	Male			Female		
Risk Factor	OR	95%CI	P	OR	95%CI	P
Age (yr)	1.02	0.95-1.10	NS	1.02	0.99-1.06	NS
Normal walking speed (0.1 m/s)	0.87	0.77-0.97	0.015	0.92	0.88-0.97	0.001
Albumin (g/dl)	1.69	0.45-6.33	NS	1.60	0.88-2.90	NS
25(OH)D (mg/ml)	1	0.95-1.06	NS	0.97	0.94-0.99	0.010

Dependent variable was "fall experience over the previous year" (yes=1; no=0).
NS= not significant

Table 2. Multiple logistic regression model of factors associated with fall experience. (Suzuki, T.; Kwon, J.; Kim, H.; Shimada, H.; Yoshida, Y.; Iwasa, H. & Yoshida, H. (2008). Low serum 25-hydroxyvitamin D levels associated with falls among Japanese community-dwelling elderly. *Journal of Bone and Mineral Research*, Vol.23, No.8, pp. 1309-1317, by permission of the American Society for Bone and Mineral Research.)

2.3 Urinary incontinence

There is general agreement on the multifactorial nature of incontinence. Permanent incontinence also is typically the result of neurological damage or, intrinsic bladder or urethral pathology. However, incontinence is associated with several potentially reversible conditions. Lower urinary tract function, environmental factors, physical and cognitive function, psychological distress, mobility, manual dexterity, medical conditions, and medications may all have an effect on urinary incontinence status in the elderly (Landi et al., 2003). The incidence of urinary incontinence is typically higher in women than men, and those who experience incontinence are usually older with lower functional fitness levels for both sexes. Although there is a large amount of information regarding the mechanisms and treatment options for urinary incontinence, little is known about the potentially reversible causes of this condition in community-dwelling elderly people. Several of the known causes that may be reversible include urinary tract infections, as they can cause the urge to void quite frequently, physical restraints and drastic limitations in mobility, and environmental hazards.

Lifestyle and functional fitness are significantly associated with the onset of urinary incontinence in community-dwelling elderly people (Kim et al., 2004) (Table 3).

3. Treatment for geriatric syndrome

Declines in functional fitness such as walking speed, muscle strength and balance ability in the elderly are strongly associated with the development of geriatric syndromes. Hence, exercise focusing on strength, balance, and mobility improvement, even into advanced age, is usually offered as a strategy for the reduction of frailty, falls, and urinary incontinence in the elderly.

Sex	Variable		OR	95%CI
Male	Age (per 1 yr)		1.23	1.11-1.38
	Plasma albumin (per 0.1 g/dl)		0.70	0.54-0.88
	Smoking status	non-smoker	1.00	
		previous smoker	1.53	0.56-4.59
		current smoker	2.33	0.82-7.61
Female	Grip strength (per 1 kg)		0.92	0.86-0.98
	Social role (per 1 point)		1.81	1.19-2.73
	BMI (per 1 kg/m^2)		1.10	1.01-1.20
	Smoking status	non-smoker	1.00	
		current smoker	7.53	1.36-41.63

Table 3. Multiple logistic regression model of risk factors associated with the onset of urinary incontinence

3.1 Frailty

Aging is characterized by a gradual decrease in muscle mass and muscle strength, which contributes to declines in physical function, increased disability, frailty, and loss of independence. Out of many factors associated with the development of frailty, muscle disuse and nutritional deficiencies are the factors that are potentially reversible or preventable through interventions and a more active lifestyle (Fiatarone et al., 1994).

3.1.1 Nutritional supplementation

Declines in muscle mass are related to declines in muscle protein synthesis rates in older adults. In order to resist and reverse the effects of muscle protein synthesis declines, protein or more specifically, amino-acids, have been the focus of research. Investigators have found that leucine enriched essential amino-acid mixtures are primarily responsible for amino-acid-induced muscle protein anabolism in the elderly. Amino-acid supplementation can increase muscle mass in this population; however, an increase in muscle mass is not always accompanied by an increase in muscle strength (Dillon et al., 2009). Essential amino-acid supplementation alone is probably insufficient in increasing muscle strength. Carbohydrate-rich supplements have also been examined for any effects on muscle strength and muscle mass. However, supplements rich in carbohydrates are inadequate for the purpose of increasing muscle mass and strength (Fiatarone et al., 1994). Vitamin D supplementation, which will be discussed further (see section 3.2.1) has also been shown to increase strength.

3.1.2 Exercise

Exercise in elderly individuals may potentially modify risk factors for age-associated reductions in muscle mass (Liu & Latham, 2009). Research has shown that high intensity resistance training is effective in counteracting muscle weakness and physical frailty in elderly people. More specifically, exercise interventions focused on the major muscle groups that are crucial for performing functional activities, are especially important for the reversal of muscle weakness.

Extensive research has confirmed that doing resistance training two to three times a week can improve physical function and functional limitations, and also reduce disability and muscle weakness in older people. Resistance training in elderly people produces increases in strength from 9 to 15% (Borst, 2004), and about 1.1 kg in lean body mass (Peterson et al., 2011). While more improvements are seen with high intensity and volume resistance training, moderate intensity exercises are also beneficial, and are much safer for aging adults. Exercise prescriptions must be of a safe intensity, duration and frequency to avoid further injury and complications (Taaffe, 2006) (Table 4).

Combinations of both exercise and nutritional supplementation have also been studied by researchers. Amino-acid supplementations alone have beneficial effects such as increasing walking speed, and exercise itself also has beneficial effects of improving physical function. Exercise and amino-acid supplementation together have significant effects in enhancing muscle mass, strength and functional fitness. The combination of high resistance exercise and a high carbohydrate mixture containing small amounts of soy protein is effective in the enhancement of muscle strength. High resistance exercise alone increases both muscle mass and strength, while the carbohydrate supplementation alone does not (Fiatarone et al., 1994). Further research is still needed to investigate which supplementations coupled with exercise, or alone, are most effective.

