

Table 1 Selected variable characteristics at baseline by study group

Variable	Ex + HSGS (<i>n</i> = 37) M ± SD	Ex (<i>n</i> = 37) M ± SD	HSGS (<i>n</i> = 37) M ± SD	GE (<i>n</i> = 36) M ± SD	<i>P</i> -value [†]
Age (years)	75.7 ± 4.6	76.7 ± 3.6	75.8 ± 4.4	75.8 ± 3.6	0.688
Height (cm)	148.4 ± 4.9	149.0 ± 6.1	148.3 ± 5.4	149.8 ± 5.8	0.638
Weight (kg)	50.3 ± 8.2	53.5 ± 8.0	54.8 ± 9.1	52.4 ± 7.1	0.113
GS (kg)	18.3 ± 4.0	19.9 ± 4.9	19.1 ± 3.7	18.2 ± 5.0	0.368
UWS (m/s)	1.2 ± 0.3	1.2 ± 0.3	1.1 ± 0.2	1.2 ± 0.3	0.774
MWS (m/s)	1.7 ± 0.4	1.8 ± 0.4	1.7 ± 0.3	1.7 ± 0.4	0.820
AMS (kg)	20.3 ± 6.1	21.6 ± 5.4	20.9 ± 4.9	22.0 ± 4.3	0.598
OLS (s)	30.5 ± 22.5	35.6 ± 25.3	29.2 ± 22.6	41.1 ± 22.6	0.121
DUS (years)	3.5 ± 5.6	5.2 ± 5.5	4.0 ± 5.8	5.9 ± 8.3	0.376
OAUS (years)	72.1 ± 6.7	71.4 ± 6.9	71.8 ± 7.4	69.9 ± 9.3	0.608
FSUL (points)	4.2 ± 1.3	4.4 ± 1.2	4.5 ± 1.2	4.1 ± 1.3	0.436
FTDT (times)	7.6 ± 2.9	7.2 ± 2.8	6.9 ± 2.5	7.3 ± 1.9	0.729
FTNT (times)	1.5 ± 0.9	1.9 ± 1.3	1.7 ± 1.2	1.6 ± 1.1	0.440
Frequency of urine loss episodes (%)					
Daily	29.7	29.7	37.8	30.6	0.493
1 every 2 days	5.4	8.1	2.7	5.6	
1–2 per week	21.6	32.4	37.8	19.4	
1–3 per month	43.2	29.7	21.6	44.4	
Chronic medical conditions (yes, %)					
Heart disease	11.8	29.4	26.5	32.4	0.131
Diabetes	26.3	21.1	15.8	36.8	0.465
Hypertension	19.4	29.2	29.2	22.2	0.659
Osteoporosis	20.6	17.6	23.5	38.2	0.177

GS, grip strength; UWS, usual walking speed; MWS, maximum walking speed; AMS, adductor muscle strength; OLS, one-leg standing time with eyes open; DUS, duration of urine loss; OAUS, onset age of urine loss; FSUL, frequency score of urine loss; FTDT, frequency of toilet in the daytime; FTNT, frequency of toilet in the night time; Ex, exercise group; HSGS, heat and steam generating sheet group; GE, general education group; M, mean; SD, standard deviation. [†]One way ANOVA for continuous variables and χ^2 -test for categorical variables.

exercise + HSGS group compared with the HSGS and general education groups; and the urge urine loss score was significantly lower in the exercise + HSGS group compared with the general education group.

Discussion

This study demonstrated that although the 3-month exercise or HSGS interventions alone were effective in improving functional fitness and reducing urine loss, the combination of exercise and HSGS was more effective not only in the treatment of UI, but also in the improvement of functional fitness in urban community-dwelling elderly women with stress, urge and mixed UI. It can be suggested that adding HSGS to exercise therapies (PFM exercises as well as muscle strength training) may increase the likelihood of curing UI.

Exercise therapies aimed to treat UI, especially PFM exercises, have been used as an effective treatment for stress UI since Kegel's first validation of an 84% cure rate,¹⁸ which has since been broadened to 17%–84% by Bo *et al.*,¹⁹ Burns *et al.*²⁰ and Cammau *et al.*²¹

It has also been reported in recent investigations that PFM exercises and muscle strength training targeting abdominal fat reduction can increase cure rates of stress UI as well. Many studies have focused only on the treatment of stress UI.^{5,15,18–20} However, one study demonstrated that 44.8% of community-dwelling Japanese elderly women are categorized into stress UI, 34.8% are urge UI and 20.4% are mixed UI, which means urge and mixed UI account for more than half of the UI cases in Japanese elderly women.²² Even though people with urge and mixed UI experience greater frequency and volume of incontinence episodes, efforts focusing on treatment of urge and stress UI are currently very limited.

Many recent studies have indicated that heating different parts of the body can cause changes in the autonomic nervous system. It has been reported that mild heat stimulation to the lower back and abdominal region suppresses the sympathetic nervous system and accelerates the parasympathetic nervous system while increasing blood flow to the muscles.^{8–10,16,23} It has also been proposed that muscular hypertrophy due to an

Table 2 Comparison of selected variable between groups after the 3-month interventions

