular basis (ACSM, 2009).

1.2.2.4 Intensity

The intensity of training is a qualitative component and is a function of the activities performed in a given unit of time. Intensity measurement varies between sports, where distance and time are factors; absolute intensity is recorded as speed. In activities performed against resistance, intensity is measured in kilograms (Smith, 2003). Exercise of at least moderate intensity (i.e., 40% to VO2 reserve that noticeably increases HR and breathing) is recommended as the minimum exercise intensity for adults to achieve health/fitness benefits (ACSM, 2009).

1.2.2.5 Progression

It is a dynamic process that requires an exercise prescription process, evaluation of training process, and careful development of target goals. The process starts with the determination of individual needs and training goals. This involves decisions regarding questions as to what muscles must be trained, injury prevention sites, metabolic demands of target training goals, etc. The single workout must then be designed reflecting these targeted program goals including the choice of exercises, order of exercise, amount of rest used between sets and exercises, number of repetitions and sets used for each exercise, and the intensity of each exercise. For progression, these variables must then be varied over time and the exercise prescription altered to maintain or advance specific training goals and to avoid overtraining (Kraemer & Ratamess, 2004).

1.2.2.6 Exercise Intensity, Duration, and Frequency

Exercise intensity, duration, and frequency are all interrelated and collectively determine the total work and volume performed, as well as the efficacy of the training session. The ACSM recommends that every adult accumulate 30 min or more of moderate intensity physical activity on most, preferably all, days of the week (Balady et al., 2002). However, this general statement does not provide information regarding the dose of exercise needed to elicit a desired cardiorespiratory effect or energy expenditure. Both longer duration, lower intensity exercise are effective in enhancing cardiorespiratory fitness and expending calories (Speer, 2005). In general, lower-frequency and duration training is associated with higher intensity exercise, while higher frequency and duration training is associated with lower intensity exercise. It is important to begin an exercise program with both lower intensities and durations and to gradually increase these variables as the individual progresses. It is also important to modify mode, intensity, duration and frequency (e.g., periodization) throughout a yearlong training program (Speer, 2005).

1.2.3 Exercise Prescription for Elderly

Exercise prescriptions should be individualized to enhance the health, fitness and well being of the individual, both physical and mental, should be specific to an individual´s needs and goals. The basic components of training session are warm up, training phase and cool down (Balady et al., 2002; Speer, 2005). According to (Tiedemann et al., 2011) exercise practitioners and health professionals need to be informed and be guided for the safe and effective prescription of exercise for the older community-dwelling people with the goal of preventing falls. The general principles of exercise prescription apply to adults of all ages. The relative adaptations to exercise and the percentage of improvement in the components of physical fitness among older adults are comparable with those reported in younger adults.

1.2.4 Evaluations of Physical fitness for Elderly

The physical fitness of the elderly is assessed through cardiovascular and muscular endurance or aerobic endurance, balance, flexibility and muscle strength. In this study, the subjects were evaluated with the use of Senior fitness test (SFT) by (R. Rikli & Jones, 1999). The SFT measures the underlying physical parameters associated with functional ability, and identifies whether an older adult may be at risk for loss of functional ability. The SFT meets the scientific standards for validity and reliability (R. Rikli & Jones, 1999). It is quick and easy to administer and score, requires minimal equipment and safe to use with a wide range of physical abilities (R. Rikli & Jones, 2001).

The Physical fitness measures give primary care providers objective information to develop a physical activity program for their patients. A physical activity program that includes recommendations for aerobic endurance, strength, flexibility, and/or balance that is based on objective findings may be a useful tool to promote better health and physical fitness in older adults (Purath et al., 2009).

1.2.4.1 Muscle Strength

The external force (properly expressed in newtons, although kilograms and pounds are commonly used as well) that can be generated by a specific muscle or muscle group; it is commonly expressed in terms of resistance lifted. Strength can be assessed either statically (no overt muscular movement or limb movement) or dynamically (movement of an external load or body part, in which the muscle changes length). Isokinetic dynamometry (figure 2, BIODEX) has been the most common method of measuring skeletal muscle performance in age-related studies of skeletal muscle. Data have revealed that all muscular actions are affected by aging; however, the magnitude of the age-related effects is not equivalent for all types of muscle action. To date, the majority of isokinetic investigations assessing the relationship between age and strength have studied concentric or isometric muscle actions. Numerous investigations have suggested that the relationship between aging and skeletal muscle performance is linear, that is, skeletal muscle performance declines as age increases (Brown, 2000). On other hand, Arm curl (R. Rikli & Jones, 2001) was used to assess the upper body strength which is needed for performing household and other activities involving lifting and carrying things such as groceries, suitcases and grandchildren.

Figure 3. Isokinetic Dynamometer (BIODEX)

1.2.4.2 Cardiovascular endurance / Aerobic endurance

The cardiovascular endurance is the ability of the circulatory and respiratory system to supply oxygen during sustained physical activity (ACSM, 2009). The 6-minute walk (R. Rikli & Jones, 2001) was assessed in this study which is important measure for walking distances, stair climbing, sightseeing while on vacation, etc.

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1.2.4.3 Agility / Balance

(R. Rikli & Jones, 2001) used 8 foot up and Go which is important in tasks that require quick maneuvering such as getting off a bus in time or getting up to attend something in the kitchen, to go the bathroom or to answer a phone. This measure is important in assessing risk fall-related aging population.

1.2.4.4 Flexibility

Flexibility is the ability to move a joint through its complete range of motion. It is important in athletic performance (e.g., ballet, gymnastics) and in the ability to carry out the activities of daily living. Consequently, maintaining flexibility of all joints facilitates movement; in contrast, when an activity moves the structures of a joint beyond a joint's shortened range of motion, tissue damage can occur (ACSM, 2009). In this study used back scratch for upper body flexibility which is important in tasks such as combing one´s hair, putting on overhead garments and reaching for a seat belt while chair sit and reach for lower body flexibility for good posture, gait patterns and for various mobility tasks such as getting in and out of a bathtub or car (R. Rikli & Jones, 2001).

1.2.5 Influenced of Physical exercise to elderly

Through sports, In the study of 83 aged over 70 years in community-dwelling people for those who took part in sports as regular exercise have higher walking performance and fewer fall experiences than the elderly people engaged in mild exercise. In addition, the frequency of playing sports was associated with knee extension muscular strength and quantity of skeletal muscle (Koguchi et al., 2008).

In the study of progressive resistance training, for 3x week for one year to 35 healthy independent community dwelling 75-80 years old women had a significant improvement in general health (p=006) and transitional health (p=.005). They produced positive results in strength, lumbar spine BMD, functional tests and health (Taunton et al., 2002). Also, non-randomized progressive resistance muscle strength training of 19 aged older 64 (mean age, 82.8 +/- 7.9 yr) recuperating hospitalized elderly for a 10 week program showed improvement in sit-to-stand maneuver and gait speed. The researchers recommended that it is a safe and possibly effective method for frail elderly recuperating from acute illnesses and subject for further study in a randomized control (Sullivan, Wall, Bariola, Bopp, & Frost, 2001).

For strength training, 8 week training program on physical fitness and psychical condition for elderly women showed a positive impact in strength and aerobic endurance but BMI and the body composition measures did not change (Abramaviciute & Zaicenkoviene, 2013). Also, for a longer period of 18 week intensive strength training (76-78 yrs women) can induce skeletal muscle hypertrophy and can also reduce the relative amount of intramuscular fat, whereas the effects of endurance training are insignificant (Sipila & Suominen, 1995).

Low intensity muscle training such as walking, stretching and recreational sports for 90 minutes, 2 x week for 3 months resulted that there is improved in physiological function and improved in reducing aortic stiffness in the elderly of 17 community dwelling persons (mean age 76 yrs) for (Itotani, Maeda, Kawaguchi, Mukakami, & Kato, 2012).

1.3 Whole body vibration exercise

1.3.1 Definition

Vibration is a mechanical stimulus characterized by an oscillatory motion where energy is transferred from the vibratory machine to the human body. The vibration load is dependent to biomechanical parameters such as frequency, amplitude, acceleration and magnitude. The amplitude of the vibration is the extent of the oscillatory motion (peak-to-peak displacement, in mm). The repetition rate of the cycles of oscillation determines the frequency of the vibration (measured in Hz). The acceleration determines the magnitude of the vibration (Cardinale & Rittweger, 2006; Cochrane et al., 2008). The duration refers to the exposure time. Normally, vibration is administered in the range of

0-45 Hz, amplitude of 0-12 mm (peak to peak amplitude) and peak acceleration of 0-18 g (Cochrane et al., 2008).

1.3.2 Types of vibration exercise

There are different types of oscillatory motions; sinusoidal vibration is the only type where the response to a single frequency can be investigated. Sinusoidal vibrations (SV) have been studied with the aim of understanding their effects in humans and their possible application as an exercise modality (Cardinale & Rittweger, 2006). The SV rotates around an antero-posterior horizontal axis, so when the feet are further from axis it results in a larger vibration amplitude (figure 1) (Cochrane et al., 2008). The other type is a vertical synchronous vibration (VV) where both legs are vibrated as the platform moves predominately in the vertical direction (figure 4) (Cochrane et al., 2008). There are numerous systems that are available commercially such as Nemes, Nemesis, The Netherlands; Galileo 2000, Novotech, Germany; and Powerplate, The Netherlands.

