◎表１　サルコペニア群と正常群の連続変数の比較

項　目	サルコペニア群	正常群	p値
年齢（歳）	79.49±2.93	78.51±2.77	<0.001
身長（cm）	146.17±5.77	148.21±5.41	<0.001
体重（kg）	40.51±4.44	52.13±6.75	<0.001
BMI（kg/m²）	18.98±2.01	23.74±2.84	<0.001
下腿三頭筋周囲径（cm）	30.17±2.03	33.92±2.60	<0.001
BMD（g/cm²）	0.248±0.053	0.296±0.061	<0.001
収縮期血圧（mmHg）	129.13±20.45	135.00±18.38	<0.001
拡張期血圧（mmHg）	70.53±11.53	74.41±10.35	<0.001
脈拍数（拍）	78.29±11.68	75.38±11.62	<0.001
肺活量（L）	1.90±0.41	2.05±0.42	<0.001
筋肉量（kg）	26.92±2.61	31.73±3.16	<0.001
下肢筋肉量（kg）	9.84±1.01	11.79±1.31	<0.001
膝伸展力（N）	155.84±38.82	209.24±47.83	<0.001

らず下肢筋力の低下が検証されたことに注目すべきである。

健康度自己評価をみると，不健康だと回答した者の割合はサルコペニア群24.3％，正常群14.2％と有意に高く，定期的な運動習慣を持っている者の割合はサルコペニア群27.3％，正常群33.5％と有意に低い（表2）。

以上のように，サルコペニア高齢者は下腿三頭筋周囲が細く，下肢筋量の減少にともなう筋力低下，健康に対する自信感の喪失という症候を示す。

2．臨床症候2：ADL障害や転倒・骨折上昇，低骨密度

サルコペニアとactivities of daily living（ADL）や手段的ADL（instrumental ADL: IADL）障害，転倒，骨折との関連性については，多くの先行研究で検証されている。ADLは，一人の人間が独立して生活するために行う基本的な，しかも各人ともに共通に毎日繰り返す食事，排泄，移乗，更衣，入浴など身の回りの動作を指し，IADLは外出，買い物，食事の支度，金銭管理，家事など，個人が社会環境に適応し，自立生活を維持するために不可欠な能力である。サルコペニア高齢者のIADLの障害について調べた研究報告によれば，サルコペニア高齢者は正常者に比べてIADL障害の危険性は5倍以上〔odd ratio（OR）＝5.04，95％ confidence interval（CI）＝1.95-13.02〕と高い[2]。今回の対象者の場合，IADL障害はサルコペニア群7.9％，

◎表2 サルコペニア群と正常群のカテゴリー変数の比較

項目	サルコペニア群	正常群	p値
健康度自己評価：不健康(%)	24.3	14.2	<0.001
外出頻度：少ない(%)	4.6	2.5	0.051
運動習慣：有(%)	27.3	33.5	0.039
IADL 障害：有(%)	7.9	4.6	0.022
転倒：有(%)	26.5	16.4	<0.001
痛み：有(%)	58.9	65.4	0.037
既往歴：有(%)			
脳卒中	6.9	7.1	0.897
心臓病	17.1	21.6	0.090
糖尿病	8.2	10.6	0.223
慢性閉塞性肺疾患	0.7	0.9	0.669
変形性股関節症	1.7	2.4	0.445
高血圧	51.0	58.0	0.029
高脂血症	32.2	40.5	0.009
変形性膝関節症	14.5	25.5	<0.001
貧血症	4.6	2.2	0.022
骨粗鬆症	38.2	30.7	0.014
60歳以降骨折	28.6	22.9	0.038

正常群4.6％と先行研究の指摘と同様にサルコペニア群で有意に高いことから，サルコペニア高齢者に対するIADL自立支援は緊急の課題であるといえる。

次に転倒問題についてみると，サルコペニア高齢者に転倒率の上昇が観察され，正常者に比べて転倒の危険性が3倍以上あることがわかった（hazard ratio＝3.23，95％CI＝1.25-8.29）[3]。今回のデータでも，過去1年間の転倒率はサルコペニア群26.5％，正常群16.4％とサルコペニア高齢者の転倒率は有意に高い（表2）。サルコペニア高齢者における転倒率上昇の背景には前述の下肢筋量の減少にともなう下肢筋力の低下が大きく関与していると推測する。また，筋力低下が転倒の危険因子であることはよく知られているところである。

転倒の影響として最も深刻なのは骨折である。高齢者に起こりやすい骨折として，脊椎，橈骨末端部，上腕骨近位部，大腿骨近位部が挙げられるが，大腿骨頸部あるいは転子部骨折は起立，歩行に最も関連し対応が適切でなければ要介護状態あるいは寝たきりに結びつきやすい。大腿骨近位部骨折

の増加は，年齢とともに骨が脆弱性を増すと同時に，転倒頻度が上昇するためである。もう一つ注目したいのは骨密度である。DTX-200より計測した橈骨の骨密度は，サルコペニア群0.248±0.053g/cm²，正常群0.296±0.061g/cm²と有意に低い。

サルコペニア高齢者に多発する骨折は，サルコペニア高齢者の条件，つまり下肢筋量の減少，下肢筋力の低下，低骨密度，易転倒が骨折増加と強く関わると推測する。60歳以降の骨折歴はサルコペニア群28.6%，正常群22.9%とサルコペニア群が有意に高い。一方，サルコペニア高齢者の骨折部位をみると，大腿骨頸部8.0%（正常群4.4%）と腰部10.3%（正常群6.4%）が多い。