Variable	G	Baseline	3-month intervention	ANOVA (time × group)	P-value
BMI (kg/m ²)	Ex + HSGS	22.8 ± 3.3	22.9 ± 3.1	<i>F</i> (3,129) =1.526	0.211
	Ex	24.0 ± 3.3	23.1 ± 2.8#		
	HSGS	24.8 ± 3.6	24.6 ± 3.4		
	GE	23.2 ± 2.7	23.2 ± 2.7		
Grip strength (kg)	Ex + HSGS	18.4 ± 4.2	19.8 ± 4.3#	<i>F</i> (3,110) =0.581	0.629
	Ex	19.6 ± 4.9	20.9 ± 4.7#		
	HSGS	19.2 ± 3.5	20.3 ± 3.0#		
	GE	17.5 ± 4.9	18.1 ± 4.2		
One-leg standing time (s)	Ex + HSGS	31.6 ± 22.2	37.5 ± 24.4#	<i>F</i> (3,124) =1.779	0.155
	Ex	32.7 ± 25.8	35.7 ± 24.7		
	HSGS	29.9 ± 22.9	26.3 ± 24.5		
	Co	39.9 ± 22.4	41.0 ± 21.4		
Adductor muscle strength (kg)	Ex + HSGS	20.3 ± 6.3	24.7 ± 6.1#	<i>F</i> (3,115) =5.108	0.002
	Ex	21.1 ± 6.3	24.9 ± 8.1#		
	HSGS	20.6 ± 4.9	22.7 ± 5.4#		
	GE	21.4 ± 4.7	22.5 ± 5.5		
Usual walking speed (m/s)	Ex + HSGS	1.2 ± 0.3	1.4 ± 0.2#	<i>F</i> (3,129) =4.798	0.030
	Ex	1.2 ± 0.3	1.3 ± 0.2		
	HSGS	1.1 ± 0.2	1.2 ± 0.3		
	GE	1.2 ± 0.3	1.2 ± 0.2		
Maximum walking speed (m/s)	Ex + HSGS	1.7 ± 0.4	1.8 ± 0.3	<i>F</i> (3,114) =2.661	0.051
	Ex	1.7 ± 0.4	1.8 ± 0.4		
	HSGS	1.6 ± 0.3	1.7 ± 0.4		
	GE	1.7 ± 0.4	1.7 ± 0.4		

#Paired Student's *t*-test of the baseline and 3-month intervention within-group difference, *P* < 0.05. G, group; Ex, exercise group; HSGS, heat and steam generating sheet group; GE, general education group.

Table 3 Cure rate of urinary incontinence according to urinary incontinence (UI) type and intervention group

Type of UI	Ex + HSGS (<i>n</i> = 37)	Ex (<i>n</i> = 35)	HSGS (<i>n</i> = 37)	GE (<i>n</i> = 34)	χ ² value	P-value [†]
Stress UI	61.5 (8)	53.8 (7)	25.0 (3)	9.1 (1)	8.94	0.030
Urge UI	50.0 (7)	16.7 (2)	13.3 (2)	0.0 (0)	12.88	0.005
Mixed UI	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 (8)	2.9 (1)	21.89	<0.001

[†]Kruskal–Wallis test. UI, urinary incontinence; Ex, exercise group; HSGS, heat and steam generating sheet group; GE, general education group.

increase in skeletal muscle protein content from thermal loading may occur.

In this study, we demonstrated the efficacy of the exercise + HSGS intervention across UI types. As a result, it can be suggested that therapies combining HSGS with exercise can increase the cure rate of UI, regardless of UI type. The fact that exercise is an effective treatment for stress UI has been discussed extensively. The mechanism explaining the increased effectiveness in treating UI by placing a HSGS on the lower back needs further discussion, but heating the lower back does seem to have physiological effects on

the nervous and muscular systems. In this study, we confirmed the synergistic effect of UI treatment, regardless of UI type, by adding a sheet that heats the lower back to a frequently used behavioral therapy for UI. The use of the HSGS may slightly increase the cost of treatment. However, thermal therapy with the HSGS is cost-efficient because it is inexpensive and accessible for use.

Therefore, the HSGS method can be an effective supplementary UI treatment method. This study has several limitations. First, changes in urine loss were assessed based on subjective self-reported data, and they were not confirmed by objective and clinical

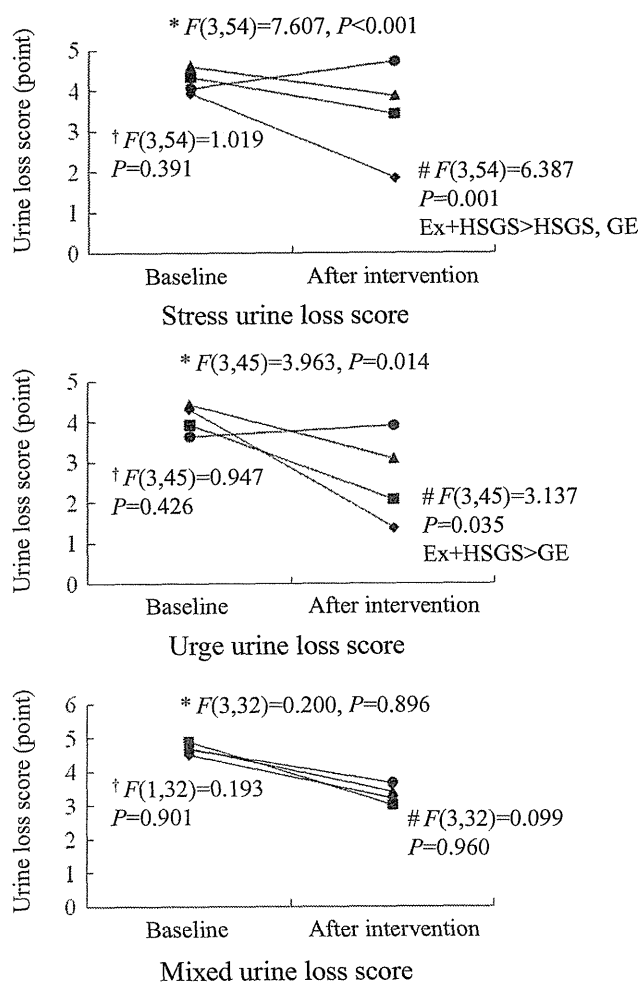


Figure 2 Changes in the mean urine loss score on the 6-point scale based on interview response at baseline and after 3-month intervention. (◆) Exercise + heat and steam generating sheet group; (■) exercise group; (▲) heat and steam generating sheet group; (●) general education group. *Comparison of urine loss scores between groups at baseline and after 3-month intervention (time \times group). †Comparison of urine loss scores between groups at baseline. #A comparison of urine loss scores between groups after 3-month intervention. Ex, exercise group; GE, general education group; HSGS, heat and steam generating sheet group.

methods. However, previous studies have reported the validity of self-reported information in older adults.²⁴ The use of data collected from interviews has little influence on the interpretation of the result of this study. Second, as indicated that measurement of PFM strength was difficult, hip adductor muscle strength was used to assess physical fitness instead of measuring PFM strength directly. Hence, whether the cure of UI was due to an increase in PFM strength, a decrease in abdominal fat, or an increase in muscle strength or walking ability could not be determined. Third, the mechanism of the physiological changes that occurred with placement of a HSGS on the lower back could not

be explained. Further investigation is necessary on a large population for more accurate results.

