CHAPTER II
LITERATURE REVIEWS

This chapter details literature review of the study. It is divided into following topics: definition and statistic of older adults, changes of age-related to functional decline in older adults, balance control, falls, quality of life, and physical activity and exercise in older adults. Details of each topic are as follows;

1. Definition and statistic of older adults

Older adult is a person who ages 60 years and older both male and female (Institute for Population and Social Research, Mahidol University, 2007). Isaacs (1993) subdivides older adults into 3 age groups which are early (65-74 years), middle (75-84 years) and late older adults (85 years and older). In Thailand, older adults are subdivided into 3 age groups which are early (60-79 years), middle (80-99 years) and late older adults (100 years and older) (Mahidol Population Gazette, 2009).

The development of medical technology and treatment improves health status and increases life expectancy of people (Brach et al., 2004). This results in the rapid changes of population structure in many countries, including Thailand. It is estimated that the increment rate of older adults of the country would be 18 percent, whereas the growth rate would be decreased 2.67 percent in 2020 (Jitapunkul, 1993; Wibulpolprasert, 2007). Moreover, the National Economics and Social Development Board has estimated the increment rate of Thai population from the year 1990 to 2020. There was 6.6 million older adults in 2005, and this number would be increased to 9.1 million in 2015 (Ministry of Public Health Thailand, 2006). Increasing age leads to the decline of functional performance and the decrease of ability to conduct daily activities independently due to body system deterioration (Mazzeo et al., 1998).

2. Changes of age-related to functional decline in older adults

Many studies reported the changes of age-related functional decline in the older adults. These changes are a complex process involving many systems which often include the decrease of physical and psychological functions, particularly in musculoskeletal, perceptual and cardiovascular systems (Howley & Franks, 2003; Hawk et al., 2006).

Several studies reported the functional decline of the musculoskeletal system in older adults. This change likely relates to the decrease of muscle mass, muscle strength, bone density and range of motion (Imamura et al., 1983; Tzankoff & Norris, 1978). With advancing age, muscle mass dramatically diminishes especially in the lower extremities (Medina, 1996). Lexell et al. (1988) investigated the number of fibers in autopsied vastus lateralis muscle and reported an average 40 percents loss of muscle area. Furthermore, there are evidences of age-related decline in muscle strength. Jette and Branch (1981) reported that the quadriceps strength of women aged 55-64 years decreased 40 percents, aged 65-74 years reduced 45 percents and aged 75-84 years declined 65 percents. Similarly, Skelton et al. (1994) investigated leg strength of 100 individuals aged 65 years and over, and reported that leg strength decreased 1-2 percents per year. An advancing age also results in the loss of bone density of at several bone sites in both women and men due to loss of calcium accumulation (Riggs et al., 1982; Rehman et al., 1994; Krall et al., 1997). In addition, Szulc et al. (2000) reported a progressive decrease of bone density from 14 to 43 percents after 65 years of age. Aging also affects range of motion of several joints of the body, especially spinal flexibility (Studenski et al., 1991). This problem leads to the change of postural alignment such as a shift of center of body mass backward to the heel which may induce impairment of balance control in older adults (Spirduso et al., 2005). These changes of musculoskeletal functions correlate to advancing age, and cause older adults unable to perform some aspects of normal activities of daily living (ADL) (Mazzeo et al., 1998).

Older adults also show changes of perceptual function that affects ability to control balance and conduct ADL (Sturniek et al., 2008). Balance control is an integration of perceptual afferent information (somatosensory, visual and vestibular), postural control center, and effectors. Somatosensory information consists of

information from receptors in muscles, tendons and joints as so-called "proprioception" (Sturniek et al., 2008). Many evidences support an age-related decline in these functions. Skinner et al. (1984) and Macaluso & De Vito, 2004 demonstrated that position sense of knee and metatarsophalangeal joints decrease with advanced age. Similarly, previous study found that older adults aged 50 to 85 years had low ability to detect directional change of hip, knee and ankle movements (Hepple et al., 2006). In addition, there is a reduction of tactile and vibration information that affects balance performance of older adults (Verrillo et al., 2002; Perry, 2006; Menz et al., 2005). Likewise, visual function becomes dramatically worse after the age of 50 years (Gitting and Fozard, 1986). This change correlates with impairment of other visual processes such as visual acuity, dark adaptation and depth perception (Jack et al., 1995; Lord et al., 1992 and Nevitt et al., 1989). However, movement of visual field correlates with movement of body such as body shifts to left while visual field shifts to right. This information would be interpreted at the brain and perform an effective movement (Sturnieks et al., 2008). Thus, an accurate and clear vision is very important for interpretation in order to perform an appropriate movement.