Figure 4. The 2 different types of vibration exercise

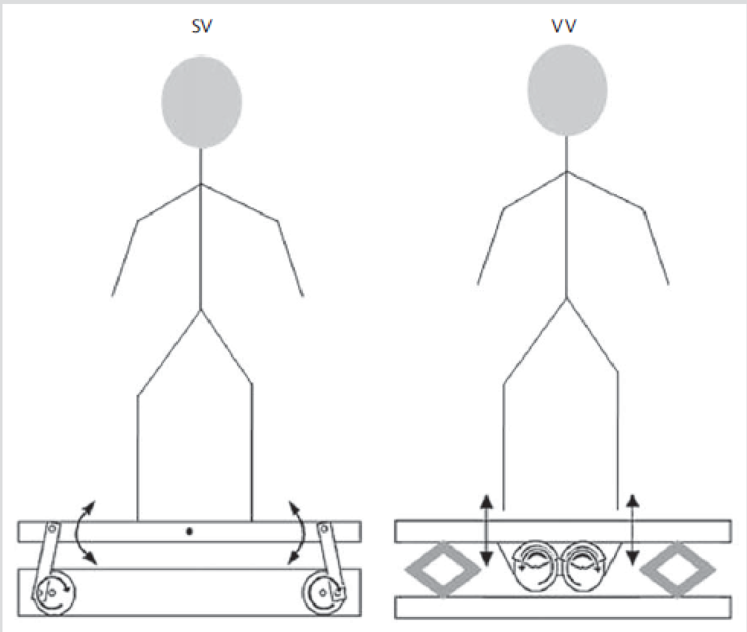


Fig. 1 The 2 different types of commercially manufactured vibrating platforms: SV and VV. (Adapted from Pel et al. [18]). The SV oscillates around a central axis, where a crankshaft on each side of the platform translates to a rotating motion of the electro-motor into a vertical displacement, inducing a seesaw motion, of which the amplitude is either small, closer to axis or larger near the edge of the platform. For VV 2 electro-motors with an eccentric mass induce vertical vibrartions where the amplitude has 2 predetermined settings: low or high.

1.3.3 Parameters of vibration exercise according to studies

The effect of vibration on strength , power development and performance enhancement appears dependent upon the vibration characteristics (method of application, amplitude, frequency and duration) (Bazett-Jones, Finch, & Dugan, 2008; Luo, McNamara, & Moran, 2005) ; different types of vibration (SV, VV) (Cochrane, 2010); exercise protocols (training type, intensity and volume) employed (Luo et al., 2005) and participant characteristics (gender, strength, stiffness, training level) (Bazett-Jones et al., 2008) and age (Cochrane, 2010). Vibration frequency should be in the range of 30-50Hz to activate the muscle most effectively (Luo et al., 2005). On the other hand, (Mester, Kleinoder, & Yue, 2006) suggested that WBV frequency range < 20 Hz should be avoided because the resonance of human body, which may induce injury effect vibration loads. The employment of a greater exercise intensity and volume within a vibration training program may facilitate a larger enhancement in strength and power (Luo et al., 2005). Consideration is given to the different time-effects of vibration: during the application of vibration (acute effect), (Koguchi et al.) immediately after the application of vibration (acute residual effect), and following a series of bouts of vibration training over an extended period (chronic training effect) (Luo et al., 2005). Duration of vibration is also a factor that should be considered in examining the effect of vibration training (Luo et al., 2005).

The difference of between the devices could be explained in part, because: a) the balance and the strength of lower limbs declines with age, particularly in the lateral direction, the direction in which the reciprocating plate used in the study showed the greater mechanical acceleration; b) the studies differed in the methodology of balance assessment (Gusi et al., 2006).

The amplitude and frequency that are delivered to a muscle being trained are influenced by the method of vibration application. With indirectly applied vibration, a situation may exist that the vibration amplitude and frequency on a muscle close to the vibration source may be sufficient to activate the muscle effectively but those on a muscle further away from a vibration may be sufficient

(Luo et al., 2005). Anticipated more robust changes in lower body muscle function than upper changes, due to dissipation of vibration transmission over the length of the body, it was true for muscle strength (Mikhael et al.). The method of vibration application either applied directly or indirectly to a targeted muscle may have influenced on the magnitude of amplitude and frequency that are delivered to the muscle (Luo et al., 2005).

In the study of (Bazett-Jones et al., 2008) that 40Hz and 50Hz vibration sessions demonstrated the greater performance enhancement than 30 Hz and 35 Hz which did not elicit changes in performance, regardless of acceleration or amplitude. The study does not confirm or deny that the frequency of vibration is the most important characteristics.

In terms of exercise protocol, static and dynamic WBV exercise conducted on a vibrating plate (the whole plate oscillating up and down at 35-40Hz, 2.28-5.09g) has been shown to improve both isometric and dynamic muscle strength (by 15% and 16% respectively) and also increases bone mineral density in the hip (by 0.93%) in postmenopausal women (Verschueren et al., 2004)

1.3.4 Contraindication and Indication

The following contraindications for Vibration exercise:

- Cardiac or vascular problems;
- Prostheses in the hip or knee;
- Hernias, discopathies or spondylosis;
- Osteoarthritis or joint disease;
- Presence of wound infections or inflammations;
- Severe Diabetes;
- Has a pacemaker;
- Inflammation;
- Epilepsy;
- Having undergone a recent bone fracture;
- Pregnancy.

The vibration exercise is indicated both on the sports field and in the treatment of different pathologies. Among the indications health-related highlights:

In the neurological aspects:

- ALS (Amiotrophic Lateral Sclerosis).
- MS (multiple sclerosis).
- Chronic Fatigue Syndrome.
- Paresis.

In muscle conditions:

- Fibromyalgia.
- Muscular atrophy.
- Muscle shortening.
- In bone and cartilage:
- Rheumatism.
- Osteoporosis.

In circulatory problems

- RSI (Repetitive Stress Injuries)
- Posttraumatic Dystrophy.
- Edema

1.3.5 Advantages

In various medical studies, whole body vibration training has been proven to enhance or maintain bone mineral density in postmenopausal women and elderly. Whole body vibration training is also known to improve muscle strength and balance in the elderly. Based on literature researches it showed positive effects in improving bone density, muscle strength, balance, physical function and quality of life etc.

1.3.6 Disadvantages

There were reported effects during the first sessions for some erythema, edema and itching of the legs after vibration exercise but these phenomenon resolved rapidly after vibration exercise (Roelants, Delecluse, & Verschueren, 2004) and some studies found side effects after acute vibration frequencies (10, 20, 30 Hz) such as hot feet, itching of the lower limbs, vertigo, severe hip discomfort, pain of jaw, neck and lower limbs but those results did not fully disclose how the participants were familiarized on the vibration platform or whether they screened the participants for vibration side effects. It was reported that side effects subsided after 7-10 days of treatment (Cochrane, 2010).

Prolonged exposure to vibrations has been shown to have detrimental effects on the soft tissues, including muscle fatigue, reductions in motor unit firing rates and muscle contraction force, decreases in nerve conduction velocity and attenuated perception (Cardinale & Wakeling, 2005). Another disadvantage to this vibration is that the machine is expensive and some institutionalized center, rehabilitation centers, sports center or nursing homes have this equipment available but not in individual homes.

1.3.7 Safety Guidelines

The treatment has to follow specific safety guidelines to prevent exercise-related injuries such as back pain, muscular discomfort, etc. by limiting the exposure to vibration to a maximum of 10 minutes and maintaining the posture of the participant in a semi-squat stance with knees flexed, with active involvement of the leg muscles to reduce the transmission of vibration to the head (Cardinale & Rittweger, 2006; Gusi et al., 2006; Liu et al., 2010; Raimundo et al., 2009). By maintaining a semi-squatting position on different vibrating plates very rarely leads to discomfort in healthy subjects, even if elderly (Cardinale & Rittweger, 2006).

1.3.8 Influenced of Whole Body Vibration

It has been suggested that the major part of the gain in strength is due to muscle activity provoked by the vibration stimulus. In a study of WBV exercise compared to placebo (without vibration), both performed static and dynamic exercises. It was found out that the placebo group didn’t gain strength while the WBV increases strength (Delecluse et al., 2005). Preliminarily, there is strong to moderate evidence that long-term whole-body vibration exercise can have positive effects on the leg muscular performance among untrained people and elderly women. There is no clear evidence for effects on muscular performance after short-term vibration stimuli (Rehn et al., 2007). WBV is a suitable training method and is as efficient as conventional RES training to improve knee extension strength and speed movement and countermovement jump performance in older woman (Roelants, Delecluse, & Verschueren, 2004). In a study of 3 months of WBV exposure significantly improved absolute and relative lower body muscle strength and relative upper body strength and peak contraction velocity (Mikhael, Orr, Amsen, Greene, & Singh, 2010).

Short training sessions using controlled whole body vibration 3 times a week for 6 weeks improved gait, body balance, motor capacity, and self-reported QOL in elderly nursing home residents (Bruyere et al., 2005). Whole body vibration was effective in improving the balancing ability in elderly women. This also provides evidence to support the user friendly WBV treatment protocol of 3 minutes a day for the elderly to maintain their balancing ability and reduce risk of fall (Cheung et al., 2007). In another study have shown on positive effect of controlled WBV gait, body balance and motor capacity (Cardinale & Rittweger, 2006).

Some studies compared whole body vibration to walking exercise for 3 sessions per week for 8 months with the vibration frequency of 12.6 Hz at 3mm. The results showed improvement in BMD femoral neck, balance (Gusi et al., 2006) and strength (Raimundo et al., 2009) for vibration exercise. Thus, the walking exercise program improved more in physical function test such as walking and chair rise test. The 8 month course of vibratory exercise using a reciprocating plate was feasible and was more effective than walking to improve two major determinants of bone fractures (Gusi et al., 2006).

Some recent studies have included in their protocols frequencies at 10-15 Hz to allow gentle adaptation in frail populations (nursing home residents, elder, and rehabilitation programs). But, to authors’ knowledge, none of them have reported the specific effect of these low frequencies on bone mass. This knowledge could specially contribute to make decisions on the WBV programs to frail people (Gusi et al., 2006).

(Roelants, Delecluse, & Verschueren, 2004) found out that WBV has a great potential for application in the geriatric and therapeutic sectors as a safe, low impact strength training method with a low starting threshold for those who are not attracted to or able to perform conventional resistance training.

1.3.9 Bone adaptation to mechanical loading

Bone is known to adapt to different loading conditions and the loading-induced strains are believed to be based on the adaptation of the bone tissue. For that reason, researchers usually administered frequencies at 15-35 Hz to obtain the maximum transmissibility of the mechanical loading produced by the vibrating plate. While the adaptation to the mechanical loading is most likely the limiting factor, elderly subjects have been shown to benefit from simulated mechanical loading (Liu et al.). Bone adapts to exogenous forces. The mechanostat theory proposes that through the biological processes of the modeling and remodeling, strains are kept within certain limits, which prevents bone from breaking (Cardinale & Rittweger, 2006).