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温泉施設を用いた複合的介入プログラムの有効性に関する研究 —無作為化比較試験による検討—

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要約 目的：温泉は古くから治療目的などにも用いられてきたが、温泉施設を高齢者に対する健康増進を目的とした介入事業の拠点として用いる有効性について検討した研究は極めて少ない。そこで我々は、運動・栄養指導、温泉入浴からなる複合介入プログラム“すぷりんぐ”を開発し、その効果を無作為化比較試験によって検討した。**方法：**65歳以上の特定健診該当者を対象に公募により本プログラムへの参加者を募集した。68名が事前調査に参加し、60名(72.7歳±6.0)がプログラムへの参加に同意した。参加者を無作為に介入群31名と対照群29名の2群に割付け、交差法により前期に介入群、後期に対照群に対して複合介入プログラムを3カ月間(週2回、90分)実施した。介入群プログラム終了時(3カ月後：第2回調査)と対照群プログラム終了時(6カ月後：第3回調査)に調査を実施し、プログラムの短期・長期的効果の検討を行った。**結果：**介入に起因した傷害、事故の発生はなく、介入群の平均プログラム出席率は76%であった。性・年齢・BMIを調整した一般線型モデルの結果、第2回調査時には対照群に比べ、介入群の握力と開眼片足立ちに有意な改善が認められた(各々 $p=0.028$, $p=0.003$)。また、第3回調査において、介入直後に確認された握力と開眼片足立ちの有意な改善の維持が認められ(各々 $p=0.001$, $p=0.024$)、改善傾向が見られたWHO-5の有意な維持・改善が示された($p=0.027$)。交差後の対照群の介入プログラム出席率も平均81%と比較的高く、対照群への介入時においても傷害、事故の発生は確認されなかった。**結論：**温泉施設を活用した複合的介入プログラムである“すぷりんぐ”は身体機能を中心とした高齢者の健康増進に寄与するプログラムであることが示された。また、その継続的効果とプログラムの出席率・安全性が確保されていることから、温泉施設を高齢者に対する健康増進を目的とした介入事業の拠点とする意義は高いものと考えられる。

Key words：高齢者、温泉、運動介入、栄養介入

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緒 言

我が国の天然資源である温泉は、湯治に代表されるように古くから治療目的に用いられており、現在ではクアハウスやスーパー銭湯に代表されるように身近な、レジャー目的としても地域住民の憩いの場となっている。温泉入浴の効能は、循環、代謝、神経・免疫・内分泌機

能の分野から検討されているが^{1)~3)}、温泉施設を高齢者に対する健康増進を目的とした介入事業の拠点として用いる有効性について検討した研究はほとんど見られない。

上岡ら⁴⁾は中高年女性を対象として、週1回、12週間の温泉入浴と生活・運動指導からなるプログラムの有効性を無作為化比較試験(randomized control study, 以下、RCTと略す)によって検証している。その結果、介入群では運動機能の改善は認められないものの、尿酸値の有意な改善や緊張状態といった心理指標の改善傾向を報告している。またKamiokaら⁵⁾は中高年女性を対象に、週1回、3カ月から6カ月の生活・運動指導に温泉入浴を組み合わせた介入プログラムの効果をRCTによって検討している。その結果、6カ月介入群ではHbA1cの有意な低下や心理指標などの有意な改善が確

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認められ、その効果が6カ月後の追跡調査においても認められたことを報告している。その一方で3カ月間の介入では、介入直後に改善が見られた項目においても、1年後の追跡調査では介入前と同じ程度に戻っていたことを報告しており、3カ月間の介入では長期的効果が乏しいことを示唆している。

以上の温泉入浴を取り入れた介入研究を概括すると、高齢者に対する健康増進効果や適切な介入方法については一致した見解が得られていないといえる。地域資源である温泉施設を利用することにより、介入への動機付けを高め、ひいては介入効果が高まる可能性も考えられる。加えて、運動および栄養介入と温泉入浴による相乗効果があるのかもしれない。そこで本研究では温泉利用型健康増進施設(以下、温泉施設と略す)を用いた運動教室・栄養教室・温泉入浴からなる複合プログラム、通称“すぶりんぐ”を開発し、地域在住高齢者に与える効果をRCTにより検証すること、および健康増進を目的とした介入事業を温泉施設で行う意義について検討することを目的とした。

方 法

群馬県草津町在住の65歳以上特定健診該当者全2,167名を対象に公募により本プログラムへの参加者を募集した。68名が事前調査に参加し、医師から運動教室への参加が禁忌と判定された8名を除く60名(平均年齢±標準偏差:72.7±6.0歳,65~93歳)がプログラムへの参加に同意した。事前調査後、乱数表を用いて参加者を介入群31名、対照群29名に無作為に割り付けた(図1)。町内にある温泉施設を主会場として介入群には3カ月間(2009年10月~12月:前期介入,週2回,1回90分)の複合プログラムを実施した。プログラムの構成は運動教室、栄養教室、温泉入浴とした。運動教室は計11回実施し、健康運動指導士3名が指導を担当した。運動内容は自重やゴムチューブを用いた筋力トレーニングであり、対象者の体力に合わせて立位、座位を適宜選択できるように配慮し(2名の健康運動指導士が運動状況を観察し、運動負荷が強すぎると判断した場合に座位を勧めた)、運動強度は主観的運動強度尺度であるBorg Scale⁶⁷⁾で12~14(ややきつい)に対応する内容を間欠的に実施した。栄養教室は、管理栄養士により適正体重を目指したグループワーク形式の講義と自己の食習慣チェックおよび調理実習を計6回行った。毎運動及び栄養教室の終了前には、6~7名の小グループ単位で約15分間、日常の運動や食習慣について各自の目標、状況、工夫についての情報交換を行い、保健師がファシリテーターとな