In addition to the vestibular function, Shumway-Cook and Woollacott (2006) reported the impairment of vestibular function of older adults because of the loss of 40 vestibular hairs and nerve cells, especially after aged 70 years. This finding indicates that the afferent information may be difficult to interpretation. Therefore, the vestibular system is one of important systems that influence balance control.

According to cardiovascular (CV) function, older adults have lower maximal cardiac output than younger adults that leads to lower maximal oxygen consumption which is the index of maximal cardiovascular function (Mazzeo, 1998). Previous studies reported the variables that may affect the cardiovascular function including heart rate, stroke volumes and left ventricular contractility. The impairment of these variables decreases physical endurance and ability to perform functions and may affect balance performance (Fleg et al., 1995; Ogawa et al., 1992; Stratton et al., 1994).

Furthermore, psychological function is directly related to aging. The most frequently reported of mental health disorders in older adults are cognitive function,

depression and perceptions of control. Impairment of cognitive function occurs owing to the decline of the central nervous system function. Impairment of psychological function induces risk of fall because of inattention during mobility (Bandura, 1997). In addition, depression is another important problem that leads to high rate of mortality and suicide in older adults (Koenig et al., 1992).

Functional decline of these systems in older adults result in an alteration of balance control and affects ability to conduct daily activities independently. This alteration can be clearly seen in older adults who are over 65 years of age (Rose & Gamble, 2006).

3. Balance control

Performance of activities of daily life requires good balance control (Covinsky et al., 2001). It involves ability to control the body center of mass (CoM) or center of gravity (CoG) in relationship to the base of support by using information from the somatosensory, visual and vestibular systems (Shumway-Cook and Woollacott, 2006). Afferent information from these systems is important for the higher center to modify bodily movements in according to the task and environmental demands (Langley and Mckintosh, 2007). Abnormal functions of the central nervous system (CNS) and effectors are likely to affect balance control (Covinsky et al., 2001). Furthermore, the causes of balance impairment may occur from alterations of sensory and motor systems. Moreover, the changes of another system with advancing age such as visual, vestibular and somatosensory systems also affect or diminish appropriate feedback to the postural control centers and result in less capacity of the efferent organs to respond during a dynamic activity (Mazzeo et al., 1998). Thus, impairment of balance control has significantly related to fall, especially older adults (Lord et al., 1994).

There are several methods to measure balance performance in older adults. Some methods require complex/costly machine such as sensory organization test (SOT) in order to precisely interpret results of the test. There are also alternative methods that can use to assess balance performance in any communities as so-called functional balance tests.

3.1 The functional balance assessment

The functional balance assessments which commonly use in older adults are as follows;

1) Tandem standing

Tandem standing (Figure 1) is a static standing balance test which requires the subjects to place one foot directly in front of the other, touching heel to toe and hold, repeat with other foot in front. Subjects can use a sturdy chair for support as needed. The time to complete the task is recorded (Ekdahl et al., 1989).

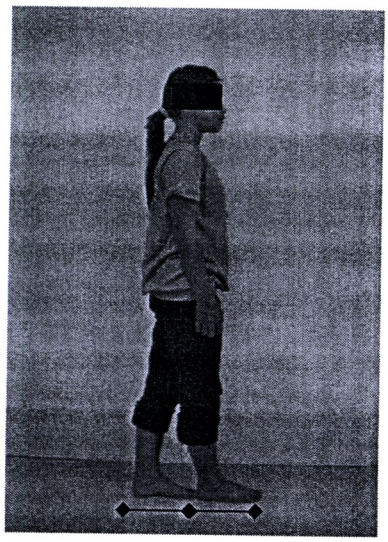

Figure 1 Functional balance test: Tandem standing

2) Romberg Test (RT)

Subjects are asked to stand erect with feet together and eyes closed for 60 seconds. This test indicates the loss of position sense which a positive sign is noted when the subjects sway or fall while eyes closed. Although, this test is a simple, reliability to identify balance capability depends on experience of the investigator (Skelton and McLaughlin, 1996). Thus, another test is developed for more appropriately such as one leg stand test (OLST) (Johansson & Jarnlo, 1991).

3) One Leg Stand Test (OLST)

The OLST (Figure 2) is used to measure static balance by lifting one foot and standing on the other leg as long as possible with eyes open or eyes

close. The time to complete the OLST shorter than 30 seconds consider to potentially useful in predicting functional decline (Hiroyuki et al., 2003). However, this test cannot be used to measure the balance capability in older adults with hip operation (Stones & Kozma, 1987).