Resistance training program recommendations	
Exercises	8-10 that target the major muscle groups
Repetitions	8-12 per set. When able to achieve 12 repetitions, increase resistance so that 8 repetitions are possible
Sets	Minimum of 1, preferable 2-3 per exercise with 1-2 minutes rest between sets
Frequency	1-3 days per week with at least 48 hours between sessions
Velocity	2-3 seconds concentric and 2-3 seconds eccentric. Some sets of rapid concentric movements can also be included
Breathing	Normal breathing on each repetition (no breath holding)
Duration	Less than 1 hour

Table 4. Resistance training program recommendations. (Taaffe, DR. (2006). Sarcopenia—exercise as a treatment strategy. *Australian Family Physician*, Vol.35, No.3, pp. 130-134. ©2011 *Australian Family Physician*. Reproduced with permission from The Royal Australian College of General Practitioners. Text and images copyright of *Australian Family Physician*. Permission to reproduce must be sought from the publisher, The Royal Australian College of General Practitioners).

3.2 Falls

The development of effective preventative strategies to reduce the fall rate in community-dwelling elderly people who are at risk of falling require a better understanding of the modifiable risk factors for falling. Among the numerous risk factors for falling, those that are considered modifiable include muscle weakness, impairments in balance and gait, and the use of multiple prescription medications. These risk factors can be modifiable through behavioral strategies such as muscle strengthening exercises, balance and gait training, and education about nonpharmacologic treatments to reduce the number of prescription medications used (Tinetti et al., 1994). Furthermore, the occurrence of falling rises with increasing number of risk factors present; therefore, strategies targeted to reduce these modifiable risk factors may be effective in the prevention of falls.

3.2.1 Vitamin D supplementation

In several trials of older individuals at risk for vitamin D deficiencies, vitamin D supplementation improved strength, function, and balance in a dose-related pattern. A high daily vitamin D supplementation dose (about 700-1000 IU) can reduce the risk of falls by approximately 20%; although small doses (less than 400 or 700 IU) may not be sufficient to reduce falls (Bischoff-Ferrari et al., 2009).

3.2.2 Exercise

Falls in older people are not purely random events but can be predicted by assessing a number of risk factors. Some of these risk factors such as decreased muscle strength, impaired balance, and gait deficit can be modified using exercise, whereas poor vision, and psychoactive medications require different strategies. Exercise can be used as a fall prevention intervention on its own or as a component of a multifaceted program. The pooled estimate of the effects of exercise was that it reduced the rate of falling by 17.0% (Sherrington et al., 2008). Home-based and tailored group exercise classes seem to be effective in reducing falls by improving balance and muscular strength. Also, while home hazard management (e.g. removing tripping hazards) and vision screening are not markedly effective in reducing falls when used alone, they add value when combined with an exercise program (Day et al., 2002).

3.2.3 An exercise-based falls prevention program

Exercise programs designed for fall prevention in elderly people should address three major areas - strength, balance and gait. People at high risk of falling due to muscle weakness, balance impairment, and gait deficit should be instructed to perform low or moderate intensity exercise containing safe and simple movements at entry level.

Strength training

A moderate-intensity strength training program aimed to reduce falls should target the major muscles such as the tibialis anterior, soleus, quadriceps femoris, iliopsoas, tensor fasciae latae, and sartorius (Fig. 3). Tripping is a leading cause of falls in community-dwelling elderly people, responsible for up to 53% of falls in this population (Blake et al., 1988). Trips may be associated with weakness of the tibialis anterior muscle, which would cause low toe-clearance or walking in a "shuffling" manner where the toes do not lift off the ground sufficiently to avoid small obstacles that may cause trips.

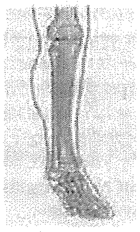
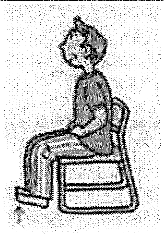
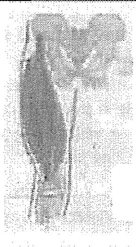
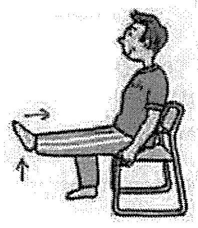
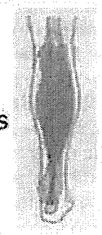
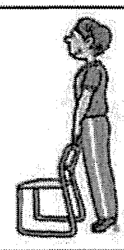
Target Muscle		Exercise		Exercise Description
Tibialis Anterior		Seated Toe Raises		Place hands in comfortable position while seated. Lift toes of both feet as high as possible with the heels still on the floor. Hold for 3-5 seconds, breath normally, and slowly lower toes to the floor. Perform 8-10 repetitions. Remind participants to not rock the body back when raising toes.
Quadriceps		Seated Knee Extension		Lift one leg still bent at the knee while inhaling, and extend the leg without "locking" the knee (keep knee slightly bent) while exhaling. Bend the knee again, with the hip still flexed, and place the foot on the floor. Perform 8-12 repetitions, and repeat on the other side. Remind participants to not lean back while lifting the leg, or extending the knee.
Soleus and Gastrocnemius		Heel Raises		Stand tall with feet flat, shoulder-width apart. Hold on to back of a chair for support. Slowly lift both heels off the floor while exhaling. Hold for 5-10 seconds, breath normally, and slowly lower the heels to the floor. Repeat 10 times.

Fig. 3. Examples of lower extremity strength training exercises.

Balance and gait training

Training is crucial for the improvement of balance in the elderly, and static as well as dynamic and lateral balance exercise have been recommended for reducing falls. Balance exercises progress from holding on to a stable supporting structure such as a chair, to performing the exercises independent of support. Not all elderly people will necessarily start at the first level of each exercise or be prescribed all the balance exercise such as one-leg standing, tandem stance, tandem walking, and side step (Fig. 4).