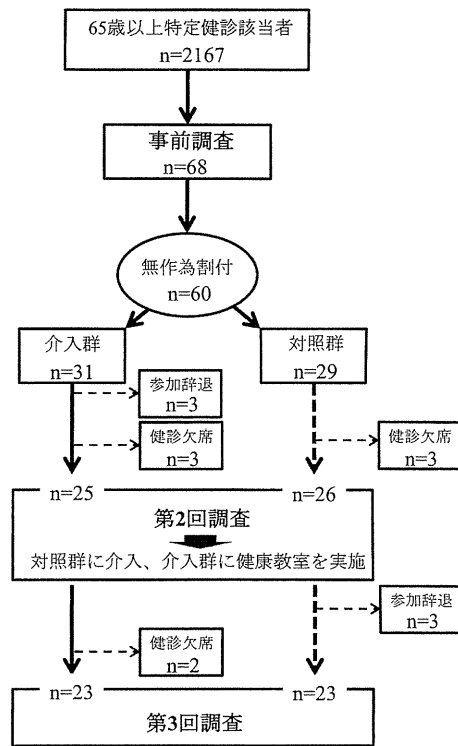


図1 本研究の流れと解析対象者の推移

り行動変容や健康行動の自主化を試みた。基本的には目標設定とセルフモニタリングを繰り返し、対象者の行動変容に対する自己効力感を高めるよう支援した。目標は実行可能な範囲で設定することにより、各人の達成感を高めるものとした。また毎運動教室終了時には30分程度の温泉入浴を課した。本研究で利用した温泉施設の泉質は酸性塩化物硫酸塩泉であり、泉温94.6℃(浴槽内水温は42℃~46℃に調整)、pH1.7であった。他方、対照群に対しては月一回の座学中心の健康教室を行った。同教室の内容は直接、本プログラムとは関連がないよう認知症や老年病の概論についての講演会とした。

介入期間終了後に介入後調査(以下、第2回調査と略す)として事前調査と同様の調査を行い、その後介入群と対照群を入れ替え、上記と同様の介入を行った(2010年1月~3月:後期介入)。後期介入終了後にも追跡調査(以下、第3回調査と略す)を行い、本プログラムの3カ月間の短期的効果と、その後3カ月間の持続効果を検討した。評価項目は体組成⁸⁾について体重、筋肉量、脂肪量、運動機能⁹⁾¹⁰⁾について握力、開眼片足立ち、通常・最大歩行速度、Timed Up & Go Test(以下、TUGと略す)、健康関連QOLについてSF-8¹¹⁾、WHO-5¹²⁾および血液検査とした。

体組成に関しては、多周波数(1 kHz, 5 kHz, 50 kHz,

250 kHz, 500 kHz, 1MHz) の8点接触型電極法により左右腕, 胴体, 左右脚の抵抗値を基に筋肉量, 体脂肪量を求める Body Composition Analyzer (InBody720, Biospace 社製) を用いて計測した。

握力はスメドレー式握力計を用いて利き手で2回測定し, 大きい値を代表値とした。開眼片足立ちは60秒を上限値とし, ストップウォッチを用いて2回測定し, 大きい値を代表値とした。歩行速度は3mと8mの地点にテープで印を付けた11mの歩行路を直線歩行し, 3m地点と8m地点の間5mの歩行時間を測定し, 歩行速度 (m/分) を算出した。快適な速さでの歩行を1回 (通常歩行速度), 最大努力下での歩行 (最大歩行速度) を2回測定し, 最大歩行速度は最速値を代表値とした。TUGは椅子座位から3m前方のポールを回って着座するまでの時間をストップウォッチにて測定した。本研究では最大努力下で2回測定し, 早い値を代表値とした。

SF-8は日本でも広く用いられている健康関連 QOL 尺度であり, SF-36の簡略版として健康関連の8領域 [身体機能, 日常生活役割機能 (身体), 体の痛み, 全体的健康観, 活力, 心の健康, 社会生活機能, 日常生活役割機能 (精神)] を測定することができる。WHO-5はWHOが開発した精神的健康状態を測定する尺度であり, 5つの質問項目から構成されている。得点 (素点) の範囲は0~25点で, 0点はQOLが最も不良であることを示しており, 25点はQOLが最も良好であることを示している。13点未満の得点は精神的健康状態が低いことを表している¹³⁾。

分析方法については, 参加者の属性及び測定項目の群間差は χ^2 乗検定, 対応のないt検定によって検討した。プログラム前後における測定項目の変化 (短期的効果) に関しては性, 年齢を調整した一般線型モデルによって検討を行い, 解析対象者は事前調査と第2回調査の両調査に参加した者とした。プログラム終了3カ月後を含めた変化 (長期的効果) に関しては, 第3回調査を含む3回の調査全てに参加した介入群を対象として, 一般線型モデルによって時間の変化の主効果を検討した。統計解析はSPSS18.0を用いて行い, 両側検定にて危険率5%未満を有意水準とした。

なお, 本研究計画は平成21年度第一回東京都健康長寿医療センター研究所倫理委員会によって審査され, 承認されており, 研究内容はヘルシンキ宣言に基づくものである。

結 果

本プログラムへの参加に同意した60名 (平均年齢±

標準偏差: 72.7歳±6.0) の調査結果の一覧を群別に表1に示した。事前調査の結果, 基礎疾患の有無や既往歴, 現病歴 (高血圧, 脂質異常症, 糖尿病, 心疾患, 脳血管障害) に関しては群間差は認められなかった。また, 事前健診の前6カ月間およびその後の介入期間の3カ月間に脳卒中発作, 心血管イベントその他, 特記すべき疾病の発症, 症状の変化, 治療内容の変化がないことを確認した。一方体重, BMI, 筋肉量, 中性脂肪, WHO-5に介入群と対照群の間に有意な差が認められた。そのため, 統計解析においてはBMIを調整変数として追加投入することとした。

介入3カ月後の第2回調査結果を表2に示した。介入群においては3名が就労, 多忙などの自己の都合によりプログラムの継続を辞退した。また介入群, 対照群ともに3名が第2回調査を欠席したため51名 (介入群: 25名, 対照群: 26名) を解析対象とした。介入群の平均教室出席率は76%であった。介入プログラム及び施設, 温泉入浴に起因した傷害, 事故の発生は確認されなかった。