Figure 2 Functional balance test: One leg stand test (OLST)

4) Tandem Gait Test

This test measures the postural control system by reducing the body base of support (Speers et al., 1998). Tandem gait is defined as walking with the toes of the back foot touch the heel of the front foot at each step. The balance capability is determined by speed of walking and number of steps. This test is simple and low cost but may not be appropriate in obese subjects (Topp et al., 1993).

5) Berg Balance Scale (BBS)

The BBS is a commonly used measure of balance control and stability using 14 sitting and standing activities. The test includes static positions such as standing and sitting without support, transition phase such as sitting to standing and picking up the object from the floor. Moreover, the test also includes more difficult tasks such as tandem gait and one leg standing that reduces body base of support (Langley and Mackintosh, 2007). Results of the test relate to leg strength, endurance and balance ability (Lusardi et al., 2003). Therefore, this test can be represented to balance ability of daily activities. It takes approximately 15 minutes to complete.

Each activity is scored on a scale of 0 to 4. Thus, a total possible score is 56 with a score of 45 or less indicated a greater risk for falls (Kulsatitporn, 2006). However, the change of the BBS ±6 points has clinical relevance (Stevenson, 2001).

6) Functional Reach Test (FRT)

The FRT (Figure 3) is a dynamic balance test that measures the longest distance a person capable to reach forward while standing. The equipment required for the FRT is a yardstick fixed to the wall at the shoulder height (Langley and Mackintosh, 2007). During the measurement, a person has to maintain a fixed base of support in the standing position (Duncan et al, 1990). The distances to complete the task less than 25 centimeters indicate an abnormal of balance control and induce risk of fall. Although functional reach test can assess the balance capability in both younger and older adults, the assessment may be difficult in subjects who have the abnormal of spine or arm movement (Weiner et al., 1992).

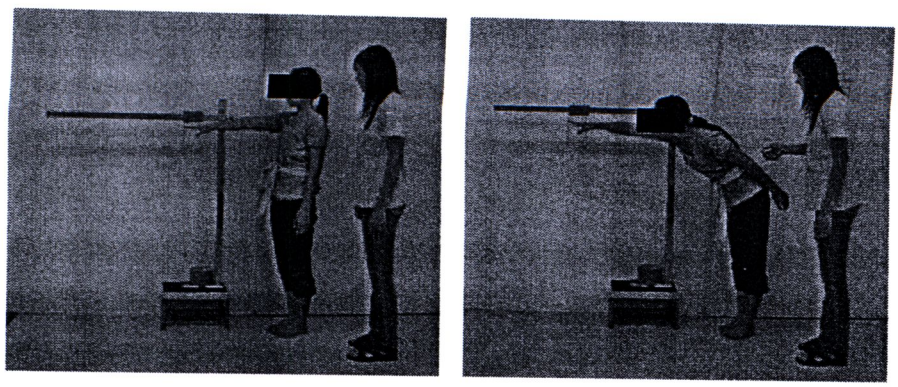

Figure 3 Functional balance test: Functional Reach Test (FRT)

7) Timed Sit to Stand (TSS)

The TSS is used to measure balance capability and functional lower extremity strength which has two methods including measuring time to complete 5 rapid chair rise cycle and counting number of sit to stand in a fixed time period (Bohannon and Leary, 1995). However, subjects reported muscle fatigue and subsequent soreness to complete counting number of sit to stand in a fixed time period (Lusardi et al., 1997). Nevertheless, the older adults who require the time of sit to

stand longer than 15 seconds can predict recurrent fall, especially aged 65 and older (Buatois et al., 2008).

8) Get Up and Go Test (GUGT)

The GUGT is a simple measure of balance control which requires subjects to rise from a chair, walk at a comfortable pace for 3 meters, turn 180-degree, walk back and sit down. Balance function is scored on a five-point scale. The scores of 1 point indicate normal balance control and 5 points indicate dramatically abnormal balance control. The GUGT is just predicting abnormal gait and balance; however, it is not sufficient to precisely assess the changing of ability of balance control (Ballard et al., 2004).