Mechanical stimulations applied to muscles or tendons induce a reflex contraction named “tonic vibration reflex” (TVR). This is caused by excitation of muscle spindles (IA fibers). It is controversial whether their responses can be elicited by low frequency vibrations (1-30Hz) or only by high frequency vibrations (over 100Hz) of low amplitude (around 1 mm). It has been reported that TVR´s can be induced at low frequency (1-30 hz) when WBV is applied and also at high frequencies (100-150 Hz) with either WBV or locally applied. The reflex response has been mainly attributed to activation of the primary endings of muscle spindles, which seem to respond in a one to one manner (Cardinale & Rittweger, 2006).

The beneficial effects on bone can be maintained for a longer time if the exercise continues, although the exercise may not maintain the age-related reduction of BMD in elderly. WBV should be implemented in an environment where supervision could be provided. Vibration, with increased stresses on the bone, stimulates remodeling but may also decrease bone resorption. Studies show that it may increase femoral neck BMD in postmenopausal women and in lower weight women, in addition to inhibiting bone loss after menopause. However, just a few studies have investigated the effect of WBV on BMD in older population and different protocols were employed in the studies. In addition, it is still unknown if these short-term effects of low intensity WBV will persist or whether body will adapt (although the parameters can be constantly changed to account for adaptation.) It is not known yet whether the benefits of WBV will disappear after the intervention is terminated, as it has been shown previously with other types of exercise (Liu et al.). Bone stress induced by vigorous weight-bearing activities can increase the risk of injuries, particularly in the elderly (Cardinale & Rittweger, 2006). According to authors review that mechanical loading stimulates osteocytes to release soluble factors that can inhibit the production of osteoclasts thereby decreasing bone turnover, thus preventing bone loss (Luo et al., 2005).

Several conditions must be met to affect bone positively, the strain produced by loading must be of high enough magnitude to exceed the minimum effective strain; the strain should be applied in an intermittent fashion, loading should produce a different from normal strain distribution within the bone. In addition, recent research implies that frequent loading on bone without rest may not allow sufficient time for osteocyte stimulation might be reduced or completely inhibited after the first loading cycle. If so, inserting short time periods between loadings will allow for recovery from the inertial dumping effort and facilitates osteocyte stimulation (Liu et al., 2010).

2 Objectives of the study

2.1 General Objective

The purpose of the study is to determine the effect of Low frequency WBV exercise training program of elderly clients in the nursing rehabilitation center after the vibration was withdrawn for 3 months;

2.2 Specific Objectives

Specifically, this study intends to:

1. Evaluate and compare the effect of low frequency WBV exercise training program for WBV exercise and CON group on Body composition after the vibration was withdrawn for 3 months.
2. Evaluate and compare the effect of low frequency WBV exercise training program for WBV exercise and CON group on Muscle strength after the vibration was withdrawn for 3 months.
3. Evaluate and compare the effect of low frequency WBV exercise training program for WBV exercise and CON group on Physical fitness after the vibration was withdrawn for 3 months.

2.3 Methodology

2.3.1 Subjects and study design

There were 18 subjects recruited to participate the program but only 8 elderly completed the program, 5 from the WBV group (82.80±5.07 years) and 3 from CON group (85.33±10.97). The subjects were volunteers in the Santa Casa Misericordia, nursing rehabilitation center. Baseline data were collected prior to intervention (table 5). The subjects were assessed by the result of their BMD right hip before assigning to each group. All volunteers obtained inform consent prior to analysis. The inclusion criteria were: resident of nursing rehabilitation center, ambulatory and need minimal assistance, adhere to the treatment regimen. The exclusion criteria were: serious heart and/or vascular diseases, fresh wounds as a result of surgery or outpatient procedures, hip or knee replacements (implants), acute hernia, discopathy, spondylolyses, severe diabetics, epilepsy, tumors, new inflammations, acute migraine, when using a pacemaker, recently placed metal pins, bolts and/or plates. The subjects were assigned and divided into two categories after screened from the BMD of the hip; CON and WBV group. Baseline data were taken before the start of the training program such as DEXA, Biodex, Senior Fitness Test and EQ-5D.

This study was approved by the University´s Ethics committee according to their ethics standard in performing experiments involving humans. After the study, this vibration exercise program was introduced to the CON group for the outcome of the study for ethical purposes.

2.3.1.1 WBV group

The subjects in the WBV group performed the vibration exercise in a standing position with semi-flexed knee position to reduce the transmission impact to the spine and head. The vibration was provided by a commercially available device (Galileo 2000, Novotec GmbH, Pforzheim, Germany). The subjects stood with feet side by side on the board, which produced side-alternating oscillations of the whole body. During the vibration sessions, the subjects were instructed to hold in the handrail of the machine, wore no shoes to standardize the damping of the vibration caused by foot wear.

The Vibration exercise experimental procedure similar to the previous studies by (Gusi et al., 2006; Raimundo et al., 2009) shown below;

Table 4 The WBV experimental procedure

Week	Sets	Frequency	Amplitude	Duration	Rest
1-2 weeks	3	12.6 Hz	3mm	1 minute	60 seconds
3	4	12.6 Hz	3mm	1 minute	60 seconds
4	5	12.6 Hz	3mm	1 minute	60 seconds
5	6	12.6 Hz	3mm	1 minute	60 seconds
6-12 weeks	6	12.6 Hz	3mm	1 minute	60 seconds

The duration of the exercise program was about 30 minutes. It consisted of the following; 10 minutes of warm-up exercise with the use of spin bike at 25 W; vibration exercise; and 3-5 minutes recovery for stretching the muscles.

2.3.1.2 CON group

The subjects were instructed to perform their day to day activities in the nursing rehabilitation center without performing vibration exercise and any form of exercises.

After the training program, the subjects were re-evaluated for the DEXA, Biodex, Senior Fitness Test and EQ-5D questionnaire.

2.3.2 Body composition assessment

2.3.2.1 Anthropometric Measurements

Weight: Measured through weighing scale in the laboratory. Weight was recorded with the subjects' barefoot and anthropometric position in the center of the scale. The recording was done in kilograms (Kg) with decimal values.

Height: Measure with a tape measure that is already placed on the improvised height measurement in the laboratory. Measurements were made on anthropometric position. After placing the participant in the relevant position, put a ruler up to support the top of the head, noting the value corresponding to the height in inches (Bazett-Jones et al.).

BMI: It was calculated according to the standard formula i.e. the ratio of the weight in kilograms divided by height in meters squared, BMI = weight (kg) / height (m^2).

2.3.2.2 BMD assessment

At baseline and at 5 months, BMD of the hip and whole body was assessed by Dual-energy X-ray absorptiometry (DEXA, ExcelPlus Norland, Norland Inc.,Fort Atkinson, USA). All subjects were placed in a standard position according to the protocol of examination course. Subjects were asked to remove all metallic jewelries that may obstruct the examination. The researcher evaluated the content (g) and bone mineral density (g/cm2) of the hip and whole body. All tests were done by the train technician assuring bone mineral content (BMC) and bone mineral density (BMD).

2.3.2.3 Muscle strength assessment

The subjects were assessed by an isokinetic dynamometer (Biodex System-3, Biodex Corp., Shirley, NY, USA) with the isokinetic strength of dominant legs. The subjects were seated and strapped in the chair; the axis of the knee was coincident with the axis of the dynamometer according to standard instructions (Perrin DH, 1993). Before beginning each test, subjects made some repetitions with the purpose of heating the muscles of the legs and to familiarize the procedure. The protocol was isokinetic unilateral knee concentric and eccentric at 60º with 3 repetitions and 180º with 20 repetitions with 45 rest periods in between. In each period, verbal encouragement was done to subjects to make their best effort to produce maximal effort.

2.3.2.4 Physical function assessment

Senior Fitness Test (SFT)

The SFT protocol was applied to assess the physical fitness according to standard protocol (Rikli and Jones, 2011). The SFT had 6 phases of test (table 1) such as second chair stand, arm curl, 6 minute walk, chair sit and reach, back scratch and 8 foot up and go. Before the test, the physical conditions necessary for the application of the SFT protocol (isolation of the study area to ensure that tests are administered effectively and that the individuals move freely during tests) had been set. The test is completed in 30–40 minutes. Participants were told ‘‘do the best you can on all of the tests. Never push yourself to the point of overexertion or beyond what you think is safe for you.’’ These statements help to standardize instructions and stress that participants should stay within their own safety limits (Rikli & Jones).The chair-stand test measured muscle strength for lower body, and the arm curl test measured upper body strength. The 6 minute walk test evaluated cardio-respiratory fitness. The chair sit-and-reach test evaluated lower body flexibility and back scratch test measurement upper body flexibility. The 8-foot up-and-go test evaluated agility and balance. All the tests were carried out in the vicinity of the rehabilitation center for elderly as well as equipments were kept ready during the tests against any probable health problems.

Table 5 : Description of Senior Fitness Test

Item (Abbreviations)	**Item category (Purpose)**	**Test Description**
Arm Curl (SFT II)	To assess upper body strength	Number of biceps curls that can be completed in 30 seconds holding a hand weigh of 5lbs (2.27kg) for women; 8 lbs (3.63kg) for men.
6 minute walk (SFT III)	To assess aerobic endurance	Number of yards /meter that can be walked in 6 minutes around a 50-yard (45.7 meter) course. (5yds=4.57 meters)
Chair sit and reach (SFT IV)	To assess lower body flexibility	From sitting position at front of chair, with leg extended and hands

		reaching toward toes, the number of inches (Smeesters, Hayes, & McMahon) (+ or -) between extended fingers and tip of toe.
Back Scratch (SFT V)	To assess upper body (shoulder) flexibility	With one hand reaching over the shoulder and one up the middle of the back, the number of inches (Smeesters et al.) between extended middle fingers (+ or -)
8 Foot up and go (SFT VI)	To assess agility/dynamic balance	Number of seconds required to get up from a seated position, walk 8 feet (2.44m), turn, and return to seated position.