3カ月の介入の結果, 介入群は対照群に比べ握力と開眼片足立ちに有意な改善が認められた (各々 $p=0.028$; $p=0.003$)。他方, WHO-5や全体的健康感得点に関しては改善傾向が確認されたが有意差が認められるには至らなかった。

前期介入終了3カ月後の持続効果を表3に示した。交差後の対照群への介入 (後期介入) では3名が自己の都合によりプログラム参加・継続を辞退した。第3回調査においては, 介入群の2名が欠席したため, 介入群23名を解析対象とした。対照群の平均教室出席率は81%であった。前期介入同様に, 後期の介入においても傷害, 事故の発生は確認されなかった。

前期介入終了3カ月後の第3回調査では, 介入直後に確認された握力と開眼片足立ちの有意な改善の維持が認められ (各々 $p=0.001$, $p=0.024$)。第2回調査時に改善傾向が見られたWHO-5の有意な改善が示された ($p=0.027$)。また, 有意差には至らなかったが最大歩行速度やTUGに改善傾向が認められた。一方, 介入直後に比べHbA1cは有意な上昇が ($p<0.001$)。日常生活機能 (精神) 得点においては有意な減少が確認された ($p=0.043$)。

考 察

本研究では, 温泉施設を用いた運動教室, 栄養教室, 温泉入浴からなる複合プログラム “すぶりんぐ” が地域在住高齢者に与える効果, 及び高齢者の健康増進を目的

表 1 対象者の事前調査時の群別属性

	介入群 (n=31) Mean ± SD	対照群 (n=29) Mean ± SD	P 値
男女比 (人)	9 : 22	9 : 20	0.866
年齢	73.2 ± 6.9	73.0 ± 4.9	0.573
既往歴 高血圧 (あり/なし)	13 : 18	12 : 17	0.965
既往歴 高脂血症 (あり/なし)	11 : 20	13 : 16	0.460
既往歴 糖尿病 (あり/なし)	5 : 26	7 : 22	0.438
既往歴 心疾患 (あり/なし)	10 : 21	6 : 23	0.277
既往歴 脳血管障害 (あり/なし)	2 : 29	2 : 27	0.973
身長 (cm)	151.4 ± 6.5	154.6 ± 9.1	0.121
収縮期血圧 (mmHg)	121.9 ± 21.6	123.9 ± 19.6	0.710
拡張期血圧 (mmHg)	70.2 ± 10.2	70.8 ± 9.8	0.807
体重 (kg)	50.6 ± 10.2	58.0 ± 9.5	0.006**
筋肉量 (kg)	18.6 ± 4.1	21.2 ± 4.6	0.025*
体脂肪率 (%)	29.6 ± 8.6	31.9 ± 6.0	0.233
BMI (kg/m ²)	22.0 ± 3.6	24.1 ± 2.5	0.012*
通常歩行速度 (m/分)	84.7 ± 14.4	88.4 ± 13.4	0.316
最大歩行速度 (m/分)	122.2 ± 29.1	124.7 ± 25.8	0.737
握力 (kg)	22.0 ± 7.0	25.6 ± 7.7	0.060†
開眼片足立ち (秒)	36.0 ± 21.0	40.4 ± 21.4	0.422
Time Up & Go test (秒)	6.03 ± 1.57	5.76 ± 1.25	0.460
T-CHO (mg/dL)	193.8 ± 25.4	200.5 ± 36.2	0.404
HDL-C (mg/dL)	55.5 ± 14.5	56.7 ± 18.6	0.774
TG (mg/dL)	139.3 ± 64.4	187.7 ± 85.8	0.016*
LDL-C (mg/dL)	113.6 ± 20.4	114.0 ± 31.0	0.947
Alb (g/dL)	4.1 ± 0.2	4.2 ± 0.2	0.077†
HbA1c (%)	5.4 ± 0.5	5.5 ± 0.6	0.560
WHO-5 (点)	17.9 ± 4.5	20.1 ± 3.5	0.045*
SF-8 全体的健康感得点 (点)	50.6 ± 5.9	52.7 ± 5.7	0.169
SF-8 身体機能得点 (点)	51.1 ± 4.4	52.7 ± 3.1	0.118
SF-8 日常役割機能 (身体) 得点 (点)	51.6 ± 4.8	53.3 ± 2.3	0.082†
SF-8 体の痛み得点 (点)	49.6 ± 9.4	52.4 ± 8.0	0.217
SF-8 活力得点 (点)	50.8 ± 6.3	52.0 ± 5.8	0.425
SF-8 社会生活機能得点 (点)	50.1 ± 8.0	53.0 ± 4.7	0.096†
SF-8 心の健康得点 (点)	51.8 ± 6.7	54.1 ± 5.0	0.147
SF-8 日常生活機能 (精神) 得点 (点)	52.0 ± 3.8	53.1 ± 3.1	0.241
SF-8 身体的サマリースコア (点)	49.1 ± 5.0	51.0 ± 3.8	0.100
SF-8 精神的サマリースコア (点)	51.0 ± 5.1	52.6 ± 4.5	0.191

† : P<0.10, * : P<0.05, ** : P<0.01

とした介入事業を温泉施設で行う意義について RCT によって検証することを目的とした。

介入群に関しては3カ月の介入によって握力と開眼片足立ちに有意な改善が認められた。本プログラムでは握力向上を目的としたゴムチューブを用いた上肢運動や、バランス機能の向上を目的とした体重移動を意識させる歩行運動を取り入れている。このような運動構成が握力と開眼片足立ちの有意な改善につながったものと推測される。高齢者における握力の低下は ADL の低下や転倒発生率、死亡率とも強い関連性が報告されており^{14)~16)}、上肢を中心とした総合的な筋力として捉えられている¹⁷⁾¹⁸⁾。また、開眼片足立ち能力の低下に関しても転倒

発生率や虚弱傾向、移動能力の低下との関連性について多くの報告があり¹⁹⁾²⁰⁾、両者ともに高齢者の機能予後を見る上で重要な身体機能項目である。握力と開眼片足立ちに改善が認められたことから、本プログラムは短期的効果として地域在住高齢者に対する身体機能向上に寄与し、ひいては介護予防に貢献する可能性が示唆された。