The results of a large scale study, known as the Frailty and Injuries: Cooperative Studies of Intervention Techniques (FICSIT) trials, suggest that exercise interventions (flexibility, resistance, balance) and Tai Chi for elderly people reduce the risk of falls (Province et al., 1995). To evaluate the effect of Tai Chi on functional fitness and falls, it is necessary to analyze the characteristic movements of Tai Chi. Tai Chi consists of a series of smooth movements linked together in a continuous sequence of whole body weight-shifting, with a low center of gravity. Also, Tai Chi movements involves shifting the weight forward and standing on one foot while lifting the other foot an inch off the floor, which contributes to the improvement of static balance. Moreover, the safe completion of the steps requires an adequate amount of dynamic balance, postural strength, and lateral stability (Li et al., 2004). Participants in the FICSIT trial were instructed on correct foot placement and posture, standing in a semi-squat position, which requires substantial lower extremity strength. These movements are directly or indirectly related to improvement of functional fitness.

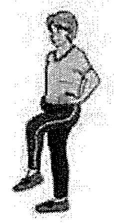
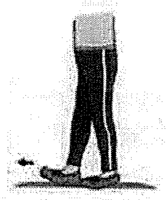
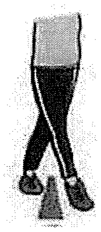
Target Balance Type	Exercise	Exercise Description
Static Balance	One-Leg Stand 	Stand tall with feet flat, shoulder-width apart. Lightly hold on to back of a chair for support or place hands on the hips. Slowly lift one foot off the floor while exhaling. Hold position for 10 seconds, breath normally, and slowly lower the foot to the floor. Repeat by lifting the other leg. Perform 2-3 sets per day.
Dynamic Balance	Tandem Walk 	Stand tall with feet flat on the floor, near a wall or railing for safety. Place one foot directly in front of the other foot, allowing the heel of the front foot to touch the toes of the back foot. Repeat with the other foot. Continue for 10 steps.
Lateral Balance	Cross Step 	Place a piece of tape or draw a line (refrain from anything that may cause trips) on the floor. Begin by standing with both feet together on one side of the tape. Lift the foot farther from the tape, and place it forward (diagonal) on the other side of the tape in a cross-fashion. Shift weight to the front foot, cross the other foot and place on the other side of tape. Note: Both feet do not come together. Continue for 10 steps.

Fig. 4. Examples of balance and gait exercises.

3.3 Urinary incontinence

The common treatments for urinary incontinence include surgery, drug therapies, and behavioral treatments. Behavioral treatments such as pelvic floor muscle (PFM) exercises and bladder training are recommended as a first line of treatment in the management of urinary incontinence, because of the potential benefits with few risks and no side effects. Urinary incontinence is usually classified into three different types: stress, urge, and mixed. Stress incontinence is urine leakage associated with increased abdominal pressure such as coughing, sneezing, laughing, heavy lifting, standing, running, or other types of physical activity. Urge incontinence is leakage associated with running water, or an urge to void and not being able to reach the toilet in time. Mixed urinary incontinence is when characteristics of both stress and urge incontinence types are present.

3.3.1 Pelvic floor muscle exercise

PFM exercises (Fig. 5), initiated by Kegal in 1948, is hypothesized to enhance urethral resistance by increasing the strength and endurance of the periurethral and perivaginal muscles and by improving the anatomic support to the bladder neck and proximal urethra (Kegel, 1948). These exercises are the preferred treatment for stress incontinence but have recently been recommended for urge or mixed incontinence because of reflex bladder inhibition associated with pelvic floor muscle contraction. The efficacy of PFM exercises in improving urine leakage has been validated by many investigators, and the improvement rate has been reported to range widely from 17 to 84% (Bo, 1995).