9) Timed Up and Go Test (TUGT)

The TUGT (Figure 4) is also referred to as the GUGT which is a timed functional test (Ballard et al., 2004). It is a sensitive and specific measure for identifying older adults who are at risk of fall and abnormal balance control (Shumway-Cook et al., 2000). The TUGT takes approximately 1-2 minutes to complete the task (Langley and Mackintosh, 2007). The TUGT times of more than 16 seconds indicate risk of falling in community-dwelling older adults (Lusardi et al., 2003). However, Shumway-Cook et al. (2000) reported that older adults who required time to complete the TUGT less than 20 seconds indicated independence in activities of daily life, whereas older adults who required 30 seconds or longer showed dependent in daily activities and depended on assistive devices. However, Bischoff et al. (2003) reported that community-dwelling older adults, aged between 65 and 85 years completed the TUGT longer than 12 seconds, indicate the necessity of an in-depth mobility assessment and early intervention, such as prescription of a walking aid, home visit or physiotherapy. The significant clinically difference of the time to complete the TUGT is longer than 0.09 seconds (van Iersel et al., 2008).

Figure 4 Functional balance test: Timed Up and Go Test (TUGT)

4. Falls in older adults

Fall is one of major health problems in older adults and its impact has many negative effects on physical and psychological function such as restricting mobility or active lifestyle (Hawk et al., 2006; Hendriks et al., 2008). Falls have been defined differently. Hornbrook et al. (1994) defined a fall as an event which leads a person to loss of balance, and results in parts of the body touching the ground. Tinetti et al. (1998) proposed the definition of a fall as an event which results in a person coming to rest unintentionally on the ground, not as a result of a major intrinsic event. Furthermore, a fall is defined as an event that people found themselves unintentionally on the ground such that their part of the body touch or hit the ground, not as the result of an overwhelming hazard (Maki et al.,1994).

Perracini & Ramos (2002) reported that 30% of older adults in Brazil and the United State suffer from fall. Moreover, Li et al. (2003) reported that 60% of healthy older adults experienced fall during the past 3 months. Approximately 35% to 40% older adults at age 65 and over fall annually (Campbell et al., 1990). Older adults, who have a prior fall history, are likely to demonstrate the loss of self-confidence due to fear of future fall (Scheffer et al., 2008). Furthermore, fall results in a functional decline owing to mild or severe injuries such as head trauma, soft tissue injuries, joint dislocation and fracture, especially hip fracture (Convinsky et al., 2001; Brotherton et al., 2007). Evidences suggested that an incidence of hip fracture increased with age

(Coming et al., 1997; Lofthus et al., 2001). Older adults who sustain a hip fracture reduce ability to perform activities of daily life independently and require the assistive devices (Osnes et al., 2004). Many studies reported that significant risk factors of falls include age, history of fall and physical illness (Fuller, 2000; van der Wiel et al., 2003).

4.1 Risk factors of fall

Several studies have classified risk factors of fall into two factors including intrinsic and extrinsic factors.

4.1.1 Intrinsic factor

The intrinsic risk factors of fall include age-related physiological changes such as visual deficits, pathologic diseases, lower extremity weakness, poor grip strength, balance disorder, and functional and cognitive impairment (Leipzig et al., 1999; Jitapunkul et al., 1998). Other intrinsic factors include drug toxicity or inappropriate medication. The association of fall and medication which found a significantly increase risk from psychotropic medication (Leipzing et al., 1999). However, male has a higher prevalence of other impairments than female such as poor vision, chronic medical conditions and abnormal gait. Thus, male often takes more risk of fall than female older adults (Lofthus et al., 2001)

4.1.2 Extrinsic factor

The extrinsic risk factors that associated with fall are environment hazard, such as styles of house, poor lighting and inappropriate footwear. Therefore, the facilitation of home environment should be considered for reducing fall (Jitapunkul et al., 1998). Moreover, knowledge for oneself care is very important to prevent falling (Ray et al., 1997).

5. Quality of life in older adults

Quality of life is a term without exact definition. However, Harris Rackham (1926) noted that quality of life was the term of well-being, whereas Fayers & Machin (2006) translated this term as happiness. Furthermore, a number of literature reported that quality of life depended on the individuals' perception of their position in life, ability to work, health condition, life satisfaction or happiness (Snaith, 2003; WHOQOL group, 1994).

5.1 Instrument of quality of life

Measurement of quality of life is become necessary for the clinical studies. Furthermore, the consideration of therapeutic treatment may be decided by quality of life and it can be represented psychological problem (Fayers & Machin, 2006). The instruments for assess quality of life are as follows;

1) Sickness impact profile (SIP) is one of the quality of life instruments which used to evaluate both physical and psychosocial dimensions (van Straten et al., 1997). This questionnaire consists 136 items and can be grouped into 12 categories including sleep and rest, emotional behavior, body care and movement, household management, mobility, social interaction, ambulation, alertness behavior, communication, work, recreation and eating (Lindeboom et al., 2003).