プログラム終了3カ月後に行った第3回調査の結果、介入群では第2回調査にて有意な改善が見られた握力と開眼片足立ちの成績が維持され、WHO-5は有意な改善が示された。待機期間中である第2回調査と第3回調査の間は、介入群は対照群同様に月1回の座学の健康教室を開催した。運営の都合上、介入群に対する健康教室は

表2 介入前後の比較

	事前調査		第2回調査		P値		
	介入群 (n=25)	対照群 (n=26)	介入群 (n=25)	対照群 (n=26)	時間	群	交互作用
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD			
収縮期血圧 (mmHg)	124.9 ± 22.9	122.7 ± 19.4	120.6 ± 15.4	123.3 ± 24.2	0.637	0.726	0.247
拡張期血圧 (mmHg)	71.9 ± 10.3	70.0 ± 9.8	68.1 ± 10.9	69.2 ± 11.4	0.367	0.440	0.254
体重 (kg)	52.0 ± 10.3	57.6 ± 9.9	52.2 ± 10.2	57.9 ± 10.0	0.119	0.034*	0.518
筋肉量 (kg)	19.0 ± 4.3	21.0 ± 4.6	19.1 ± 4.3	21.2 ± 5.0	0.012*	0.054†	0.185
体脂肪率 (%)	30.3 ± 8.7	32.0 ± 6.1	30.7 ± 8.9	31.9 ± 7.2	0.479	0.805	0.963
通常歩行速度 (m/分)	86.5 ± 13.0	88.0 ± 14.0	87.6 ± 14.5	86.2 ± 13.8	0.641	0.962	0.413
最大歩行速度 (m/分)	126.9 ± 26.7	122.9 ± 26.4	126.3 ± 23.3	128.7 ± 34.0	0.101	0.967	0.183
握力 (kg)	22.7 ± 7.4	25.7 ± 8.0	24.4 ± 7.9	25.8 ± 8.1	0.117	0.147	0.028*
開眼片足立ち (秒)	37.9 ± 20.7	43.4 ± 20.3	43.6 ± 23.3	38.0 ± 21.6	0.676	0.979	0.003**
Time Up & Go test (秒)	5.66 ± 1.00	5.80 ± 1.32	5.54 ± 1.50	5.46 ± 1.13	0.024*	0.971	0.118
T-CHO (mg/dL)	189.9 ± 22.4	198.8 ± 37.6	197.6 ± 33.1	202.1 ± 35.6	0.424	0.343	0.687
HDL-C (mg/dL)	54.5 ± 15.6	55.3 ± 18.5	55.8 ± 16.2	55.6 ± 16.1	0.509	0.614	0.957
TG (mg/dL)	147.7 ± 63.8	186.6 ± 88.6	141.6 ± 85.4	164.5 ± 121.0	0.099†	0.326	0.316
LDL-C (mg/dL)	109.8 ± 18.3	113.7 ± 32.0	116.0 ± 27.2	116.8 ± 29.1	0.460	0.798	0.610
Alb (g/dL)	4.15 ± 0.17	4.23 ± 0.19	4.27 ± 0.24	4.28 ± 0.20	0.189	0.343	0.343
HbA1c (%)	5.4 ± 0.5	5.5 ± 0.6	5.5 ± 0.5	5.6 ± 0.7	0.085†	0.600	0.951
WHO-5 (点)	18.1 ± 4.5	20.0 ± 3.7	20.1 ± 4.5	20.2 ± 4.0	0.706	0.251	0.073†
SF-8 全体的健康感得点 (点)	51.0 ± 5.7	52.2 ± 5.6	51.7 ± 5.6	50.4 ± 5.2	0.033*	0.835	0.061†
SF-8 身体機能得点 (点)	50.9 ± 4.8	52.7 ± 3.2	49.3 ± 5.1	49.3 ± 9.1	0.839	0.276	0.374
SF-8 日常役割機能(身体)得点(点)	51.5 ± 5.2	53.5 ± 2.2	49.6 ± 7.2	49.0 ± 8.8	0.722	0.427	0.324
SF-8 体の痛み得点 (点)	52.0 ± 8.2	52.7 ± 7.7	51.1 ± 9.7	51.0 ± 8.8	0.419	0.723	0.847
SF-8 活力得点 (点)	52.1 ± 5.7	52.1 ± 5.9	52.7 ± 5.8	51.2 ± 6.5	0.953	0.745	0.282
SF-8 社会生活機能得点 (点)	51.0 ± 7.2	53.4 ± 4.0	51.0 ± 6.4	51.1 ± 6.8	0.456	0.260	0.314
SF-8 心の健康得点 (点)	53.8 ± 5.6	54.0 ± 5.2	53.2 ± 6.1	52.4 ± 7.2	0.831	0.999	0.547
SF-8 日常生活機能(精神)得点(点)	52.3 ± 3.8	53.0 ± 3.3	52.3 ± 3.5	52.5 ± 2.9	0.797	0.444	0.610
SF-8 身体的サマリースコア (点)	49.3 ± 5.3	51.1 ± 3.8	48.0 ± 6.4	47.6 ± 8.2	0.531	0.426	0.246
SF-8 精神的サマリースコア (点)	52.4 ± 4.4	52.5 ± 4.5	52.9 ± 5.0	52.4 ± 4.9	0.819	0.951	0.593

† : P<0.10, * : P<0.05, ** : P<0.01

温泉施設から離れた別の温泉施設で行ったが、介入プログラム同様の高い出席率が得られ、対象者の健康意識の維持がうかがえた。施設の変更や、プログラムの終了にかかわらず介入終了後の長期的効果が示されたことから、本プログラムが日常生活における健康行動を促進するような行動変容を促すものであった可能性が考えられる。

行動科学に基づいた行動変容型プログラムは一般成人のみならず、高齢者に対しても身体活動を促進することが報告されている²¹⁾。本プログラムでは教室終了毎に健康活動を自主化することを目的としたグループワークを実施した。その手法は自己効力感の向上に主眼を置いたBandura²²⁾の理論に依るものである。運動・栄養教室と併せて効果的に行動変容を促したことが、寒冷地であるため冬季に高齢者が閉じこもりがちになる草津町においても介入効果の維持に寄与したものと推察される。加えて、コミュニティーサロンともいえる温泉施設の性質が健康行動を促進する一因となっていた可能性も考えられ