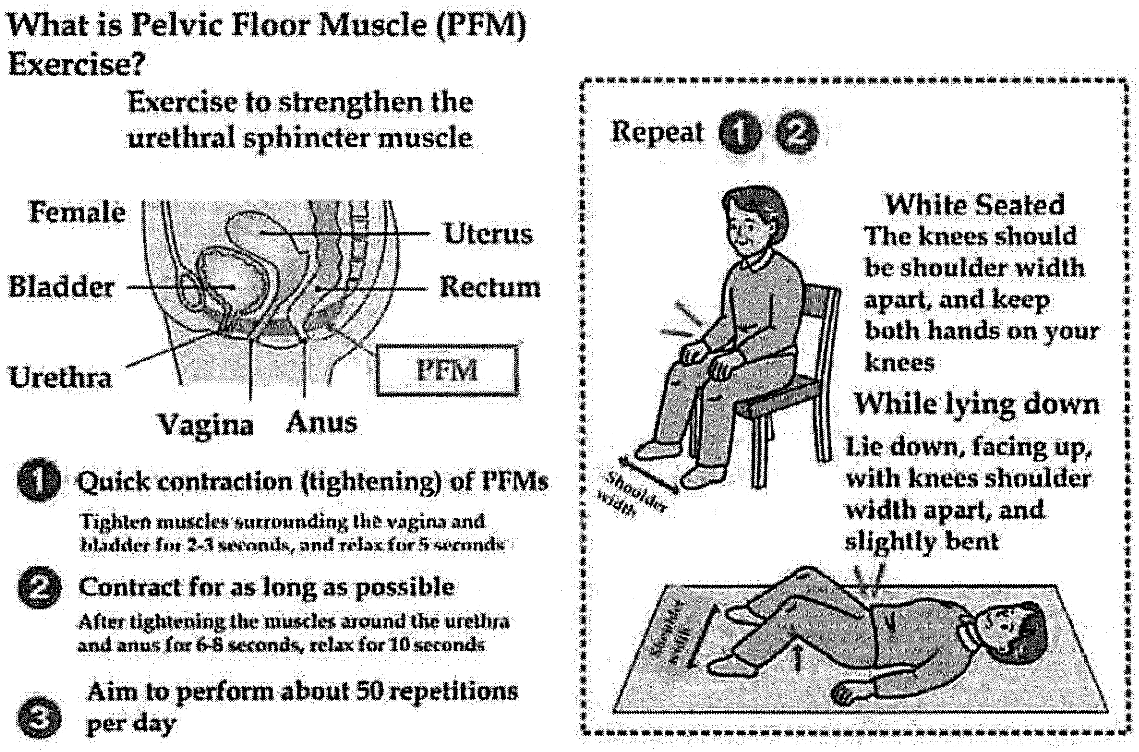


Fig. 5. Pelvic floor muscle exercise for the prevention of urinary incontinence.

At the beginning of PFM training, it is important to teach the elderly people participating in a training program, the structure of the PFM in order to gain awareness of these muscles. The participants should be taught that straining the abdomen would increase the abdominal pressure and would exert load on the PFM. Training should focus on how to exert force on the PFM without excessively straining the abdomen. Most exercise regimens are designed to strengthen the fast and slow-twitch fibers located at the pelvic floor. PFM exercise programs often incorporate alternations of fast contractions, usually held only for about three seconds, sustained contractions, where the participants would hold the contraction for about six to eight seconds, and ten-second relaxation periods between the contractions. The PFM exercises are usually performed in the seated, lying, and standing positions with the legs apart, and the emphasis placed on training of the PFM and relaxing of the other muscles.

The durations of the exercise training periods vary between 3 weeks and 6 months. Bladder training appears to have its greatest efficacy at 6 weeks; PFM exercise appears to be best between 11 to 12 weeks; and combined bladder training and PFM exercise seems to be most effective between 8 to 12 weeks of training (Wyman et al., 1998) (Fig. 6).

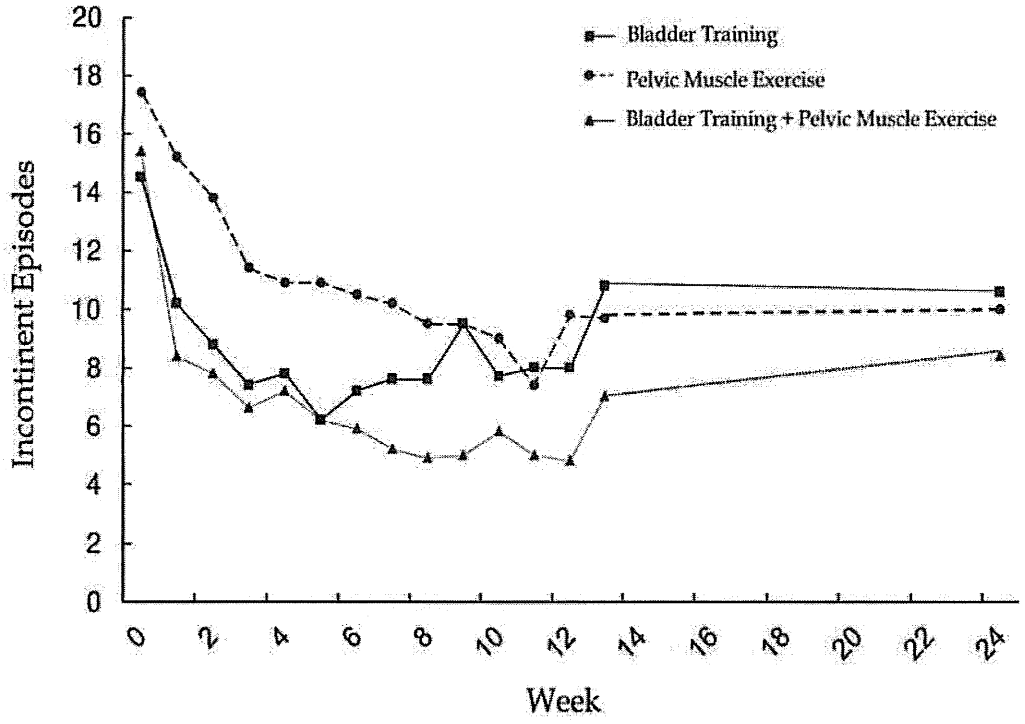


Fig. 6. Change in mean weekly number of incontinent episodes over time by treatment group. (Wyman, J.F.; Fantl, J.A.; McClish, D.K. & Bump, R.C. (1998). Comparative efficacy of behavioral interventions in the management of female urinary incontinence. Continence Program for Women Research Group. *American Journal of Obstetrics and Gynecology*, Vol.179, No.4, pp. 999-1007, with permission from Elsevier).

3.3.2 Fitness exercise

Several studies have reported that obesity and high body mass index (BMI) are associated with urinary incontinence. Presumably, increases in body weight causes increases in abdominal-wall weight, hence increasing intra-abdominal pressure and intra-vesicular pressure (Bo, 2004). Therefore, reductions in abdominal fat from exercise may contribute to decreasing intra-abdominal pressure, causes improvements in urethral sphincter contraction, and therefore decreased risk of urinary incontinence (Fig. 7; Fig. 8). Weight reduction is desirable for women complaining of urinary incontinence (Subak et al., 2009). Bump et al. (1992) found that surgically induced weight loss in obese women significantly reduces weekly incontinence episodes.

Although a direct cause-effect relationship between obesity and incontinence has not yet been established, there is evidence that weight reduction or decrease in BMI may be beneficial for treatment of incontinence. Kim et al. (2007) investigated the distribution of subjects cured from urinary incontinence according to tertiles of BMI, maximum walking speed, and adductor muscle strength, found that a significantly higher proportion among those who were cured of incontinence episodes, demonstrated improvements in BMI and walking speeds (Kim et al., 2007). Therefore, weight reduction, decrease in BMI, and increase in walking ability are desirable qualities for the treatment of urinary incontinence (Table 5).