もう一つの特徴は痛みである。痛みの有症率はサルコペニア群58.9%，正常群65.4%とサルコペニア群の方が低い（p＝0.037）。サルコペニア高齢者は正常者より痛みの有症率は低いが，痛みを有するサルコペニア高齢者の各種健康指標は顕著に悪いことが深刻な問題である。また，痛みを有するサルコペニア高齢者は痛みがないサルコペニア高齢者に比べて，不健康32.4%，運動習慣無78.8%，転倒恐怖感81.0%，尿漏れ39.1%，60歳以降骨折歴34.6%と高くなっている。

以上のように，サルコペニア高齢者は，正常者に比べてIADLの障害率が高く，転倒や骨折歴が多いという特徴を示す。さらに，サルコペニア群内で痛みを持っているサルコペニア高齢者は，より深刻な健康問題を多く抱えていることが示唆される。

3．臨床症候3：骨粗鬆症多発，小肺活量

サルコペニアと疾病との関連性については，おもに骨粗鬆症に焦点を当てた検討が散見される。骨粗鬆症は低骨量で，かつ骨組織の微細構造が変化し，骨の脆弱化とその結果として起こる骨折の危険が増大した病態と定義される。骨粗鬆症の発症には複数の生活習慣に関連する要因と遺伝的素因が関わるが，サルコペニアが骨粗鬆症と密接に関連するとの指摘も多い。サルコペニア高齢者は正常者に比べて骨粗鬆症の危険が2倍くらい（odds ratio＝1.80，95%CI＝1.07-3.02）高い[4]。骨粗鬆症のみならず，サルコペニア高齢者の既往歴を総合的にみると，高血圧症51.0%（正常群58.0%），

高脂血症32.2％（正常群40.5％），変形性膝関節症14.5％（正常群25.5％）は正常群より低い割合を示すが，先行研究と同様に骨粗鬆症38.2％（正常群30.7％）と高く，さらに貧血も4.6％（正常群2.2％）と有意に高い割合を示す。一方，脳卒中，心臓病，糖尿病，慢性閉塞性肺疾患，変形性股関節症は両者間で有意差は見られない（表2）。しかし，狭心症はサルコペニア高齢者35.3％（正常群24.8％）と高い傾向を示す。一方，収縮期血圧（サルコペニア群＝129.13±20.45mmHg，正常群＝135.00±18.38mmHg，$p<0.001$），拡張期血圧（サルコペニア群＝70.53±11.53mmHg，正常群＝74.41±10.35mmHg，$p<0.001$）はサルコペニア群が正常群より低い値を示すが，脈拍数（サルコペニア群＝78.29±11.68拍，正常群＝75.38±11.62拍，$p<0.001$）はサルコペニア群で高い。しかし，肺活量はサルコペニア群1.90±0.41L，正常群2.05±0.42Lとサルコペニア群で顕著に減っている（表1）。

以上のことから，サルコペニア高齢者は，下肢筋力の低下に起因する転倒増加，骨密度の低下や骨粗鬆症にともなう骨折の危険性が高く，診断にあたってはこれらの臨床症候の把握が必要であることが示唆される。

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Chapter 6

Behavioral Therapy for Urinary Incontinence

Hunkyung Kim
Tokyo Metropolitan Institute of Gerontology, Japan

Abstract

Background

Urinary incontinence among the elderly is a common problem that leads to loss of independence, decreased quality of life, social restrictions, and increased risk of hospitalization. Several treatments are currently available for elderly people with urinary incontinence including surgery, drug therapies, and behavioral interventions. Recently, much attention has been placed on the behavioral treatments for UI, including pelvic floor muscle (PFM) exercise and bladder training, weight loss exercise, and thermal therapy, as they have few risks, no side effects, and are effective.

Treatment

Pelvic floor muscle exercise: PFM exercises, which were first initiated by Kegel in 1948, has been found to be effective in reducing stress urinary incontinence with improvement rates ranging from 17%-80%. However, current focus has extensively been on treatment of stress urinary incontinence with little attention on the effects of behavioral treatments on other types of urinary incontinence, such as urge or mixed urinary incontinence. Previous research has found that PFM exercise reduced urine leakage in people with urge and mixed urinary incontinence because of the inhibition of the bladder reflex associated with PFM contractions. While further investigation is still needed, there is evidence indicating that exercise interventions may be equally effective in treating stress, urge, and mixed urinary incontinence.

Weight loss exercise: Several factors such as obesity and high body mass index (BMI) have been associated with higher risk of urinary incontinence. Surgically induced weight loss in morbidly obese women has been found to reduce stress and urge urinary

incontinence. Hence, fitness exercises focused on strengthening the abdominal muscles and reducing abdominal fat as well as BMI may also decrease the risk of urinary incontinence in the elderly. An 8% weight reduction in obese women has been reported to decrease weekly incontinence episodes by 47%. In light of such recent information, weight loss has been suggested as a first-line treatment for obese women with urinary incontinence.

Thermal therapy: Recent studies have expanded the focus of urinary incontinence interventions to thermal therapy as well. Previous research has indicated that abdominal and lower back heating may have positive effects on renal function via renal sympathetic nerve activity suppression, promotion of bladder voiding, and increasing urination frequency. Moreover, the combination of both heat therapy and exercise has shown to be effective in the treatment of stress, urge, and mixed urinary incontinence.

Conclusions

Behavioral treatments for urinary incontinence, especially PFM and fitness exercises along with combinations of other therapies, are effective in reducing incontinence in the elderly population. These treatments are often recommended as first line treatment because they are considerably safe with no risks and no side effects.