2.3.3 Instruments

- Biodex System-3, Biodex Corp., Shirley, NY, USA
- Dual-energy X-ray absorptiometry (DEXA, ExcelPlus Norland, Norland Inc.,Fort Atkinson, USA)
- Rikli and jones (SFT)
- Consent letter
- EQ5D Quality of life
- Stadiometer
- Ruler and tape measure
- Blocks
- Weighing machine

- Dumbbells

2.4 Statistical Design

In the treatment of these variables were analyzed by the IBM SPSS v.20 software application. The clinical variables and descriptive statistics (mean, standard deviation) were calculated. The baseline characteristics were compared using T-test for independent samples. The data were analyzed using the Non-parametric, Shapiro-Wilk test to analyze normality among variables which is more appropriate for the sample size. To compare WBV group and CON group in relation to body composition, muscle strength and physical fitness measures were applied, for the variables with normality, the ANOVA (one way) and for the variables without normality, the Mann-Whitney test. The results considered statistically significant when the P value is < 0.05. In addition, P values, the researcher provided detailed statistics including the mean and 95% confidence interval for the change between groups from baseline to 5 months follow-up and the treatment effect. The change to 5 months follow-up was defined as increase or decrease from baseline to post follow-up training by that group. The treatment effect was calculated by the following formula: WBV change score- CON change score mean. The mean and 95% confidence interval changes were calculated using Student´s t test for independent sample in each.

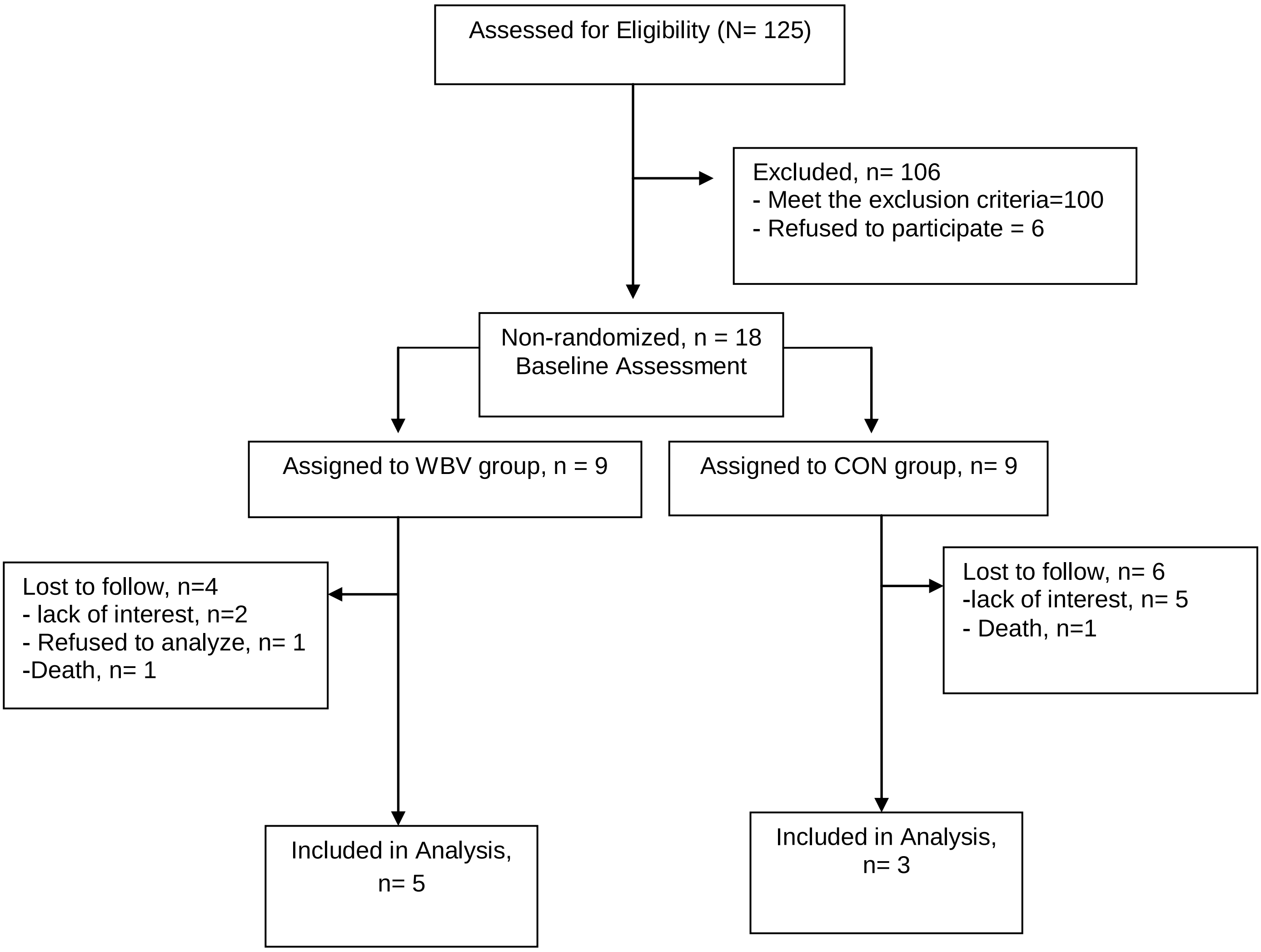
3. Presentation, Treatment and Analysis

3.1Presentation of Results

The results are presented below by summing up the values for the comparative effects of values on body composition, muscle strength and physical fitness measures. The data composed of 8 elderly in the nursing rehabilitation center who completed the treatment and were analyzed for the differences between each group (Figure 3). The data presented as mean, standard deviation, the difference of the mean, 95% confidence interval, the treatment effect and the p values < 0.05, for each variable considered.

The comparison between the WBV group and CON group is the fundamental procedure to identify the differences among the variables between them.

Figure 5. Flow chart of participants throughout the study



3.1.1Baseline data

In table 6 shown below, there is no significant difference between the WBV exercise group and CON group in terms of Age, Height and BMI. Only weight has significant difference (p=0.043), where WBV exercise group have a higher values than CON group.

Table 6. Baseline Characteristics* of the subjects before intervention

Variables	WBV M ± SD	CON M ± SD	p
Age (yrs)	82.80 ± 5.07	85.33 ± 10.97	0.663
Height (cm)	158.4 ± 7.53	152.33 ± 11.02	0.384
Weight (Kg)	75.0 ± 11.75	55.67 ± 6.66	0.043**
BMI (Kg/m²)	29.82 ± 3.43	24.1 ± 3.25	0.059

*values presented mean ± standard deviation
p-analysis of difference between WBV and CON group; **p<0.05. T test of student

3.1.2 Comparative effects of the training for Body Composition, Muscle strength and Physical Fitness

In tables 7, 8 and 9 shows the comparative effects of body composition, muscle strength and physical fitness.

Table 7. Comparative effects of WBV and CON group on Body Composition

Variables	Group	Baseline M ± SD	Change to 5months follow-up Mean (95% CI)	Treatment effect Mean (95% CI)	p
Weight (Kg)	WBV	75.0 ± 11.75*	0.20 (-2.34 to 2.74)	-1.8 (-4.96 to 1.36)	0.250[b]
	CON	55.67 ± 6.66*	2.00 (0.48 to 4.48)		
BMI (Kg/m²)	WBV	29.82 ± 3.43	0.10 (-0.97 to 1.17)	-0.73 (-2.03 to 0.56)	0.250[b]
	CON	24.10 ± 3.25	0.83 (0.07 to 1.59)		
Total Fat %	WBV	35.44 ± 7.65	-1.66 (-2.34 to -0.98)	-1.09 (-2.74 to 0.56)	0.156[a]
	CON	36.13 ± 4.87	-0.57 (-4.05 to 2.91)		

BMD Lumbar (g/cm²)	WBV	0.99 ± 0.30	0.07 (-0.56 to 0.19)	0.20 (-0.19 to 0.60)	0.786[b]
	CON	0.98 ± 0.31	-0.13 (-1.02 to 0.75)		
BMD Neck (g/cm²)	WBV	0.78 ± 0.15*	-0.03 (-0.07 to 0.01)	-0.03 (-0.10 to 0.03)	0.270[a]
	CON	0.50 ± 0.031*	0.00 (-0.12 to 0.12)		
BMD trochanter (g/cm²)	WBV	0.74 ± 0.23	-0.02 (-0.05 to 0.00)	-0.01 (-0.05 to 0.02)	0.786[b]
	CON	0.41 ± 0.073	-0.01 (-0.07 to 0.06)		
BMD Wards Triangle	WBV	0.53 ± 0.175	-0.03 (-0.06 to -0.00)	-0.09 (-0.17 to -0.01)	0.036[b]
	CON	0.365 ± 0.098	0.06 (-0.11 to 0.22)		
BMD Total Whole body	WBV	1.17 ± 0.220	0.07 (-0.00 to 0.14)	0.03 (-0.07 to 0.14)	0.481[a]
	CON	0.88 ± 0.021	0.04 (-0.13 to 0.20)		
BMD Total Right Hip	WBV	0.92 ± 0.198*	-0.06 (-0.21 to 0.08)	-0.05 (-0.23 to 0.13)	0.786[b]
	CON	0.56 ± 0.055*	-0.02 (-0.10 to 0.06)		

BMI= Body mass index; BMD= Bone mineral density; WBV= Exercise group; CON= control group
Outcomes at baseline and changes at 5 months follow-up. Values expressed as mean ± SD and 95% CI.
p- values of analysis of variance to compare differences between groups; $p<0.05$.
[a] ANOVA Test (one-way)
[b] Mann Whitney U-Test
*$p < 0.05$ results of the baseline, T-test independent samples

In table 7, shows the comparative effect of WBV and CON group on Body composition. There were no significant differences in Weight, BMI, Total fat %, BMD Lumbar, neck, trochanter, total whole body and total right hip except the BMD wards triangle (P = 0.036). In the baseline data, BMD neck (g/cm²) and BMD total right hip (g/cm²) showed a significant difference between groups (P= 0.019; P=0.023), respectively. Also, WBV group have better baseline values than CON group. After 5 months follow-up, there were no significant differences between them. The CON group gained weight (4%) than the WBV group (0.3%). There is no significant difference between groups. More in detail, 2 subjects in the WBV group both losses 2 kilograms (3%) of weight. In contrary, the rest gained weight. There is no significant difference between CON and WBV group in their body mass index. More in detail, the WBV group has 3 subjects were classified to obese category 1, 1 normal and 1 overweight. On the other hand, CON group has 2 normal and 1 obese classified as category 1.