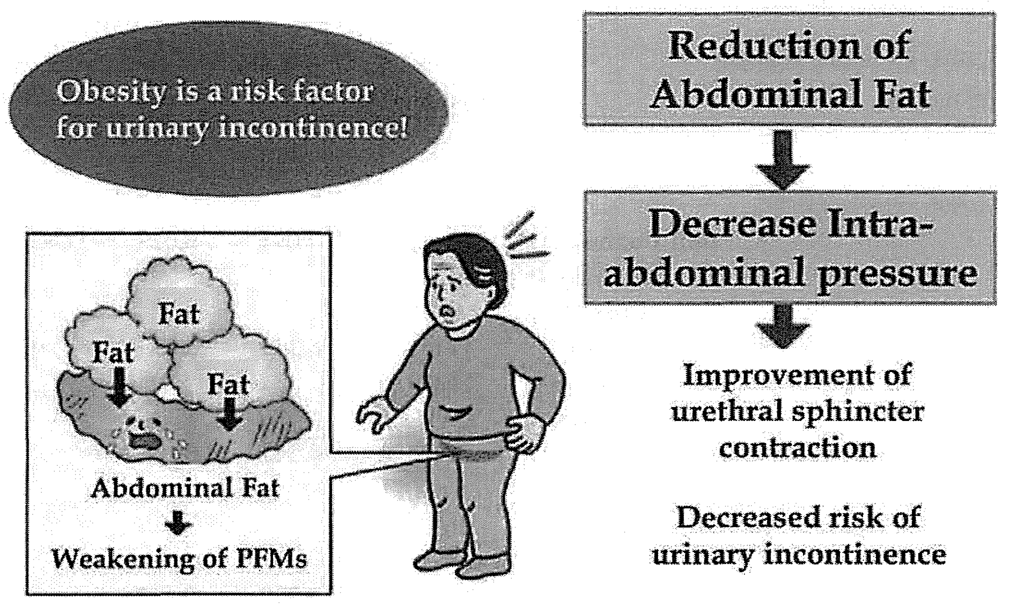


Fig. 7. Strengthening exercises to reduce abdominal fat prevents urinary incontinence

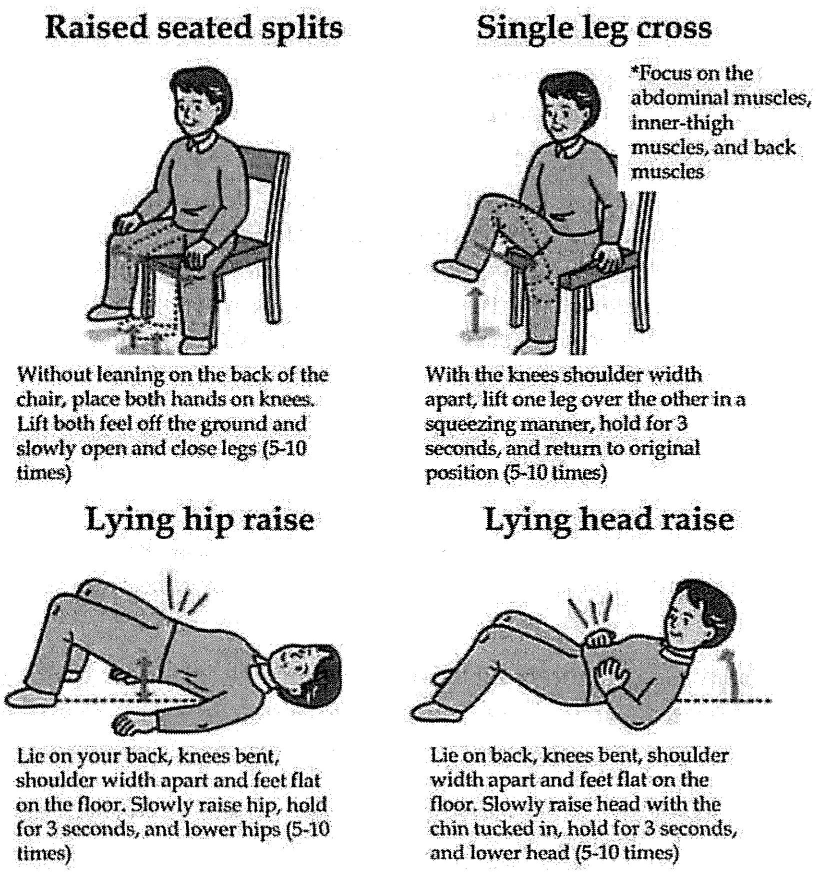


Fig. 8. Examples of exercises aimed to reduce abdominal fat.

Variable Changes Compared with Baseline		Cured of Urine Leakage n(%)	Cochran's Q value	*p*- value	Post-hoc †
3-month exercise (n=33)					
BMI	Decreased (D)	16 (48.5)	7.091	0.029	D,N > I
	No change (N)	13 (39.4)			
	Increased (I)	4 (12.1)			
Maximum walking speed	Increased	17 (51.5)	6.545	0.038	I > D
	No change	11 (33.3)			
	Decreased	5 (15.2)			
Adductor muscle strength	Increased	11 (33.3)	4.545	0.103	
	No change	6 (18.2)			
	Decreased	16 (48.5)			
1-Year Follow-up (n=20)					
BMI	Decreased	10 (50.0)	3.700	0.157	
	No change	3 (15.0)			
	Increased	7 (35.0)			
Maximumn walking speed	Increased	10 (50.0)	6.100	0.047	I > D
	No change	8 (40.0)			
	Decreased	2 (10.0)			
Adductor muscle strength	Increased	9 (45.0)	3.100	0.212	
	No change	8 (40.0)			
	Decreased	3 (15.0)			

Table 5. Cured of urine leakage according to body mass index (BMI), maximum walking speed, and adductor muscle strength tertiles. (Kim, H.; Suzuki, T.; Yoshida, Y. & Yoshida, H. (2007). Effectiveness of multidimensional exercises for the treatment of stress urinary incontinence in elderly community-dwelling Japanese women: a randomized, controlled, crossover trial. *Journal of the American Geriatrics Society*, Vol.55, No.12, pp. 1932-1939, with permission from the American Geriatrics Society.)