This chapter will discuss the benefits of behavioral treatments on different types of urinary incontinence, as well as the rationale behind how and why weight loss can reduce the risk of urinary incontinence. The chapter will present and examine in detail the effects of PFM exercise, biofeedback, pelvic floor electrical stimulation, vaginal cones, and thermal therapy on improving urine leakage episodes in people with urinary incontinence. While further research is still necessary, the combinations of behavioral interventions seem to be promising in the treatment of urinary incontinence.

1. Introduction

Urinary incontinence, particularly in the elderly, is considered to be an important determining factor for admission into long-term care and has been associated with loss of independence, reduced quality of life, restricted social activities, and increased anxiety and social isolation. Thus, prevention and treatment of urinary incontinence in its early stages are important strategies in maintaining health and independence among the elderly.

There is general agreement on the multifactorial nature of incontinence. Permanent incontinence is typically the result of neurological damage, intrinsic bladder or urethral pathology. However, incontinence is also 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 a lower functional fitness level 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 limits of mobility, and environmental hazards.

Obesity, lifestyle (such as smoking status and social activity), and functional fitness are significantly associated with the onset of urinary incontinence in community-dwelling elderly people (Kim et al., 2004) (Table 1).

Table 1. Multiple logistic regression model of risk factors associated with the onset of urinary incontinence

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

2. Treatment

Urinary incontinence is often differentiated into stress, urge, and mixed urinary incontinence. Stress incontinence is defined as urine leakage associated with coughing, sneezing, laughing, heavy lifting, standing, running, or other types of physical activity that increase abdominal pressure. Leakage associated with running water or an urge to void and not being able to reach the toilet in time is urge incontinence. Mixed urinary incontinence shows symptoms of both stress and urge incontinence.

Surgery, drug and behavioral therapies are common treatments for urinary incontinence. Behavioral treatments such as pelvic floor muscle (PFM) exercises and bladder training are often recommended for the management of stress urinary incontinence, because they are non-invasive, have potential benefits, few risks and no side effects. While until recently, treatments have varied according to incontinence type, with an emphasis on stress incontinence, results of research have suggested that behavioral treatments are not only more effective than drug treatments, they are also safe, effective conservative treatments for urge and mixed incontinence as well (Burgio et al., 1998). The recommended conservative treatments for the prevention of urinary incontinence are behavioral treatments involving PFM exercises and various different combinations of other treatments including bladder training, biofeedback, electrical stimulation, vaginal cones, and/or thermal therapy.

Table 2. Summaries of different interventions targeting reductions in urinary incontinence episodes.

Table 2. Summarizes several research trials that have investigated the effects of these behavioral treatments on urinary incontinence

Study	Participants	Intervention	Outcomes	Conclusion
Kegel (1951)	500+women with stress urinary incontinence (UI)	PFM exercise 20 minutes a day, 3 times a day, or a total of 300 contractions using a Perineometer	Continence improved in 84% of patients with stress UI	Physiological therapy for stress UI is useful and successful
Burns et al. (1993)	123 women, age 55 and older with stress UI	8 week treatment, 3 month, 6 month follow-up Biofeedback(n=40) PFM exercise(n=43) Control(n=40)	Improvement in urine loss frequency Biofeedback=61% PFM exercise=43% Control=6%	Biofeedback and PFM exercise are effective and benefits are maintained for 6 months
Bo et al. (1999)	107 women, age range 24-70 years with stress UI	6 month trial PFM exercise(n=25) Electrical stimulation(ES)(n=25) Vaginal cones(n=27) Control group(n=30)	Reduction in leakage PFM exercise =-30.2g ES=-7.4g Cones=-14.7g Control=-12.7g	PFM exercise is most effective
Goode et al. (2003)	200 women, age range 40-78 with stress UI	8 weeks PFM exercise(n=66) PFM=ES(n=67) Self-help booklet(n=67)	Reduction in weekly episodes PFM exercise=68.6% PFM=ES71.9% Self-help booklet 52.5%	PFM+ES did not increase effectiveness in treating UI
Kim et al. (2007)	70 women, age 70 and older with stress UI	3 month trial, 1 year follow up PFM and fitness (n=35) Control (n=35)	Cure rate of urine leakage Exercise=54.5% Control=9.4%	↓ in BMI and ↑ in walking speed may contribute to improvement of UI
Fantl et al. (1991)	123 women, age 55 and older with UI	6 weeks, 6 months follow up Bladder training(n=60) Control(n=63)	Bladder training reduced UI episodes by 57%. Urine loss volume was reduced by 54%	Bladder training recommended as an intial step in UI treatment
Goode et al. (2011)	208 men, age range 51-84 with UI persisting after radial prostatectomy	8 weeks Behavior(PFM exercise+bladder training(n=70) Behavior+biofeedback and ES(n=70) Control (n=68)	Reduction in weekly UI episodes Behavior=55% Behavior+biofeedback and ES=51% Control=24%	Additional biofeedback and ES did not increase effectiveness in treating post prostatectomy incontinence
Burgio et al. (2002)	222 women, age range 55-92 years with urge or mixed UI	8 weeks PFM exercise(n=74) PFm and Biofeedback(n=73) Self-help booklet(n=75)	Reduction in weekly UI episodes	Improvement in urge UI was seen in all interventions
Kim et al. (2011a)	127 women, age 70 and older with stress urge, and mixed UI	3 month trial, 7 month follow up PFM and fitness(n=63) Control(n=64)	Cure rate of urine leakage PFM and fitness=44.1% Stress UI=63.2% Urge UI=35.0% Mixed UI=40.1% Control=1.6%	Multidemsional exercise may be effective for all tree types of UI
Kim et al. (2011b)	147 women, age 70 and older with stress urge, and mixed UI	3 month trial PFM and fitness +heat and steam generating sheet (HSGS) (n=37) PFM and fitness (n=37) (HSGS) (n=37) Education (n=36)	Cure of urine leakage PFM and fitness+HSGS=54.1% PFM and fitness=34.3% HSGS=21.6 Education=2.9%	HSGS can be used in addition to PFM and fitness exercise to reduce incontinence
Stubak et al. (2005)	40 obese women, age range 46-62, with UI	3 month, 6 months follow-up Liguid diet weight reduction program(n=24) Weight-list control(n=24)	Reduction in weekly UI episodes Weightloss program=60% Control=15%	Weight reduction is effective in treating UI for obese women
Stubak et al. (2009)	338 overweight and obese women with IU	6 months Intervention (diet and excercise weight-loss program with behavior modification) (n=22) Education (n-112)	Reduction in weekly UI episodes Intervention=47% Education=28%	Behavioral intervention targeting weight loss reduced UI episodes among overweight and obese women