る。自主的な運動活動などにおいては集団型で、かつ住民間の交流を図る形での活動運営が好ましいことが示唆されている²³⁾。本研究は、地域資源である温泉施設での健康増進プログラムが参加者同士の交流や利用のしやすさといった点から健康行動の動機付けができる可能性を示しており、温泉施設での健康増進を目的とした保健事業実施は、事業への参加・活動維持の面から大きな可能性を持っていると考えられる。

介護予防事業に代表されるような高齢者を対象とした介入事業においては特定高齢者の様な虚弱傾向にある高齢者の低い出席率、継続率が課題となっており、全国自治体を対象とした実態調査では、本人に生活機能低下の自覚がないことや、住民に身近な場所で開催できていないことが挙げられている²⁴⁾²⁵⁾。本研究では、研究参加者の年齢層が65歳から93歳と幅広いにもかかわらず介入・対照両群において比較的高い介入教室への出席率が得られた。その理由の一つとして、公募により研究参加者を募ったため、健康に対する意識が高い高齢者が集

表3 事前検査から第3回調査までの推移

	事前調査 Mean ± SD	第2回調査 Mean ± SD	第3回調査 Mean ± SD	P 値
収縮期血圧 (mmHg)	123.8 ± 20.9	118.3 ± 13.9	126.2 ± 20.1	0.101
拡張期血圧 (mmHg)	71.0 ± 10.4	66.1 ± 10.3	66.8 ± 12.0	0.050 †
体重 (kg)	52.4 ± 11.2	53.3 ± 10.6	52.3 ± 11.2	0.334
筋肉量 (kg)	19.4 ± 4.6	19.5 ± 4.6	19.4 ± 4.6	0.582
体脂肪率 (%)	29.6 ± 8.8	30.8 ± 8.4	29.7 ± 8.3	0.286
通常歩行速度 (m/分)	84.9 ± 13.4	88.1 ± 15.3	91.3 ± 16.9	0.052 †
最大歩行速度 (m/分)	124.8 ± 28.1	126.9 ± 22.7	127.4 ± 21.7	0.740
握力 (kg)	22.1 ± 7.8	23.9 ± 8.3	23.9 ± 7.8	0.001 **
開眼片足立ち (秒)	35.9 ± 21.0	42.8 ± 23.7	43.2 ± 23.4	0.024 *
Time Up & Go test (秒)	5.8 ± 1.1	5.6 ± 1.6	5.4 ± 1.4	0.115
T-CHO (mg/dL)	187.4 ± 23.2	194.4 ± 34.3	194.1 ± 27.6	0.426
HDL-C (mg/dL)	53.4 ± 16.1	54.1 ± 16.3	52.6 ± 15.6	0.739
TG (mg/dL)	143.1 ± 65.6	144.0 ± 91.0	141.3 ± 79.8	0.981
LDL-C (mg/dL)	109.2 ± 19.1	114.6 ± 28.5	115.0 ± 23.9	0.385
Alb (g/dL)	4.15 ± 0.17	4.26 ± 0.24	4.18 ± 0.23	0.182
HbA1c (%)	5.5 ± 0.6	5.5 ± 0.5	5.7 ± 0.6	0.001 **
WHO-5 (点)	18.5 ± 4.3	20.1 ± 4.6	20.0 ± 3.9	0.027 *
SF-8 全体的健康感得点 (点)	50.5 ± 5.8	51.5 ± 5.9	50.6 ± 6.3	0.700
SF-8 身体機能得点 (点)	50.6 ± 5.1	49.6 ± 4.9	49.6 ± 5.5	0.592
SF-8 日常役割機能(身体)得点(点)	52.1 ± 4.8	49.8 ± 6.7	51.1 ± 5.3	0.077 †
SF-8 体の痛み得点 (点)	51.5 ± 8.4	50.8 ± 8.9	51.3 ± 8.8	0.866
SF-8 活力得点 (点)	52.3 ± 5.6	51.8 ± 5.8	51.5 ± 6.5	0.816
SF-8 社会生活機能得点 (点)	50.8 ± 7.7	51.8 ± 5.6	51.4 ± 6.8	0.602
SF-8 心の健康得点 (点)	54.2 ± 5.3	53.7 ± 5.6	54.0 ± 5.6	0.587
SF-8 日常生活機能(精神)得点(点)	52.6 ± 3.6	52.6 ± 3.3	50.8 ± 5.4	0.043 *
SF-8 身体的サマリースコア (点)	49.0 ± 5.3	47.8 ± 6.6	48.4 ± 6.0	0.493
SF-8 精神的サマリースコア (点)	52.8 ± 4.5	53.3 ± 4.8	52.3 ± 5.1	0.421

n = 23, † : P < 0.10, * : P < 0.05, ** : P < 0.01

まっていたことも考えられる。しかしながら、一方で本プログラムが参加者の体力レベルに合わせて座位でも行いやすい運動で構成されていることから、年齢や体力レベルにかかわらず参加者が同一カリキュラムに参加することが可能であったためとも考えられる。また、本プログラムが代替医療、健康増進、リラクゼーション、地域交流などの多面的機能を持つ温泉施設を拠点としていたためとも推測される。つまり、高齢者の自主活動の場として一般的な公民館や地区会館などとは異なり、温泉施設は利用目的が健康志向に合致しやすいため、介入終了後も健康行動を継続しやすい可能性がある。更に、本プログラムは特殊な運動器具や広いスペースを必要としないため、今後は地域の公衆浴場の有効活用、活性化に寄与する可能性も推察される。しかしながら、高齢者の入浴においては温熱環境の急激な変化や浴室環境に起因した疾患・事故死が報告されている²⁶⁾。そのため、本プログラムの一般化に際しては、室内温度の一定化などの浴室環境を考慮する必要がある、心疾患を中心とした循