While the details of the beneficial effects that exercise may have on the different types of urinary incontinence is not entirely clear, the current literature seems to suggest that PFM and fitness exercises are beneficial for all three types of urinary incontinence after a training period of three months. However, the effects of exercise training are maintained more in those with stress incontinence compared with those urge or mixed incontinence (Kim et al., 2011a) (Table 6).

Recently, other treatment methods including abdominal and lower back heating have been introduced. The heating may have positive effects on renal function such as renal sympathetic nerve activity suppression, promotion of bladder voiding, and increasing frequency of urination.

The heat and steam generating sheet (HSGS) can be any thin, flexible filmed sheet that generates heat and steam immediately after unsealing. When the sheet is placed on the body, the temperature of the skin surface rises to 38 to 40℃and it continues to generate heat

Variables[a]	G[b]	Baseline	3-month exercise	7-month follow-up	ANOVA[c] G×T	p Value
Body Weight (kg)	I	52.0 ± 8.9	51.9 ± 8.8	50.9 ± 8.9	F=5.78	0.018
	C	53.9 ± 8.2	53.9 ± 8.2	53.9 ± 8.1		
BMI (kg/m^2)	I	23.7 ± 3.4	23.5 ± 3.0	23.2 ± 3.1	F=11.49	0.001
	C	24.1 ± 2.9	24.0 ± 2.7	24.4 ± 3.4		
WC (cm)	I	78.8 ± 10.3	77.8 ± 9.7	77.7 ± 9.9	F=4.06	0.041
	C	79.3 ± 10.4	79.2 ± 10.5	78.9 ± 9.6		
UWS (m/sec)	I	1.2 ± 0.2	1.2 ± 0.2	1.2 ± 0.2	F=2.79	0.099
	C	1.1 ± 0.3	1.1 ± 0.3	1.1 ± 0.2		
MWS(m/sec)	I	1.7 ± 0.4	1.8 ± 0.4	1.8 ± 0.4	F=5.10	0.027
	C	1.7 ± 0.4	1.6 ± 0.3	1.6 ± 0.4		
GS (kg)	I	19.0 ± 4.7	20.7 ± 5.0	19.8 ± 5.7	F=0.37	0.547
	C	19.0 ± 4.2	20.2 ± 3.5	19.5 ± 3.8		
AMS (kg)	I	20.5 ± 7.1	24.1 ± 7.7	24.3 ± 7.9	F=11.00	0.001
	C	21.2 ± 4.8	22.1 ± 4.8	21.8 ± 4.9		
ULS (point)	I	5.0 ± 1.0	3.0 ± 2.0	3.6 ± 2.2	F=7.64	0.007
	C	5.1 ± 1.0	4.4 ± 1.6	4.8 ± 1.6		
Cure of urine leakage	I	0.0	44.1	39.3	21.96	<0.001
	C	0.0	1.6	1.6		
Cure of urine leakage in intervention group	Stress	0.0	63.2^{d}	66.7^{e}	15.77	<0.001
	Urge	0.0	35.0^{d}	26.1^{e}	7.49	0.032
	Mixed	0.0	40.0^{d}	30.0^{e}	9.56	0.016

[a] Data are presented as mean and standard deviation.
WC=waist circumference; UWS=usual walking speed; MWS=maximum walking speed; GS=Grip strength; Ams=adductor muscle strenght; ILS=urine leaking score.
[b] G=group, I=intervention group, C=control group
[c] ANOVA=analysis of variance, T=time.
Chi-square and p values are from generalized estimating wquation.
Cochran's Q-value.
[d] Kruskal-Wallis test : chi-square=1.99, p=0.391
[e] Kruskal-Wallis test : chi-square=10.28, p=0.008
(Scheffe's *post-hoc*=stress >urge, mixed urinary incontinence)

Table 6. Cured of urine leakage after the 3-month exercise between the intervention and control groups. (Kim, H.; Yoshida, H. & Suzuki, T. (2011a). The effects of multidimensional exercise treatment on community-dwelling elderly Japanese women with stress, urge, and mixed urinary incontinence: A randomized controlled trial. *International Journal of Nursing Studies*, doi:10.1016/j.ijnurstu.2011.02.016, with permission from Elsevier.)

and steam for over 5 hours. Research has suggested that the HSGS in combination with exercise yields the highest cure rates of urinary incontinence compared with exercise or the HSGS alone. The HSGS also has beneficial effects for the different urinary incontinence types. Research reveals higher cure rates in those with stress urinary incontinence with the combination of both exercise and heat; however, there is strong evidence that the HSGS can be used as a supplementary treatment method in order to enhance the effects of exercise on those with urge, mixed, and stress urinary incontinence (Kim et al., 2011b) (Table 7).

Type of UI	Ex+HSGS n=37	Ex n=35	HSGS n=37	GE n=34	χ^2 value	*P*-value*
Stress UI, %(n)	61.5(8)	53.8(7)	25.0(3)	9.1(1)	8.94	0.030
Urge UI, %(n)	50.0(7)	16.7(2)	13.3(2)	0.0(0)	12.88	0.005
Mixed UI, %(n)	40.0(4)	30.0(3)	30.0(3)	0.0(0)	3.02	0.389
Total cure rate	51.4(19)	34.3(12)	21.6(1)	2.9(1)	21.89	<0.001

UI=urinary incontinence; Ex=exercise group; HSGS=heat and steam generating sheet group; GE=general education group.
*Kruskal-Wallis test.