2.1. Pelvic Floor Muscle Exercise

PFM exercises (Figure 1), were first initiated by Kegal in 1948. These exercises are hypothesized to enhance urethral resistance by increasing the strength and endurance of the periurethral and perivaginal muscles as well as by improving the anatomic support to the bladder neck and proximal urethra (Kegel, 1948). The effectiveness of PFM exercises for the improvement of urine leakage has been validated by many investigators, with improvement rates ranging widely from 17 to 84% (Bo, 1995). PFM exercises have been the preferred treatment for stress incontinence; however, recently they have been recommended for urge or mixed incontinence as well, due to the reflex bladder inhibition associated with pelvic floor muscle contraction (Kim, 2012).

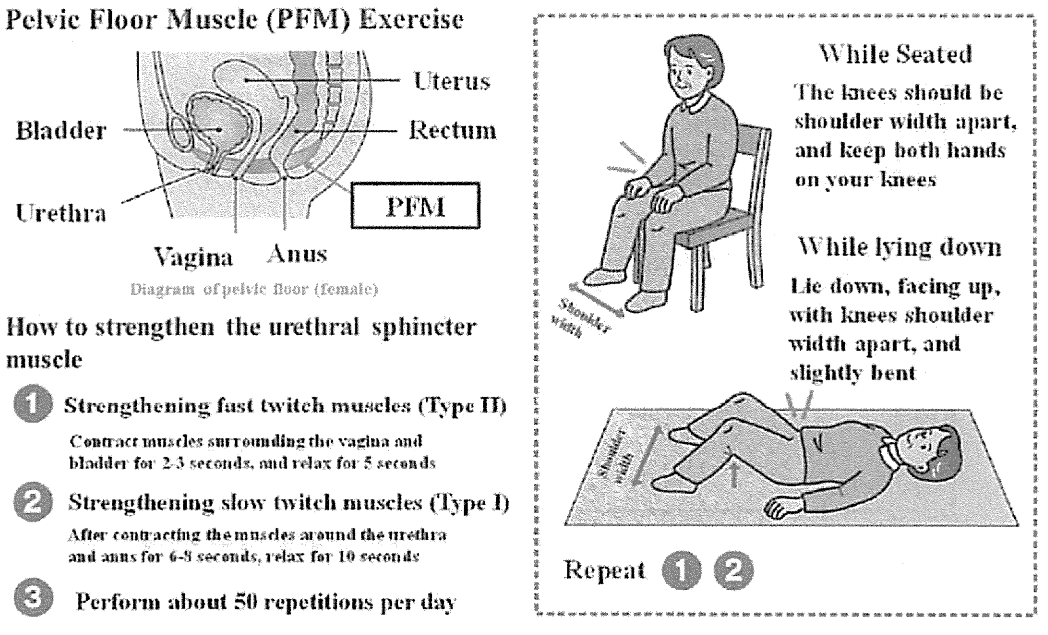

Figure 1. Pelvic floor muscle exercise for the treatment of urinary incontinence.

Elderly people participating in PFM training programs should be educated in the structure of the pelvic floor muscles (Figure 1) in order to gain awareness, and ultimately for proper execution of the exercises (Kim, 2012). Particularly, participants should be informed that straining the abdomen and increasing abdominal pressure would exert an added load on the PFMs. Training should focus on isolated force exertion of the PFMs without excessively straining the abdomen. Commonly, exercise programs include strengthening of both the fast and slow-twitch muscle fibers located at the pelvic floor. PFM exercise programs often incorporate alternations of: fast contractions, usually held for about three seconds followed by five second relaxation periods; 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 can be performed in the seated, lying, and standing positions with the legs shoulder-width apart, and the emphasis placed on isolated training of the PFMs

(Figure 1). Regardless of the positions the exercises are performed (seated, lying, standing), the beneficial effects are equal (Borello-France et al., 2006).

Kegel (1948) also introduced a device known as the Perineometer to monitor PFM strength progress by measuring the strength of perineal muscular contraction, and is now widely used as a biofeedback instrument (described in further detail below). The Perineometer consists of a pneumatic vaginal chamber (8 cm in length, and 2 cm in diameter), which is inserted into the vaginal cavity, connected to an external pressure gauge. Women can watch the dial on the gauge as they contract their PFMs as instructed and monitor their progress. In the study conducted by Kegel (1948), the initial measurements (the first five days of starting PFM training) showed weak muscular contractions of about 20 mm of mercury resistance. Over the course of 25 days of progressive PFM training (20 minutes, three times a day), stronger muscular contractions were detected, at 80 mm of mercury resistance.