In the Figure 6 showed significant difference between groups from baseline to 5 months follow-up.

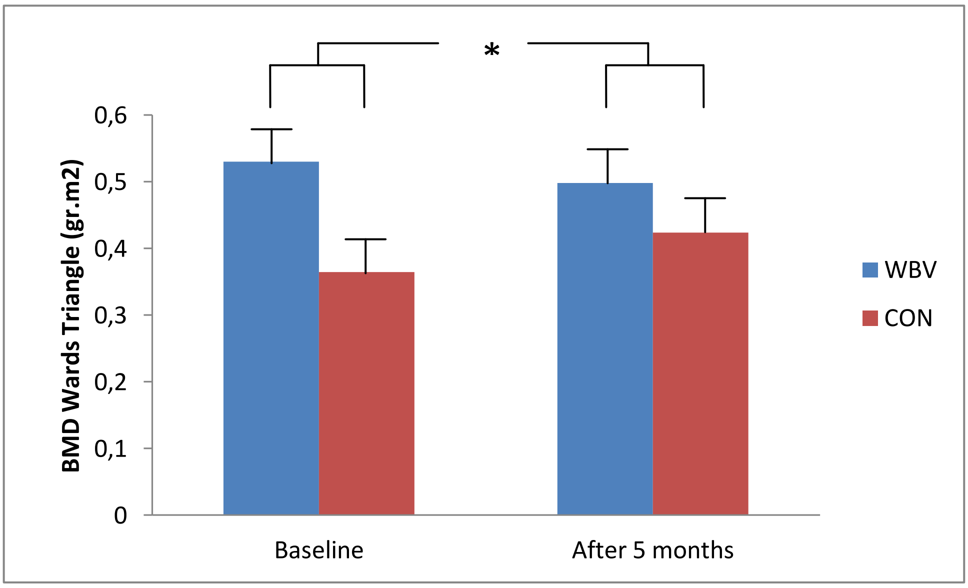


Figure 6. Bone mineral density in Wards triangle (gr.m²). *P<0.05 ANOVA to analyze the treatment effect.

In this figure 6 above, shows the significant differences between groups after 5 months follow-up for the 3 months intervention in the Bone mineral density in Wards triangle area. The WBV group significantly decreased by 6% while the CON group increased by 14%.

Table 8. Comparative effects of WBV and CON groups on Muscle strength

Variables	Group	Baseline M ± SD	Change to 5months follow-up Mean (95% CI)	Treatment effect Mean (95% CI)	p
Peak Torque (ext) 60°	WBV	60.04 ± 28.54	-16.5 (-46.00 to 13.0)	-16.1 (-54.3 to 22.1)	0.341[a]
	CON	31.27 ± 12.86	-0.40 (-39.0 to 38.2)		
Peak Torque (flex) 60°	WBV	31.78 ± 12.86	-11.5 (-16.4 to -6.51)	-3.38 (-16.8 to 10.1)	0.562[a]
	CON	22.03 ± 14.62	-8.10 (-37.4 to 21.2)		
Average Power (ext) 60°	WBV	29.86 ± 17.66	-11.8 (-33.6 to 10.0)	-13.6 (-41.3 to 13.9)	0.272[a]
	CON	15.03 ± 07.21	1.83 (-22.8 to 26.5)		
Average Power (flex) 60°	WBV	14.48 ± 09.02	-6.92 (-11.8 to -2.00)	-1.48 (-12.5 to 9.51)	0.752[a]
	CON	09.83 ± 09.96	-5.43 (-28.0 to 17.1)		
Peak torque (ext) 180°	WBV	37.56 ± 15.06	-2.38 (-24.2 to 19.5)	-5.31 (-31.2 to 20.6)	0.634[a]
	CON	24.90 ± 04.73	2.93 (-5.40 to 11.2)		
Peak torque (flex) 180°	WBV	25.36 ± 03.81*	-0.30 (-11.5 to 11.0)	-5.06 (-20.4 to 10.2)	0.393[b]

	CON	18.40 ± 01.99*	4.76 (-13.8 to 23.3)		
Average Power (ext) 180°	WBV	43.28 ± 18.61	-6.70 (-32.3 to 18.9)	-15.8 (-45.9 to 14.3)	0.247[a]
	CON	18.57 ± 09.12	9.10 (5.52 to 12.7)		
Average Power (flex) 180°	WBV	11.34 ± 12.04	1.08 (-11.7 to 13.8)	0.25 (-14.9 to 15.4)	0.970[a]
	CON	06.40 ± 06.25	0.83 (-5.23 to 6.90)		

ext=extension; flex=flexion
Outcomes at baseline and changes at 5 months. Values expressed as mean ± SD and 95% CI.
p- values of analysis of variance to compare differences between groups; $p<0.05$.
[a] ANOVA Test (one-way)
[b] Mann Whitney U-Test
*$p < 0.05$ results of the baseline

In table 8, shows the comparative effects of WBV and CON groups on Muscle strength. There were no significant differences between groups in Peak torque and Average Power, both concentric action in knee extension and flexion at 60°/s and 180°/s, respectively. Based on the baseline data, only Peak torque (flex) at 180°/s showed significance difference between the group (P=0.028). Moreover, the WBV group showed better results than CON group in the baseline. On the other hand, WBV group showed negative changes in Peak torque concentric knee extension and flexion at 60°/s (27% and 36%, respectively); Average power concentric knee extension and flexion at 60°/s (40% and 48%, respectively); and Average power concentric knee extension at 180°/s (15%) compared to CON group with minimal changes either positively or negatively.

Table 9. Comparative effects of WBV and CON group on Physical Fitness test measures

Variables	Group	Baseline M ± SD	Change to 5months follow-up Mean (95% CI)	Treatment effect Mean (95% CI)	p
6 minutes walk (m)	WBV	210.2 ± 76.57	33.8 (-32.6 to 100.2)	109.5 (19.9 to 198.9)	0.024[a]
	CON	197.3 ± 36.96	-75.7 (-181.1 to 29.7)		
Arm curl up	WBV	11.60 ± 4.93	4.60 (-0.26 to 9.46)	5.93 (-0.83 to 12.7)	0.075[a]
	CON	07.33 ± 6.81	-1.33 (-10.1 to 7.39)		
Sit and Reach	WBV	10.20 ± 10.035	-6,70 (-16.6 to 3.23)	0.47 (-13.1 to 14,1)	0.936[a]
	CON	9.67 ± 10.60	-7.17 (-24.0 to 9.70)		

Back scratch	WBV	27.30 ± 7.014	-2.10 (-7.48 to 3.28)	7.40 (0.34 to 14.5)	0.043[a]
	CON	36.33 ± 6.81	-9.50 (-17.1 to -1.94)		
8 Foot up and go	WBV	17.60 ± 10.90	-2.80 (-9.57 to 3.97)	-17.1 (-49.4 to 15.1)	0.571[b]
	CON	23.33 ± 4.16	14.3 (-60.9 to 89.6)		

Outcomes at baseline and changes at 5 months. Values expressed as mean ± SD and 95% CI.
p- values of analysis of variance to compare differences between groups; p<0.05.
[a] ANOVA Test (one-way)
[b] Mann Whitney U-Test
*p < 0.05 results of the baseline

In table 9, shows the comparative effects between WBV and CON groups on Physical fitness measures. There were significant differences between WBV and CON groups in 6 minutes walk (P=0.024, P<0.05) and Back scratch P=0.043, P <0.05). Also, there were no significant differences between each group in their baseline data. Furthermore, WBV group showed better results than CON group in the baseline.

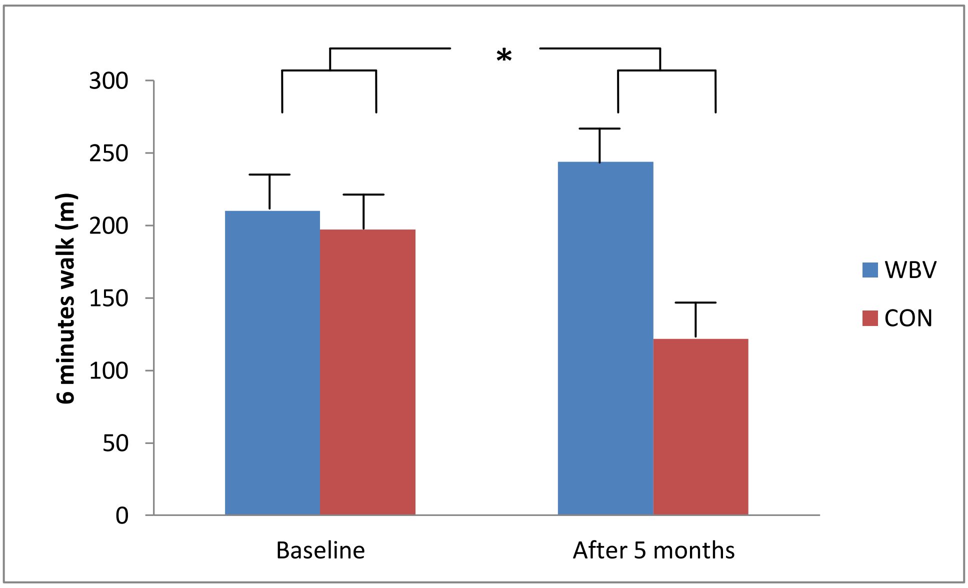


Figure 7. The distance spent (meters) by 6 minutes walk test. *P < 0.05 ANOVA to analyze the treatment effects between groups.

In figure 7, it showed the significant changes between the WBV and CON groups from baseline and after 3 months of follow-up for a 3 months intervention program. The WBV group have greater increased compared to CON group which is decreased.