Table 7. Cure rate of urinary incontinence according to urinary incontinence type and intervention group. (Kim, H.; Yoshida, H. & Suzuki, T. (2011b). Effects of exercise treatment with or without heat and steam generating sheet on urine loss in community-dwelling Japanese elderly women with urinary incontinence. *Geriatrics and Gerontology International*, doi: 10.1111/j.1447-0594.2011.00705.x, with permission from the Japan Geriatrics Society.)

	After 3-month exercise			After 7-month follow-up		
Variable	Adjusted OR *	95%CI	*p* Value	Adjusted OR *	95%CI	*p* Value
Amount of urine leakage	0.69	0.39-0.98	0.049	0.78	0.26-1.88	0.600
Frequency of urine leakage	1.16	0.24-5.79	0.856	1.63	0.73-4.01	0.248
Compliance to exercise	1.03	1.01-1.16	0.048	1.13	1.02-1.29	0.031
Decreased of BMI	0.67	0.48-0.89	0.011	0.78	0.60-0.96	0.028
Increased of walking speed	0.97	0.91-1.04	0.414	0.99	0.94-1.06	0.913
Period of urine leakage	1.01	0.91-1.13	0.919	1.01	0.91-1.14	0.913

Table 8. Adjusted odds ratios for cure of urine leakage after intervention and the 7-month follow-up. (Kim, H.; Yoshida, H. & Suzuki, T. (2011a). The effects of multidimensional exercise treatment on community-dwelling elderly Japanese women with stress, urge, and mixed urinary incontinence: A randomized controlled trial. *International Journal of Nursing Studies*, doi:10.1016/j.ijnurstu.2011.02.016, with permission from Elsevier.)

3.3.3 Predictor variables

Multiple characteristics that may influence the treatment outcome such as age, gender, urine loss frequency and amount, incontinence type, duration of urinary incontinence, chronic conditions, medications, and functional fitness as well as adherence to the prescribed exercise regimen have been examined. Many previous studies have emphasized that compliance to exercise is the key factor to long-term success (Lagro-Janssen & van Weel., 1998; McDowell et al., 1999), and confirmed that BMI reduction have positive influences on urge, mixed and stress UI treatment (Kim et al., 2011a) (Table 8).

4. Conclusion

Geriatric syndromes are highly prevalent and associated with substantial morbidity and poor outcomes. Various factors cause frailty, falls, and urinary incontinence in elderly people including chronic disease, lack of physical activity, malnutrition, and aging itself, some of which are unpreventable. Exercise and nutritional supplementation are among the beneficial treatments promoting healthy and independent lifestyles in the elderly.

Evidence reveals that exercise targeted at reducing risk factors is an effective strategy for treating geriatric syndromes in elderly people. Progressive and moderate-intensity exercise should be encouraged among elderly people to minimize the degenerative physical and mental function that occurs with aging.

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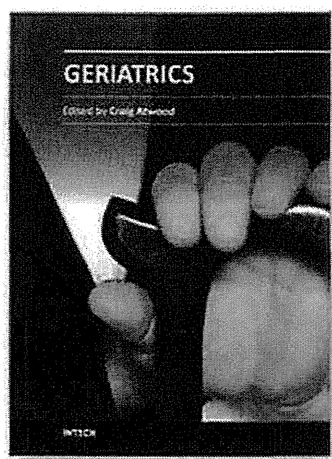

Geriatrics
Edited by Prof. Craig Atwood

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With the baby boomer generation reaching 65 years of age, attention in the medical field is turning to how best to meet the needs of this rapidly approaching, large population of geriatric individuals. Geriatric healthcare by nature is multi-dimensional, involving medical, educational, social, cultural, religious and economic factors. The chapters in this book illustrate the complex interplay of these factors in the development, management and treatment of geriatric patients, and begin by examining sarcopenia, cognitive decline and dysphagia as important factors involved in frailty syndrome. This is followed by strategies to increase healthspan and lifespan, such as exercise, nutrition and immunization, as well as how physical, psychological and socio-cultural changes impact learning in the elderly. The final chapters of the book examine end of life issues for geriatric patients, including effective advocacy by patients and families for responsive care, attitudes toward autonomy and legal instruments, and the cost effectiveness of new health care technologies and services.

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歩行速度

金 憲経

Summary

●「高齢者は何故つまずきやすくなっているのか」に対する理解が、転倒と歩行機能との関連性を把握するうえで重要である。
●歩行速度の低下は転倒の危険要因になる。

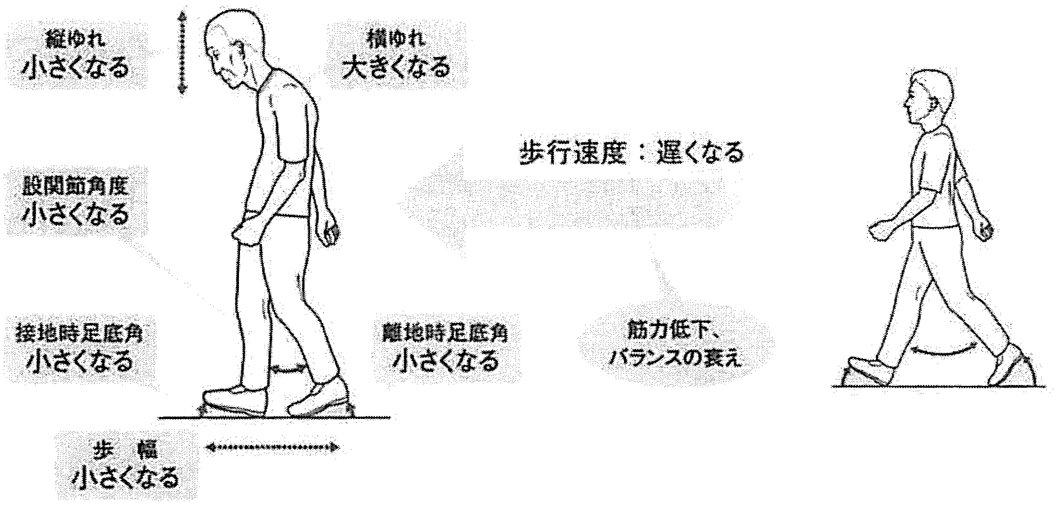
疾病によらない身体機能に関連した転倒の危険因子はいずれも加齢（老化）、生活習慣（不活動）に伴う機能の減衰に基づくものであり、高齢者の転倒原因の大きな割合を占めている。ここでは、歩行機能と転倒との関連性について簡単に記述する。