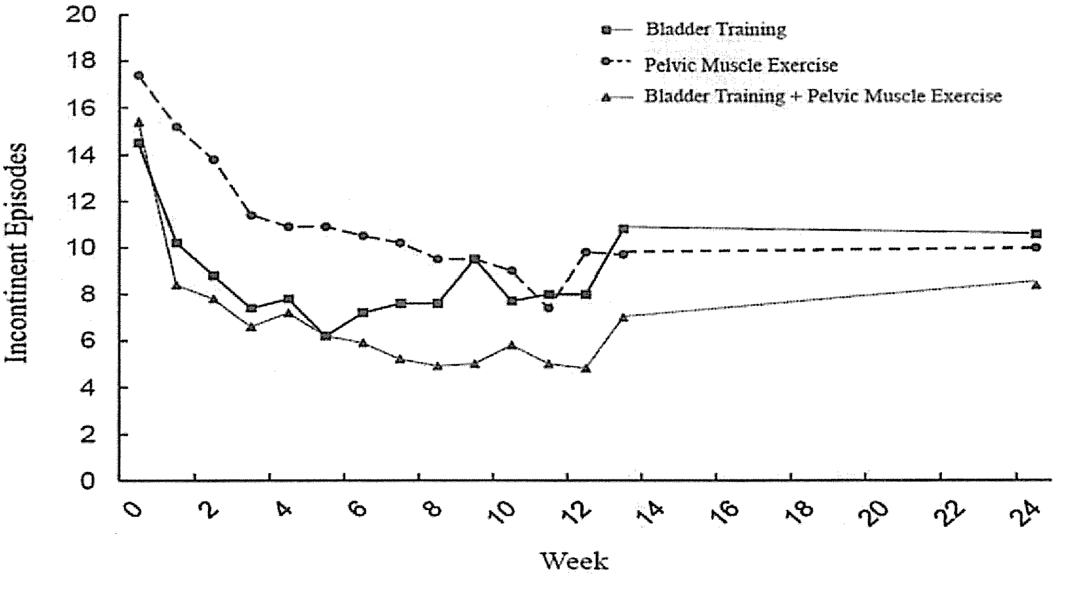

Figure 2. Change in mean weekly number of incontinent episodes over time by treatment group. (Wyman, J.F.; Fantl, J.A.; McClish, D.K. & Bump, R.C. (1998). Comparative efficacy of behavioral interventions in the management of female urinary incontinence. Continence Program for Women Research Group. *American Journal of Obstetrics and Gynecology,179,* 999-1007, with permission from Elsevier).

Exercise training periods vary between 3 weeks and 6 months. The greatest effect is seen at 6 weeks for bladder training; between 11 to 12 weeks for PFM exercise; and combined bladder training and PFM exercise seems to be most effective between 8 to 12 weeks of training (Wyman et al., 1998) (Figure 2).

2.2. Fitness Exercise

Previous studies have reported that urinary incontinence is associated with obesity and high body mass index (BMI). These studies suggest that increases in body weight causes increases in abdominal-wall weight, which in turn increases intra-abdominal pressure and intra-vesicular pressure (Bo, 2004). Therefore, abdominal fat reduction from exercise may decrease intra-abdominal pressure, perhaps causing improvements in urethral sphincter contraction; hence, decreasing urinary incontinence risk (Figure 3). Bump et al. (1992) found that surgically induced weight loss in obese women significantly reduces weekly incontinence episodes. Weight reduction is desirable for obese women with urinary incontinence (Subak et al., 2009).

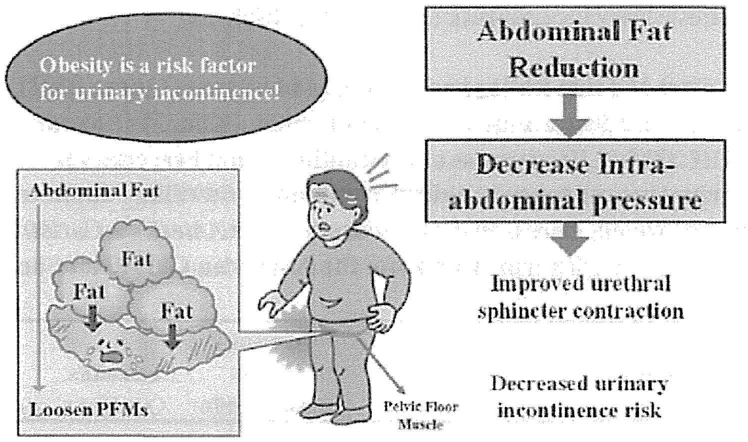

Figure 3. Relationship between abdominal fat and loosened pelvic floor muscles.

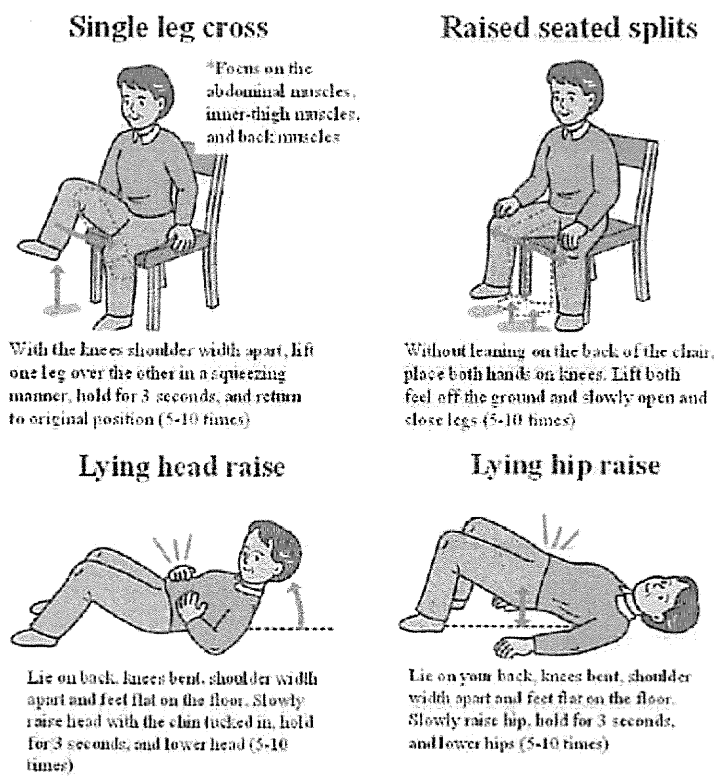

Figure 4. Examples of exercises aimed to reduce abdominal fat and increase mobility.