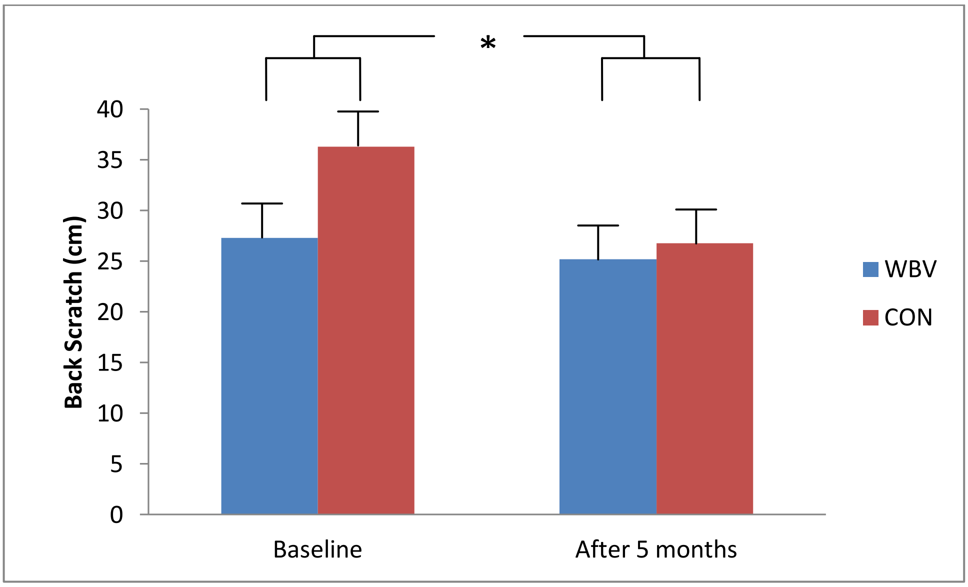


Figure 8. The length reached (centimeter) for upper flexibility by back scratch. *P < 0.05 ANOVA to analyze the treatment effects between groups.

Also, in figure 8 shows the significant differences between WBV and CON group from baseline and after 3 months follow-up. Both groups decreased significantly, WBV group (8%) and CON group (26%) .

4. Discussion

The study of 3 months low frequency whole body vibration exercise to elderly in nursing rehabilitation have no significant differences in general between WBV and CON group on baseline data and after 3 months follow-up about the body composition, muscle strength and physical fitness measures. Nonetheless, it has positive effects but still needs further research study to the optimum-dosage response of WBV program for the elderly.

The attendance rate of this study for the WBV group was about 74% which is likely similar to study of (Bruyere et al., 2005) with 72.7 % who completed the analysis. Both subjects in the studies were elderly in nursing rehabilitation centers. In contrary, the study of (Bautmans et al., 2005) 96% subjects who completed the program for 6 weeks WBV training. The differences of the studies are the subjects' Age. In the current study and (Bruyere et al.,

2005) subjects age were (82.80 ± 5.07 years and 81.9 ± 6.9 years, respectively) which were very older than (Bautmans et al., 2005) with the age (77.5 ± 11 years). Moreover, the two studies of (Bruyere et al., 2005) and (Bautmans et al., 2005) were done for 6 weeks while in the current study were 12 weeks duration. The researcher assumes that the longer the study programs the greater chance of falling out of the WBV training because of old age, related sickness to old age and personal reasons, etc. According to literature, in order to improve retention of the program, there should be musical environment and behavioral education (Gusi et al., 2006) and more platforms working at the same time etc. (Raimundo et al., 2009).

In this study, 4 subjects in the WBV group were lost to follow-up. Two drop-outs after one week of intervention. One subject died, the death was not related to WBV, and the subject left the program after 2 months of intervention for personal reasons. Three subjects completed the 3 months WBV program. One subject who completed the 3 months WBV program did not submit himself for post-evaluation. The other three (3) subjects just completed after 2 months but were included for follow-up due to limited number of WBV group. On the other hand, 6 subjects in the CON group, one died for unknown reason and 5 subjects showed lack of interest to perform the post-evaluation. These 5 subjects were willing to do WBV exercise prior to selection and screening but were saddened after they were screened and found out the result which categorically belongs to osteopenia or osteoporosis, exclusion to participate the WBV program. The researcher assumed that they lack of interest for that reason.

Body Composition

According to literature that Wolff´s law, bone mass adapts to the demands of mechanical loading in addition to metabolic influences. Much of the understanding of mechanically-induced osteogenesis comes from data collected on young and healthy individuals who suffer from bone fragility. Bone remodeling patterns differ between young and elderly individuals and mechanical stimulation of the skeleton that is appropriate for one group may be ineffective for the other. Moreover, it has been shown that aging alters the responsiveness of skeletal tissue to mechanical loads (Prisby et al., 2008).

Bone mineral density

According to these authors (Gomez-Cabello et al., 2013) that the minimum duration of the WBV interventions was 6 months that may lead to improve BMC or BMD. Therefore, the researchers suggested to have a longer WBV training program in the oldest people should be performed. Moreover, suggested by the authors that considering the numerous possible combinations of amplitudes and frequencies with the current technology, long term studies are needed in order to develop the most effective vibration training protocol to prevent or reverse sarcopenia (Machado, Garcia-Lopez, Gonzalez-Gallego, & Garatachea, 2010). In this current study, the WBV group performed 3 months of vibration with a moderate intensity exercise of 12.6 Hz, 3mm amplitude for 6 sets per 3 times a week. Obviously, this current study did not show any significant changes of BMD. Only BMD in the wards triangle showed a statistically significant changes between WBV (6% decrease) and CON (4% increase) group (P=0.036). In a recent study of 49 non-institutionalized elderly, 24 were trained squat positioned 3 times per week for 11 weeks of WBV showed no changes in bone mineral content and bone mineral density parameters. At the tibia, total, trabecular and cortical volumetric bone mineral density decreased significantly in the whole body vibration group (all $P<0.05$). The study concluded that is not enough to cause any changes on BMC and BMD. It only produces a slight variation on bone structure among elderly people (Gomez-Cabello et al., 2013). According to (Rubin et al., 2004) and (Torvinen et al., 2002) that the population with osteopenia or osteoporosis could obtain a greater improvement of BMD due to low baseline scores. In this study the WBV group was better BMD than in the CON group on baseline data. The latter group had osteopenia or osteoporosis risk result in their BMD right hip which they were excluded for WBV training program. The total bone mineral density in the WBV group showed 6% increased compared to control group with 4%. In contrary, bone mineral density at the right hip showed 7% decreased for WBV group compared to 4% decreased in CON group. These imply that elderly as they aged, the bone mineral density declines. The WBV group has higher decreased values than CON group because CON group was under neither osteopenia nor osteoporosis status. According to review, it was still unknown if these short term effects of low intensity WBV will persist or whether body will adapt (although the parameters can be constantly changed to account for adaptation. It was not known yet whether the benefits of WBV will disappear after the intervention is terminated (Liu et al., 2010).

On the other hand, a long term study of (Gusi et al., 2006) showed seven participants in the WBV group and three in the walking group prevented the bone mass density loss with no change nor improvement of the BMD at femoral neck. The WBV group was increased by 4.3% (P=0.011) compared to walking group. In contrast in this study showed that no statistical significant changes to BMD in the femoral neck, trochanter, wards triangle, total body and right hip between groups. The WBV group showed negative decline of the femoral neck (-2%), trochanter (-3%), ward triangle (-6%), right hip (-7%) compared to control group. Therefore, the researcher assumed that the WBV program was withdrawn did not retain nor improved after 3 months follow-up. The 3 months training program is a short term program to take effect on bone mineral density compared to (Gusi et al., 2006) for 8 months duration. The latter study were participated by post-menopausal women compared in this study who were elderly population in nursing rehabilitation center.

In comparison between WBV and resistance training, WBV reported increased in BMD compared to resistance training on lower body than in the spine (Gusi et al., 2006; Verschueren et al., 2004). In contrary, 8 months of WBV plus resistance training with 30-40 Hz, 2-4mm (Powerplate, North America, Inc., Northbrook, IL), showed a significantly decreased in Right total hip and right femoral neck BMD (P<0.05) (Bemben et al., 2010). Moreover, after 1 year of two-10 minutes per day at 30 Hz, showed no significant changes in spine, hip or distal radius BMD were detected with intention to treat analysis, however, to those compliant showed 2.175 benefit at the femoral neck and a 1.55 benefit at the spine compared to CON group (Rubin et al., 2004). They differ in variables in exercise program. Only (Verschueren et al., 2004) showed significant mean of BMD in the lower body. The study of (Verschueren et al., 2004) had 6 months duration (35-40 Hz, 3 times weekly) with static and dynamic knee-extensor exercises using (PowerPlate, Amsterdam,The Netherlands) compared to (Gusi et al., 2006) and (Bemben et al., 2010) with 8 months duration (12.6 Hz, 3 times weekly at standing position with angle flexion of the knees at 60º and 30-40Hz, 2-4mm with 8 exercises, respectively). These studies entails that higher frequencies is not a guarantee to have a significant effect of BMD but the exposure or duration of the WBV which is one of the important factors to consider in future studies. (Verschueren et al., 2004) had a vibration exposure of 20 minutes while (Gusi et al., 2006) and (Bemben et al., 2010) at 6 minutes.

Total fat mass

Total fat mass decreased significantly during the intervention period (-2.4%; 95% CI, -4.3 to -0.4, P=0.01 in the WBV group and -3.1%; 95% CI, -4.9 to -1.3; P<0.001 in the RES group). In contrast, no significant change in fat mass was observed in the CON group (+0.5%; 95% CI, -1.3-2.4, P=0.60) (Verschueren et al., 2004) . In this current study, showed a decreased of total fat % for the WBV group (5%) compared to CON group (1.6%). The data showed no statistically significant difference between groups (P=0.156).