2) Short-form 36 item (SF-36) is a short-form health survey with 36 questions including 1 transition question that asks to rate the amount of general health change during the past year. Thirty-five questions on quality of life are divided into 8 scales. These scales are physical functions, role-physical, bodily pain, general health, vitality, social functioning, role-emotional and mental health. However, the 8 scales included 2 categories are the physical and mental component summary (Jordan-Marsh, 2002).

3) Nottingham health profile (NHP) contains 38 items which is organized into 6 sections including pain, sleep, emotional reactions, social relationship, energy level and physical mobility (Fayers & Machin, 2006).

4) WHOQOL-100 is a 100-item quality of life questionnaire that takes a long time to complete (Fayers & Machin, 2006). Therefore, WHOQOL-BREF is developed as a short form with 26 questions and divided into 4 domains including physical, psychological, social relationship and environment domains. Each item is scored on a scale of 1 to 5. Thus, a total possible score is 26 to 130 with a score of 26-60 indicated poor QOL, 61-95 indicated moderate QOL and 96-130 indicated good QOL (Mahatnirunkul, 2002). Furthermore, this questionnaire can be assessed to evaluate over all aspects of QOL including physical, psychological, social relationship and environment.

These instruments describe above general quality of life. However, many clinical trials are required to evaluate for dept information, hence, the instruments for specific aspects of quality of life are mentioned such as Hospital Anxiety and Depression Scale (HADS), McGill Pain Questionnaire (MPQ) and Bathel Index of Disability (BI), etc. (Fayers & Machin, 2006).

6. Physical activity and exercise, and physical activity and exercise for older adults

Many studies reported that physical activity and exercise confer health benefits, improve physical function and mental status of individuals (Brach et al., 2004; Choi et al., 2005). However, the terms 'physical activity' and 'exercise' have different meanings. Physical activity is defined as bodily movements produced by the contraction of skeletal muscles that result in increased energy expenditure, whereas exercise is defined as a planned, structured and repetitive bodily movement aiming to improve and maintain one or more component of physical fitness (Mazzeo et al., 1998). Hence, exercise is one type of physical activity (Brach et al., 2004). Mazzeo et al. (1998) recommended an appropriate exercise and physical activity for older adults which should be progressive resistance training of major muscle groups of the upper and lower extremities, and trunk at least 2-3 days/week, with 2-3 sets of each exercise. Furthermore, aerobic training is suggested because of aerobic conditioning such as walking results in muscle strength, joint stability and balance improvement. Walking for aerobic training should be performed at least 20 minutes, 3 days/week , with appropriate intensity (40 to 60 percents of heart rate reserve, or 11 to 13 on the Borg scale) (Mazzeo et al, 1998).

Most of previous studies reported effects of exercise on balance ability compared to sedentary lifestyle groups. Charuchit et al. (2008) compared a balance performance between regularly and irregularly exercise elderly. The researchers concluded that the balance performance of regularly exercise elderly were significantly better than the irregularly exercise elderly. Similarly, Hawk et al. (2006) reported that balance performance in older adults was significantly improved after 4-week exercise. Ballard et al. (2004) reported that 15-week exercise increased balance and leg strength without the differences of fall history between the control and

exercise groups. In addition, Shumway-Cook et al. (1997) investigated effects of a multidimensional exercise program on balance, mobility, and risk for falls in community-dwelling older adults who fully and partially adhere to exercise. The results showed that both exercise groups scored better than the control group on all measures of balance and mobility, with the greatest reduction was found in the fully adherent exercise group. Furthermore, Brown (1999) reported that balance training and treatment or rehabilitation of an abnormal balance control is also necessary for the older adults because of prevention of fall is critical to health condition of older adults, especially older adults who have underlying diseases or gait dysfunction. These problems may lead to restrict of mobility and may result in fall.

Both physical activity and exercise are accounted as behavioral interventions that improve mental status by decreasing symptoms of depression, promoting relaxation and health status (Craft et al., 2004). However, there is only a few studies that compares effects of lifestyle active and regular exercise. Brach et al. (2004) reported that more than 60% of older adults do not participate in regular exercise. Thus, it is doubtful whether older adults who have lifestyle active have similar functional capacity as exercise individuals. Brach et al. (2004) compared physical function of older adults who were inactive, lifestyle active and regularly exercise. The study found that older adults who participate in regular exercise activities appeared to derive additional benefits for physical functional capacity that were not conferred by physical activity.