While a direct cause-effect relationship has not been established between obesity and incontinence, 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 changes in BMI, maximum walking speed, and adductor muscle strength, and found that a significantly higher proportion among those who were cured of incontinence episodes, demonstrated improvements in BMI and walking speeds. Therefore, decrease in BMI and increase in walking speed are desirable outcomes for the treatment of stress urinary incontinence (Kim, 2012) (Table 3).

Table 3. 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, 55,* 1932-1939, with permission from the American Geriatrics Society)

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)			
Maximum 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)			

2.3. Other Treatments

Commonly, PFM exercises are recommended for people with stress urinary incontinence, and fitness exercises have been effective in reducing incontinence episodes in the obese. Several other incontinence treatments have been developed apart from PFM and fitness exercises, and they have been the focus of recent investigation in order to determine the efficacy and validity of these treatment methods.

The use of an educational or retraining program as an intervention was introduced by Jeffcoate and Francis in 1966. The therapy, known as bladder training or sometimes as bladder discipline or drill, consists of three components: patient education, scheduled voiding, and positive reinforcement. Patient education includes teaching patients about the bladder and how continence is normally maintained; scheduled voiding is a fixed or flexible time table for voiding aimed to increase the interval between voids; and positive reinforcement offers encouragement and support provided by a healthcare professional. Bladder training is often prescribed to those experiencing urge urinary incontinence, with uninhibited bladder contractions, as well as those with stress or mixed incontinence. The purpose of bladder training is to inhibit involuntary bladder contractions, increase the interval between voids, and/or induce unspecified psychological benefits. The mechanism of bladder training remains unclear: one hypothesis is that the capacity of the bladder increases by lengthening the interval between voids, which may lead to the reduction in urinary incontinence (Wallace et al., 2009). While research has shown that bladder training can reduce the number of incontinence episodes and the volume of urine loss, this treatment method seems to be more effective as a supplement to PFM exercises, than as a stand-alone treatment (Wyman et al., 1998).

Unlike bladder training, which is very difficult to implement in those with cognitive impairment, other forms of toileting assistance methods such as prompted voiding and timed voiding can be used for elderly people with cognitive impairments. Prompted voiding is used to teach elderly people who may or may not be cognitively impaired to initiate toileting through the requesting of help, or notifying the urge to void to caregivers, and in turn receiving positive reinforcement from the caregivers, a form of operant conditioning. This therapy also requires more mobility in the elderly by having caregivers assist them to the toilet instead of simply changing urinary pads after each incontinence episode. The distinction between prompted voiding and other toileting assistance interventions is that prompted voiding is not initiated and controlled by caregivers, but the individuals with urinary incontinence themselves. The disadvantages with prompted voiding are that it requires a significant amount of commitment and motivation from caregivers, and there are major resource implications which may make this therapy inconvenient. While there has been evidence suggesting that prompted voiding is more effective than no therapy, the evidence is quite weak and further validation is necessary (Eustice et al., 2000).

Timed voiding sometimes referred to as scheduled, routine, or regular toileting is a therapy where the intervals between voiding are fixed. This program is considered a passive toileting assistance program initiated by caregivers, and is often provided to elderly people in long-term residential care facilities with cognitive or motor impairments. In contrast to bladder training, the intervals between voids are not lengthened or shortened, and the aim of this method is to avoid incontinence episodes and not to improve bladder function. Timed voiding is different from prompted voiding in that the caregivers initiate and maintain the program without participation from the elderly patients or residents, and there are no positive reinforcements. However like prompted voiding, evidence of the efficacy of timed voiding toileting assistance programs is inconclusive, and the evidence is insufficient (Ostaszkiewicz et al., 2004). There are also limited investigations where toileting assistance interventions are combined with other forms of behavioral urinary incontinence treatments.

Biofeedback is a training technique aimed to reduce urinary incontinence. Biofeedback can be defined as "augmented, concurrent or terminal feedback of biological signals that enables a person to identify and modify a bodily function of which they are usually unaware" (Herderschee et al., 2011). Augmented feedback refers to any supplementary information given, such as verbal feedback on performance, which can be given during muscle contraction (concurrent) or after (terminal). Kegel first published a report of biofeedback for stress urinary incontinence, where he developed the perineometer (1948), which as previously described, is an instrument now regarded as a biofeedback devise. A perineometer measures the strength of PFM contractions in women using an intravaginal balloon attached to an external manometer. Biofeedback is not only limited to squeeze pressure. Other devices are also used to measure different biological signals such as electrical activity or movement with ultrasound. Whether or not biofeedback is essential for behavioral treatment of urinary incontinence remains uncertain. Several researchers have investigated the role of biofeedback on the treatment of incontinence. Burgio et al.,(1986) indicated that biofeedback is more effective than verbal feedback for teaching selective sphincter control, and only those who had biofeedback treatment demonstrated increases in sphincter strength with training. These results however, were obtained from a very small sample size. Burns et al.,(1993) conducted a randomized controlled trial to assess the efficacy of biofeedback and PFM exercise for the treatment of stress incontinence in older community-dwelling women showing that biofeedback and PFM exercise are effective for treating stress incontinence. Although there were no significant differences in treatment effects between PFM exercise and biofeedback, the results suggest that there is a possibility that biofeedback may be more effective for incontinence of moderate and severe frequency. Burgio et al., (2002) evaluated the effects of training with and without biofeedback for urge incontinence. Behavioral training with biofeedback yielded a mean 63.1% reduction and verbal feedback a mean 69.4% reduction in incontinence episodes. Biofeedback showed less improvement in urinary incontinence compared with verbal feedback alone. A recent randomized controlled trial conducted to evaluate the effectiveness of behavioral therapy for reducing persistent post-prostatectomy incontinence found that the combination of biofeedback with pelvic floor electrical stimulation did not result in greater effectiveness (Goode et al., 2011).