According to literature that body composition improves when there is declines of fat mass while the muscle mass and bone mass increase, thus improve muscle strength and balance, aerobic capacity, physical activity and functional capacity (Galetta et al., 2006; Hakkinen et al., 1998; Kohn, 2006; Zoico et al., 2004). Also, body composition were influenced by genetic potential, early growth and development, differences in socio-economic status, health status, as well as geographic region and ethnic group affiliation (Milanovic et al., 2011)

In future studies, gender should be considered given that the results of this study seem to indicate that men and women respond differently to WBV (Bazett-Jones et al., 2008). Other studies applied complicated programs for the elderly, involving different exercises and durations in different weeks or systematic increased of training volume (Cheung et al., 2007). Discrepancies among studies often are linked to differences in WBV protocols and methods. Notwithstanding the participants characteristics, and by incorporating activities that may be able to specifically target muscle groups higher up the leg, the potential for WBV training to improve performance would appear to be enhanced (S. S. Rees et al., 2008)

Muscle strength

According to literature that WBV has effects on muscle strength with the stimulus being formulated by vibration to muscles (Delecluse et al., 2005) and this excites the muscles exposed to it which elicit response of TVR (Torvinen et al., 2002). It was proven that low frequencies (1-30 Hz) induced muscle strength, this study used 12.6 Hz which was also used by previous research (Gusi et al., 2006; Raimundo et al., 2009) that is recommended for elderly. According to literature, assumed that if WBV is effective, adaptation in muscle function would become measurable within short time (6 weeks). Moreover, prolongation over a longer period might result in occurrence of confounding factors in these frail nursing home residents (acute disease such as influenza, cognitive decline, changes in medication use and instability of co-morbidity. However it is not excluded that higher benefit of WBV on muscle performance might be obtained after longer or more intensive training programmes (Bautmans et al., 2005).

Based on literature that theoretically the lower extremity muscle strength decreases than the upper extremity as we aged (Chodzko-Zajko et al., 2009). Nonetheless, WBV can stimulate a number of muscle groups of the lower body at the same time. However, the muscle group closer to the vibration platform will attenuate more of the vibration stimulus than muscles higher up the leg (S. S. Rees et al., 2008). Based on this current study, the muscle strength in the lower extremities that were measured by isokinetic dynamometer found no significant changes of the WBV group (All $P>0.050$) compared to CON group. On the other hand, the muscle strength in the upper extremity through arm curl also showed no significant changes of the WBV group ($P=0.075$). The latter showed a significant increase of 28% in the arm curl for the WBV group compared to CON group with 18% decrease. These assessments need further research if there is improvement in the upper extremities with the use of isokinetic dynamometer rather than arm curl test.

In a short term study, this study was to investigate the effects of three different durations of continuous WBV exposure on isometric right knee extensor strength measured pre and post exposure, showed 2 minutes of WBV produced a significant increased (3.8%, $P < 0.05$) in peak torque compared to 4 and 6 minutes of WBV, which both produced strength decreases (Stewart et al., 2009). Moreover, after 10 weeks of lower limb WBV training produces a significant increase in muscle strength induced by thigh muscle hypertrophy, with no change in muscle power. The adaptations to WBV found in this study may be use in counteracting the loss of muscle strength and mobility associated with age-induced sarcopenia (Machado et al., 2010).

On the other hand for a long term study, the researchers concluded that one year of resistance and aerobic and or WBV training can equally reverse the adverse effects of aging on muscle quality in older men but their residual impact after follow-up was different. In a 1 year follow up of a RCT comparing the effects of 1 year of fitness training in non-institutionalized center (aged 60-80 years, adult men) including combined resistance training and aerobic, WBV training and a control group. This was the first study to evaluate the residual impact of Resistance and aerobic and WBV training. WBV training group decreased the muscle power ($P<.0001$) but remained significant higher than the baseline ($P=.034$). In the WBV training group, both isometric and concentric muscle strength did not change significantly from post intervention to 1-year follow-up ($P=.287$ and $P=.115$) but were no longer different from baseline values at follow-up ($P=.189$ and $P=.762$, respectively) (Kennis et al., 2013). Moreover, Isometric and dynamic knee extensor strength increased significantly ($P< 0.001$) in the WBV group (15.0± 2.1% and 16. 1±3.1 %, respectively) after 24 weeks of training, with the training effects not significantly different between the groups (Roelants, Delecluse, & Verschueren, 2004). Also, 6 months of vibration training at 35-40 Hz, 1.7-2.5 mm amplitude improved isometric and dynamic strength (+15% and +10%, respectively; P<0.01) (Verschueren et al., 2004). In addition, there were gains in isometric and dynamic strength realized between 12 weeks and 24 weeks of training were small and mostly statistically insignificant, 2.7% and 3.7% (P= 0.046), respectively for the WBV group and 1.7 and 1.4%, respectively for the resistance group (RES) . In both WBV and RES, most of the strength gain was realized after 12 weeks of training. These findings suggest that neural adaptations are the most relevant mechanism of strength gain not only in the RES group but also in the WBV group, as hypothesized for the young adults (Roelants, Delecluse, Goris et al., 2004).

To sum up the differences between studies that have significant effects to muscle strength whether short term or long term were the following; only the study of (Kennis et al., 2013) evaluated the residual effects after the vibration was withdrawn compared to other studies which evaluated after the training program which showed immediate effects, young healthy subjects vs. elderly, characteristics of the subjects, varied exercises program in WBV such as loaded vs. unloaded and static vs. dynamic, low frequency vs. high frequency, amplitude, duration, and vibratory machine whether synchronous or asynchronous.

Moreover, a lower strength gain in older adults than in young adults could be expected because older adults might be less sensitive to the vibratory stimulus for instance because of a decreased number of muscle spindles (Roelants, Delecluse, Goris et al., 2004). In contrary, most of the studies with positive effects on muscle performance, the target subjects were mostly elderly or post-menopausal women or physically weak people like Myasthenia gravis and unilateral chronic stroke patients (Cheung et al., 2007). It has been reported that prolonged exposure has detrimental effects on performance (Stewart et al., 2009) and a long term irritation of the muscle spindles by vibration leads to muscle fatigue (Torvinen et al., 2002).

Furthermore, according to (Raimundo et al., 2009) that the lack of effects on strength measured in isokinetic dynamometer with the intensity of 12.6 Hz was probably not high enough to induce any change in the contractile power properties of the leg muscle. Moreover, the researchers cited that vibration causes reciprocal inhibition of the antagonist muscles which explain the lack of effects on strength measured in an isokinetic dynamometer. Regarding their study with post-menopausal women, the WBV group showed a tendency to decrease in all of the isokinetic strength variables measured, neither significant changes nor comparative effects between exercise programs (Raimundo et al., 2009). It is manifested on this current study which showed that there are no significant differences on peak torque and average power with eccentric and concentric action at 60º/s and 180º/s (All $P>0.050$) Moreover, WBV group decreased in most of all muscle strength measures compared to CON group, were remain unchanged. Additionally, a study of 24 nursing home residence, showed significant improvements in leg extension performance ($P<0.05$) however, differences in change between groups were not statistically significant. None of the participants showed difficulties in performing the tests indicating that this variability reflected their heterogeneous condition (Bautmans et al., 2005) and even in this current study as well as (Bruyere et al., 2005).

WBV can be separated into 2 training stimuli: the reflex muscle contraction induced by vibration and the body-weight exercise performed on the platform. Previous research has reported that strength gains following WBV were associated with the reflex muscle contractions it provokes and not the body weight exercises (S. Rees, Murphy, & Watsford, 2007; S. S. Rees et al., 2008). Anticipated that more robust changes in lower body muscle function than upper body changes, due to dissipation of vibration transmission over the length of the body, this was true for muscle strength (Mikhael et al., 2010)

The researchers assumed that as exercise programs are promoted to prevent or at least attenuate age-related loss of muscle mass, muscle strength, and muscle power in the long term, it is important to follow-up the effects of these programs after the discontinuation of the structured intervention (Kennis et al., 2013) which is also the goal of this current study. However, (Kennis et al., 2013) study showed that the interventions had no impact on the general physical activity behavior over time after the study completed because none of the subjects took the opportunity to continue engaging exercises especially in fitness centers where they received information on the availability and prices. These results are in line with previous findings that reversal in muscle hypertrophy can occur while muscle strength gains are preserved. In contrary to the current study, the subjects were continuously involved in exercise program in the rehabilitation center. The study needs further research if how long the muscle strength gains are preserved after the vibration exercise is withdrawn. According to (Kennis et al., 2013) that strength retention after training depends on prior training intensity. It is therefore to assume that there is a need to continue engaging in exercise activities for the elderly in the institutionalized center, nursing rehabilitation center, home-based, community centers etc., in order to neither maintain nor improve the muscle strength after the exercise program.

Physical fitness measures

In the current study showed that there were significant effects of fitness measures of elderly of the WBV group which showed better results than CON group but only 6 minute walk test and back scratch showed statistical changes between the groups.

Endurance Capacity

In the current study showed that there was a statistical significant difference between WBV and CON group ($P<0.05$) in 6 minute walk test. There was a positive increased of 14% for the WBV group while decreased of 38% for the CON group. In a previous study conducted the effect of WBV exercise in addition to muscle strengthening, balance and walking exercises for the walking ability of the elderly for 2 months. The walking speed, step length and the maximum standing time on one leg significantly improved in the WBV exercise plus routine exercises group while no significant changes in the parameters were observed in the routine exercises group (Kawanabe et al., 2007). Also, there was greater improvement in the WBV group + strength and balance exercises compared to exercise group alone (Pollock, Martin, & Newham, 2012). In contrary, the previous study showed improvement of WBV group ($P<0.05$) from baseline but no significant difference compared to CON group

(Avelar et al., 2011). It was still uncertain if the 3 months with 3 times a week of WBV at 12.6 Hz attenuate the walking performance of the elderly. More on detail, 3 of the WBV group did the walking warm-up because they had the difficulty to execute in the spin bike which helps master the walking test, the principle of specificity. Even the previous studies (Kawanabe et al., 2007; Pollock et al., 2012) need further study on optimum dosage-response of WBV for the walking performance because their study program incorporated with other exercises not WBV alone. The authors (Pollock et al., 2012) concluded that the addition of WBV to strength and balance exercise resulted in greater improvements in functional mobility, time up and go and 6 minute walk at $P < 0.05$ than exercise alone, despite achieving lower than exposure. The gains from neither intervention were sustained at six months. This was a study of frail older fallers (80 ± 8.1 years) performed WBV up to 5 x 1 minute, 15-30Hz and 2-8mm peak-to-peak (Galileo, 2000) with 30s rest period each session with exercise program (60 minutes) for 8 weeks.