まず、注目すべき点は転倒のほとんどは歩行中に発生することである[1]。したがって、歩行機能の加齢変化についての理解が必要である。高齢者の歩行パターンの特徴は、歩行速度の低下、歩幅の短縮、両脚支持期の延長、遊脚期での足の挙上の低下、歩隔の増大、腕の振りの減少、不安定な方向転換などにまとめられる（図1）。

一方、転倒者の歩行を分析した研究によれば、転倒経験がある高齢者は転倒経験がない高齢者に比べて歩幅は短くて、歩調の変動は大きくて、歩行速度は遅いという特徴を示し、歩行速度の低下のみならず不安定な歩き方が転倒につながる可能性が示唆されている[2]。

一方、転倒の主な理由につて調べた調査によれば、「つまずいた44.8%、滑った17.2%、めまい10.3%」である（レベルⅡ）[3]。「高齢者は何故つまずきやすくなっているのか」に対する理解が、転倒と歩行機能との関連性を把握するうえで重要なポイントである。つまずく、すなわち「すり足」の原因は、歩くときつま先を上げる役割を担っている「前脛骨筋」の衰弱に起因すると考えられる。次に、膝を伸ばすとき、股を上げるとき、椅子から立ち上がったり階段を昇ったりするときに使われる「大腿四頭筋」、股を上げるとき、階段を昇るときに使用する「腸腰筋」、膝を曲げるとき、大きく歩幅をとって歩くときに使われる「ハムストリングス」、つま先立ちするとき、地面を蹴るときに使用する「下腿三頭筋」の筋力の衰えは、歩幅の短縮を招き、ひいては歩行速度の低下に結び付き、転倒の危険要因となる。

図1　高齢者歩行の特徴



歩行速度の計測

歩行速度の計測には5mあるいは10mがよく採用されているが、ここでは5m歩行について説明する。障害物のない平坦な床に3mと8m地点にテープで印を付けた11mの歩行路上で直線歩行を行い、3m地点を体幹の一部（腰または肩）が越えた時点から8mを越えるまでの時間を計測する。通常歩行は「いつも歩いている速さで歩いてください」と被験者に指示する。試行は2回行い、速い値を採用する。

歩行速度のカットオフポイント

歩く速さはさまざまな健康指標として活用され、多数のカットオフポイントが提案されている。アメリカで普段の日常生活で必要とされる歩行速度の目安である横断歩道を渡りきる速さを1.22m/秒で設定し[4]、1.0m/秒以下になると下肢障害や入院、死亡の危険性が上昇することを[5]、0.8m/秒以下はサルコペニアの診断基準の1つとして使用されている（レベルⅡ）[6]。このように、カットオフポイントには差があるものの、歩行速度は高齢者の生活機能の自立や日常生活の良し悪しを判断する指標として幅広く採用されている。

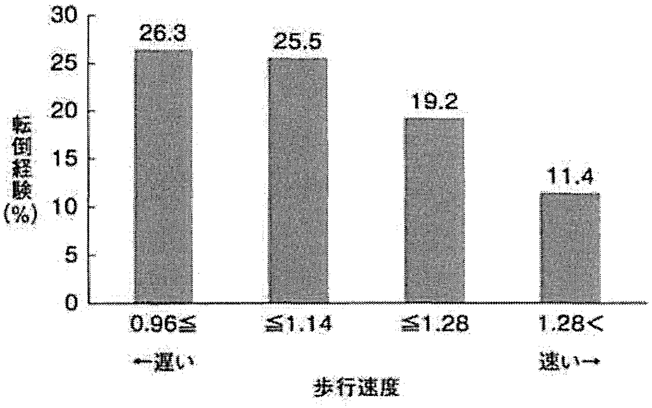
歩行速度と転倒との関連性

歩行速度と転倒との関連性については、さまざまな角度から検討されている。多く

の研究で、歩行速度の低下は、転倒のみならず再転倒(relative risk ; RR=5.4、95% CI : 2.0−14.3)と密接に関連すると指摘している(レベルⅡ)[7]。

地域在宅高齢者の転倒発生率について調べた追跡調査によれば、5年間2回以上の複数回の転倒発生と関連する要因は、過去1年間の転倒経験(オッズ比[OR]=3.80、95%CI : 2.22−6.49)、通常歩行速度(OR=0.20、95%CI : 0.08−0.52)、皮下脂肪厚(OR=0.97、95%CI : 0.94−0.99)であり、特に自由歩行速度が速い群で転倒発生率が11.4%と低く、遅い群では26.3%と高い傾向が観察されている(図2)[8]。さらに、歩行速度の低下は大腿骨頸部骨折の予知因子(RR=1.4、95%CI : 1.1−1.6)であることも検証されている[9]。

図2 歩行速度と5年間の複数回転倒率



(鈴木隆雄ほか : 地域高齢者の転倒発生に関連する身体的要因の分析的研究−5年間の追跡研究から−. 日老医誌 1999 ; 36 : 472-8. より引用)

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