PFM exercise is the most common conservative treatment of urinary incontinence. The correct execution of these exercises is an essential factor for the improvement of incontinence, as improper PFM contractions may reduce the force of urethral contraction (Bump, 1991). Therefore, there have been attempts to make it easier for women to train their PFMs. One method that has been developed is using a set of graded weighted vaginal cones (Peattie et al., 1988). The vaginal cone is placed in the vagina so that the PFMs must contract in order to prevent the cone from slipping out. Research has shown that cones were better than no active treatment; however, there is not enough evidence to show that adding cones to PFM exercise is more effective than cones or PFM exercise alone (Herbison and Dean, 2002).

Pelvic floor electrical stimulation has been suggested as an effective and safe therapy for treatment of stress urinary incontinence (Sand et al., 1995). Electrical stimulation consists of brief electrical impulses administered via needle or surface electrodes and is used to inhibit detrusor overactivity or to cause contraction of PFMs, providing passive exercise. A randomized controlled trial found that the addition of pelvic floor electrical stimulation to an extensive PFM exercise program did not significantly reduce the frequency of episodes, but pelvic floor stimulation group had significantly better patient self-perception of outcomes and satisfaction with progress (Goode et al., 2003).

Table 4. 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, 48,* 1165-1172, with permission from Elsevier)

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 strenghth; AMS=adductor muscle strength; ULS=urine leakage score.

[b] G=group, I=intervention group, C=control group.

[c] ANOVA=analysis of variance, T=time. Chi-square and p values from generalized estimating equation. 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

(scheffes post-hoc=stess>urge, mixed urinary incontinence)

Previous research has not shown convincing evidence that biofeedback, electrical stimulation, and vaginal cones together with PFM exercise have significant effects on improving urinary incontinence compared with PFM exercise alone. Furthermore, several problems arise with the use of electrical stimulation and vaginal cones. Electrical stimulation, while offering passive exercise of the PFMs, is not as effective as voluntary contraction of the muscles, and most patients have low tolerance for electrical stimulation. Many women have also reported that electrical stimulation as well as vaginal cones was difficult to use (Bo et al., 1999).

Despite the aforementioned limitations of pelvic floor electrical stimulation and vaginal cones, these methods of treatment may be helpful for elderly people who have difficulty with voluntary contraction of the PFMs whether from weakness or decline in cognitive and motor function. Elderly people who cannot identify and isolate their PFMs can benefit greatly from pelvic floor electrical stimulation and vaginal cones without having to resort to more invasive treatments with greater risks.

One recent trial suggested that PFM and fitness exercises are beneficial for all three types of urinary incontinence after a training period of three months; however, the mechanisms of these positive effects have not been made clear. This study did find that the effects of combined PFM and fitness exercises are maintained more in those with stress incontinence compared to those with urge or mixed incontinence (Kim et al., 2011a) (Table 4).

Among the different combinations of treatments previously described, the combination of PFM exercises with a fitness exercise program is recommended. By repeating PFM exercises with fitness exercises aimed to reduce abdominal fat, improvements in cure rates of urinary incontinence can be expected (Figure 5).

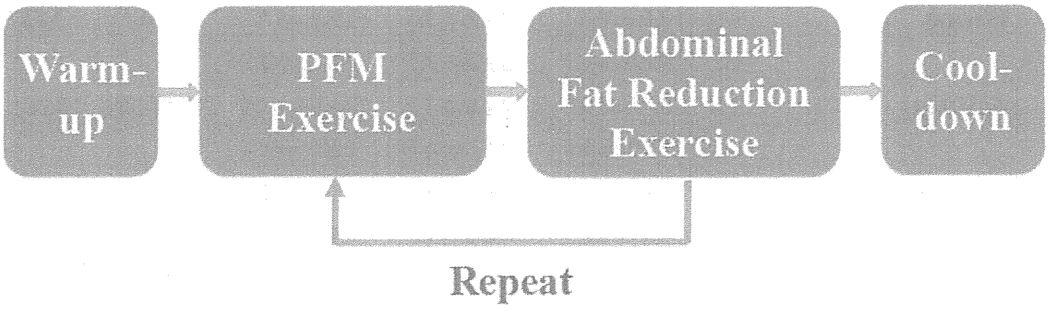

Figure 5. Recommended flow of combined PFM and abdominal fat reduction exercise.

Performing both PFM and fitness exercises may lead to greater physical function in elderly adults with urinary incontinence, which in turn may lead to a more active social lifestyle, increasing their quality of life. In fact, Kim et al. (2007), who investigated the effects of a combined PFM and fitness exercise intervention on cure rates of stress urinary incontinence as well as correlations between functional fitness measures and cure rates of incontinence, found that 54% of women who completed a 3 month PFM and fitness exercise class were cured of urine leakage (Table 5).