Flexibility (Upper and Lower)

Chair sit and reach improved significantly in the WBV group but no significant difference in change between the groups (Bautmans et al., 2005). In this current study, both have improvement in lower flexibility even they didn’t have any significant changes ($P>0.05$) The result showed a better improvement of the WBV group because they performed cool down exercise through stretching which also helps attenuate the result, also applies to the principle of specificity. It is uncertain and need further research if WBV attenuate in lower flexibility for elderly. It is assumed that vibration can improve flexibility by central mechanisms such as increase in stretch tolerance (higher pain threshold) and the stimulation of Golgi tendon orgrans (contraction inhibition) (Bautmans et al., 2005; Issurin, Liebermann, & Tenenbaum, 1994) Since the participants in the study firmly held the front handle of the vibration device, the vibration stimulus was also partly transmitted through upper limbs. However no significant changes in upper limb flexibility were observed (Bautmans et al., 2005).

On the other hand, there was a statistical significant difference of WBV and CON group in the back scratch (P<0.05). The CON has better improvement changes than the WBV group (26% and 8%, respectively). This confirms that women have better flexibility than men. CON group composed with older women while WBV group have 2 older men which cloud the result of the whole group. According to (Hui & Yuen, 2000) that women tend to be significantly more flexible than men and also reported by (R. E. Rikli & Jones, 1999a), showed women were more flexible on both the chair sit and reach and back scratch tests across all age groups. Moreover, sex emerged as a significant, independent correlate of the flexibility factor, with women being more flexible than men (Roach & Miles, 1991).

Upper body strength

In the current study there was a greater improvement of arm curl for WBV group compared to CON group (28% increase and 18% decrease of repetitions, respectively). There was no significant change between the groups. According to (Bautmans et al., 2005) that there was partly transmission to upper limbs. It is still uncertain if there is a positive effect of WBV to upper body strength given that in this study had a semi-flexed position but they hold firm in the front handle. This needs further study.

Agility/ Dynamic Balance

In this study showed a better performance improvement of the WBV compared to CON group (16% decrease and 38% increase in time, respectively). There was no statistical significant change between groups. According to review that the greatest improvements for timed up and go were reported in the elderly with 10-26 Hz and 30-40Hz, 30-60 s vibrations, and 90 and 30-60 s rest between sets, respectively (Madou & Cronin, 2008).

In previous studies, timed-up and go test increased significantly after training (9.0%) (Machado et al., 2010) while decreased by 11.0± 8.6 seconds in the WBV group compared with an increase of 2.6 ± 8.8 seconds in the control group (P <0.001) (Bruyere et al., 2005). Also, significantly improved from baseline at four and eight weeks for both groups (WBV + exercise, P=0.002 and

Exercise group, P=0.007) while no differences from baseline for either group after 6 months of follow-up and were similar to baseline (Pollock et al., 2012). Berg balance scale improved significantly after 8 weeks but returned to baseline values after 6 months follow-up for both groups (Pollock et al., 2012). The timed up and go consists of a number of components including standing, walking, turning and sitting. It is unknown in which component improvement occurred, but some was probably due to the increased walking speed demonstrated by faster 6 minute walk times (Pollock et al., 2012) which is also manifested in this current study that the WBV group had a better performance on walking performance than the CON group. Furthermore, study of (S. Rees et al., 2007) after training consisted of 3 sessions per week for 2 months, showed improved sit to stand (12.4%), 5 minute fast walk (3%) and knee extension strength (8.1%) compared with the control ($p<0.05$). In other investigation, Time up and go decreased significantly in the WBV group (-13.6% , $p< 0.001$) and in the CON group (-5.21%, $p <0.001$). The improvement was larger for WBV group (P=0.002) (A. Bogaerts et al.). On the other hand, study showed that calcium and vitamin D supplementations improves preferred walking speed and preferred time up and go speed in elderly institutionalized women (A. Bogaerts et al.). Therefore, the researcher assumes that may or may not the medication helps improve in the performance. This needs further investigation for future studies. In this current study, there was no data gathered on the medications taken by subjects because they forgot the names of the medications and the researcher have no access to clients' data base in the rehabilitation center. In a short term single bout of whole body vibration transiently body balance in young healthy adults which showed improvement (P=0.049). The effects were observed 2 minutes after the vibration but had disappeared more or less completely 1 hour later (Torvinen et al., 2002). The researcher assumes that there was improvement in the current study because some subjects continuously attend the exercise program provided in the rehabilitation center which attenuates the declining performance of elderly as they aged. Also found on a 24 nursing residents (77.5 ± 11.0 years) underwent 6 weeks static WBV exercise induced changes in timed up and go (P=0.029) compared to control group. The WBV group improved significantly (P=0.008) (Bautmans et al., 2005). However, during the study period, all participants continued to attend to weekly seated gymnastic sessions together with other residents of the nursing home. It might be possible that the decrease of balance scores in the controls reflects the frail and physically unstable status of nursing home residents (Bautmans et al., 2005). On the other hand, WBV group had a significantly better baseline value on the chair rising test (P <0.050) and probable reason that this group had more difficulty to improve chair rising compared to the walking group (Raimundo et al., 2009). In contrary to this current study, showed that the WBV group had better baseline than CON group but also showed better improvement after the follow-up, although, there is no statistical significance between the groups (P>0.05).

5. Limitation of the study

The study is non-randomized and the subjects were purposely assigned to WBV and CON group. The researcher and the physical therapist selected the subjects based on previous clients' engagement in rehabilitation center. There was a pre-selection based on their profile before the subjects were informed and invited. The small size of the study cannot generalize the elderly population. The WBV subjects were healthy individuals and passed the inclusion and exclusion criterion than the CON group resulted to neither osteopenia nor osteoporosis risk status. The study did not evaluate the subjects after 3 months training but followed up after 3 months that vibration training was withdrawn. There was no data if there is significant changes after 3 months training neither maintain or decline after 3 months follow-up when the vibration training was withdrawn. There were some continuously involved to other exercises program after the 3 months training which the researcher didn't have the data on the mode, frequency, duration and intensity of the exercises that may attenuate the effect of this study. The subjects were post evaluated after a week of getting recovered from sickness. The assumptions of the researcher that the subjects were free from sickness but don't mean that they were physically conditioned to perform the post-evaluation, which may or may not alter the results of this study. The researcher assumes that the language barrier also took part that the retention of the WBV group is too low. Moreover, the subjects were very old and prone to sickness which they had to escape sessions or discontinue the intervention program for lack of interest or personal reasons. Demographic data was not obtained. Calcium, vitamin d, biphosphonates and other medications were not included in this study that may or may not alter the result. Others, physical activity participation of the subjects may also affect the results and some subjects after the intervention program did not continue to exercise.

6. Conclusion

The study has the objective to compare the effects of Low frequency WBV exercise training program and CON group of elderly clients in the nursing rehabilitation center after the vibration was withdrawn for 3 months about the body composition, muscle strength and physical fitness with the following major results;

- Total fat % diminished more in the WBV group compared to CON group but not significant.
- BMD ward triangle significantly decline in WBV group compared to CON group, statistically significant ($P<0.05$).
- Peak torque and average power of WBV group had greater decline compared to CON group, statistically not significant.
- Aerobic endurance has greater improvement in WBV group compared to CON group, statistically significant ($P<0.05$).
- Balance and Agility has positively decline of time for WBV group compared to CON group, statistically not significant.
- Upper flexibility has greater improvement in CON group compared to WBV group, statistically significant ($P<0.05$). Mainly, because CON

group composed of old women, based on literature that woman has better flexibility than men.

Based on the findings of this study, the researcher draws conclusion for the following:

1. Generally, concludes that there is no significant difference of WBV exercise and CON group on Body composition. But, there is a statistical difference on BMD wards triangle, WBV group diminished while CON group improved.

2. Generally, concludes that there is no significant difference between WBV and CON group in muscle strength. But, the WBV group had a tendency to decline in peak torque and average power compared to CON group.

3. There is a significant difference on 6 minute walk test and back scratch between the groups. WBV group showed greater improvements in the physical fitness parameters compared to CON group, except on back scratch and sit and reach (Upper and lower flexibility, respectively) which showed a greater improvement for the CON group.

7. Recommendation

The researcher recommends that the future study should perform the post-evaluation after 72 hours of training intervention and will be followed-up according to the duration of the training period. In this study, the researcher did not evaluate the subjects immediately after the vibration training was withdrawn which is lack of comparison of the effect of the training program. However, further research on follow-up if how long does the training effect will retain after the WBV is withdrawn. Also, the researcher recommends a long term study of a minimum of 6 months to obtain a positive change in bone mineral density, muscle strength and physical fitness function test.

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9. Annex

AVALIAÇÂO DE QUALIDADE DE VIDA- EQ-5D

Assinale com uma cruz (assim x, um quadrado de cada um dos seguintes grupos, indicando qual das afirmações descreve melhor o seu estado de saúde hoje.

Mobilidade

Não tenho problemas em andar--□
Tenho alguns problemas em andar--□
Tenho de estar na cama--□

Cuidados Pessoais

Não tenho problemas em cuidar de mim---□
Tenho alguns problemas a lavar-me ou vestir-me---□
Sou incapaz de me lavar ou vestir sozinho/a---□

Actividades Habituais (ex. Trabalho, estudos, actividades domésticas, actividades em familia ou de lazer)

Não tenho problemas em desempenhar as minhas actividades habituais----------------------------□
Tenho alguns problemas em desempenhar as minhas actividades habituais-------------------------□
Sou incapaz de desempenhar as minhas actividades habituais---□

Dor / Mal Estar

Não tenho dores ou mal estar---□
Tenho dores ou mal estar moderados---□
Tenho dores ou mal estar extremos---□

Ansiedade / Depressão

Não estou ansioso/a ou deprimido/a---□
Estou moderadamente ansioso/a ou deprimido/a---□
Estou extremamente ansioso/a ou deprimido/a--□

Comparado com o meu nivel geral de saúde durante os últimos 12 meses, o meu estado de saúde hoje é:

Melhor--□
O mesmo---□
Pior--□