Moreover, as depicted in Tables 3 and 5, the PFM and fitness exercise program increased maximum walking speed in community-dwelling elderly women. Not only is this increase in walking speed an indicator of improved function, maximum walking speed may be correlated with being cured from urine leakage. Kim et al. (2007) suggested that an increase of 10.0% or more in walking speed may lead to improvements in urinary incontinence, and increased walking speeds can be maintained for at least one year after an exercise program (Table 3).

Table 5. Comparison of functional fitness and incontinence variables between the intervention and control groups after the 3-month exercise program. (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, 55,* 1932-1939, with permission from the American Geriatrics Society)

Variable	Group	Baseline	3-Month Exercise	Analysis of Variance (Group ×Time)	*P*-Value
Body Weight, kg, mean±SD	I	52.2 ± 9.2	50.8 ± 9.2	*F*(1, 63)=9.1	0.004
	C	53.1 ± 9.4	52.9 ± 9.1		
BMI, kg/m², mean±SD	I	24.5 ± 4.2	23.8 ± 4.0	*F*(1, 63)=5.9	0.019
	C	24.2 ± 3.8	24.1 ± 3.6		
Usual walking speed, m/s, mean±SD	I	1.1 ± 0.3	1.1 ± 0.2	*F*(1, 63)=1.0	0.312
	C	1.1 ± 0.2	1.1 ± 0.3		
Maximum walking speed, m/s, mean±SD	I	1.6 ± 0.4	1.7 ± 0.4	*F*(1, 63)=4.7	0.035
	C	1.7 ± 0.3	1.6 ± 0.3		
Grip strength, kg, mean±SD	I	17.5 ± 4.3	18.2 ± 4.0	*F*(1, 63)=0.1	0.729
	C	18.5 ± 4.8	18.9 ± 4.8		
Adductor muscle strength, Nm, mean±SD					
Seated	I	48.6 ± 14.4	59.4 ± 14.7	*F*(1, 63)=13.4	0.001
	C	50.2 ± 12	51.5 ± 13.1		
Supine	I	42.3 ± 14.6	49.2 ± 17.3	*F*(1, 63)=10.8	0.002
	C	39.8 ± 10.1	40.7 ± 11.2		
Frequency score of urine leakage, point,	I	3.4 ± 1.3	1.5 ± 1.8	*F* (1,63)=6.0	0.018
mean±SD	C	3 ± 1.4	2.4 ± 1.4		
Cured of urine leakage (%)	I	0	54.5	Z=3.863	<0.001
	C	0	9.4		

SD = standard deviation; I = intervention group; C = control group.

2.4.3. PFM and Thermal Therapy

Recently, abdominal and lower back heating have been introduced as treatments for urinary incontinence (Kim, 2012). Heating may have positive effects on renal function by suppressing renal sympathetic nerve activity, promoting bladder voiding, and increasing frequency of urination (Tsai and Chen, 1993).

One previous study used a heat and steam generating sheet (HSGS), a thin, flexible filmed sheet that generates heat and steam immediately after unsealing, as a thermal treatment (Kim, 2011b). The sheet increases the temperature of the skin surface to 38 to 40℃ as it generates heat and steam for over 5 hours. This particular study showed that the HSGS combined with exercise yielded the highest incontinence cure rates compared with exercise or the HSGS alone. The HSGS also seems to have beneficial effects for different urinary incontinence types. Research reveals higher cure rates in those with stress urinary incontinence with the combination of both exercise and HSGS; however, there is strong evidence that the HSGS can be used as a supplementary treatment method in order to enhance the effects of behavioral therapy on those with stress, as well as urge and mixed urinary incontinence (Kim et al., 2011b) (Table 6).

Table 6. 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, 11,* 452-459, with permission from the Japan Geriatrics Society)

	Ex+HSGS	Ex	HSGS	GE		
Type of UI	n=37	n=35	n=37	n=34	χ^2 value	*P*-value*
Stress UI, %(n)	61.5(8)	53.8(7)	25.0(3)	9.1(1)	8.94	0.03
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.

3. Predictor Variables

Several characteristics that may influence treatment outcomes have been examined, including age, gender, urine loss frequency and amount, incontinence type, duration of urinary incontinence, chronic conditions, medications, and functional fitness as well as compliance to the prescribed exercise therapy. Compliance to exercise is the key factor to long-term success (Lagro-Janssen & van Weel., 1998; McDowell et al., 1999). BMI reduction also has positive influences on urge, mixed and stress UI treatment (Kim et al., 2011a) (Table 7), and weight loss may be an effective treatment in obese women (Subak et al., 2005, 2009).

Behavioral treatments are effective in reducing urinary incontinence episodes; however, in some cases, the treatments described in this chapter may be insufficient. When the behavioral methods do not successfully reduce incontinence episodes in the elderly, other medical treatments such as surgery and pharmacological therapies may be necessary to alleviate the symptoms of urinary incontinence.

Table 7. 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, 48,* 1165-1172, with permission from Elsevier)

	After 3-month exercise			After 7-month follow-up		
	Adjusted			Adjusted		
Variable	OR *	95%CI	*p* Value	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

Conclusion

Urinary incontinence is highly prevalent in the elderly population and associated with morbidity and poor outcomes. Many factors contribute to the development of urinary incontinence in the elderly including sex, chronic disease, obesity, low sphincter muscle strength, lifestyle (smoking, alcohol, sedentariness), impaired mobility, and aging itself, some of which are preventable and/or modifiable. The benefits of behavioral treatments such as PFM and weight or BMI reduction exercises are that they are safe with few risks and no side effects. These therapies are often recommended as first line treatments for elderly people with urinary incontinence.

Evidence reveals that PFM training and fitness exercise targeted at reducing modifiable risk factors are effective strategies for treating urinary incontinence in elderly people, regardless of urinary incontinence type.

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