環器疾患や虚弱な高齢者に対しては医師の判断が必要である。

本研究では第3回調査時にHbA1cに有意な上昇が認められた。機序は不明であるがHbA1cは冬季に上昇する傾向が大規模調査より示されており²⁷⁾、本研究で確認された上昇も季節変動の範囲であると考えられる。また、同様に第3回調査において日常生活機能(精神)得点に有意な減少が認められた。これは介入群の1名が第3回調査の直前に眼科手術を行ったためと推測され、この参加者は総じてQOL指標の成績が低く、分析から除外した場合には日常生活機能(精神)得点の低下は有意差が見られなくなった。

本研究では自己免疫疾患に有用であるとされる酸性塩化物硫酸塩泉を用いたが¹³⁾、本研究で得られた結果が泉質特有であったかは明らかではない。温泉入浴と運動・栄養介入の併用効果について泉質の違いによって検討している研究は極めて少ない。しかしながら異なる泉質を用いた場合でも一定の効果が得られていることを考慮す

ると、温熱効果なども含めた複合的な要因が作用していると考えられ、温泉ではない入浴施設でも効果が得られるのではないかと推測される⁴⁾⁵⁾。

本研究の特徴は温泉施設を利用した複合プログラムが地域在住高齢者に与える効果をRCTによって検証している点である。しかしながら、本研究の限界としては温泉入浴のみの介入効果を検討していない点が挙げられる。大塚²⁸⁾は運動・栄養教室と温泉入浴からなるプログラムを高齢者に実施し、開眼片足立ちや6分間歩行距離などの運動機能とQOL(Quality Of Life, 生活の質)に改善が認められたことを報告している。この研究では温泉入浴のみの高齢者を対照群としているが、対照群にはQOLの改善が認められず、温泉入浴が高齢者のQOLに与える効果は乏しいことを指摘している。しかしながら、対照群は保健事業に参加せず、運動機能測定を拒否した高齢者で構成されており、研究結果にはサンプリングバイアスが生じている可能性がある。また、入浴頻度・期間が不明瞭なため、研究デザイン上のクオリティが担保されていない。また一般成人に関しては温泉入浴頻度が高いほどQOLが上昇傾向にあるとの報告も見られ²⁹⁾³⁰⁾、対象者の世代により得られた見解は異なる。本研究で、温泉入浴のみのプログラムを設定しなかった理由は以下の2つである。一つは、草津町をはじめ全国の温泉保養地に共通する過疎化の問題がある。介護予防事業は2006年度に創設された後、二次予防事業(旧特定高齢者施策)の全高齢者人口に占める出席率の目標は、5%であるのに対して実績の全国平均は0.5%と低調である。地元職員らの懸命な広報活動をもってしても、草津町の高齢者人口を勘案すると、温泉入浴のみ群を設定しうほどの研究対象者の増員は望めなかった。第二の理由は、同町では各家庭への温泉の配給はないが、個人的に温泉を引き入れたり、無料の共同温泉浴場が町内に散在しており、高齢者の多くが、日常的に温泉を利用する環境下にあるため、温泉入浴の単独効果を検証しにくい点であった。

引き続き、同地域において追試験を行うとともに、新たに大都市部フィールドにおいて温泉入浴のみの群を設定した同様の介入試験を実施することが望まれる。

結 論

温泉施設を活用した複合介入プログラムである“すぶりんぐ”は身体機能を中心とした健康増進効果が期待でき、ひいては介護予防に貢献する可能性が示唆されるプログラムであるといえる。加えて、健康行動を継続する行動変容を促進する可能性が示され、その継続的效果と

プログラム出席率・安全性が確保されていることから、温泉施設を高齢者に対する健康増進を目的とした介入事業の拠点とする意義は高いものと考えられる。

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A randomized controlled trial of the effects of a comprehensive intervention program for community-dwelling older adults

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Abstract

Aim: The objective of this study was to evaluate the effects of a comprehensive intervention program named SPRING, which utilizes a hot spring facility, in community-dwelling older adults in a randomized controlled trial.

Methods: A total of 60 community-dwelling elderly people (mean age, 72.7 ± 6.0 years) participated in this program. After baseline investigation, participants were randomly assigned to an intervention group (n = 31) or a control group (n = 29). The intervention group participated in a comprehensive intervention program (including exercise classes, nutrition classes and bathing) twice a week for 3 months. After 3 months and 6 months, we evaluated the effects of the intervention.

Results: The attendance rate of the intervention group was 76%, and there were no accidents or injuries associated with this program. After 3 months, grip strength and one-leg standing with eyes-open scores significantly improved among the intervention group, compared with the control group (p = 0.028; p = 0.003, respectively). On follow-up, grip strength, one-leg standing with eyes-open scores and the World Health Organization Well-Being Index (WHO-5) scores were statistically significantly maintained or had improved in the intervention group (p = 0.001; p = 0.024; p = 0.027, respectively).

Conclusion: The comprehensive intervention program SPRING may improve physical function among community-dwelling older adults. In addition, SPRING may have long-term beneficial effects for older adults.

Key words: *Older adults, Spa, Exercise intervention, Nutrition intervention*

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RESEARCH ARTICLE

Open Access

Relationship between subjective fall risk assessment and falls and fall-related fractures in frail elderly people

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Abstract

Background: Objective measurements can be used to identify people with risks of falls, but many frail elderly adults cannot complete physical performance tests. The study examined the relationship between a subjective risk rating of specific tasks (SRRST) to screen for fall risks and falls and fall-related fractures in frail elderly people.

Methods: The SRRST was investigated in 5,062 individuals aged 65 years or older who were utilized day-care services. The SRRST comprised 7 dichotomous questions to screen for fall risks during movements and behaviours such as walking, transferring, and wandering. The history of falls and fall-related fractures during the previous year was reported by participants or determined from an interview with the participant's family and care staff.

Results: All SRRST items showed significant differences between the participants with and without falls and fall-related fractures. In multiple logistic regression analysis adjusted for age, sex, diseases, and behavioural variables, the SRRST score was independently associated with history of falls and fractures. Odds ratios for those in the high-risk SRRST group (≥ 5 points) compared with the no risk SRRST group (0 point) were 6.15 ($p < 0.01$) for a single fall, 15.04 ($p < 0.01$) for recurrent falls, and 5.05 ($p < 0.01$) for fall-related fractures. The results remained essentially unchanged in subgroup analysis accounting for locomotion status.

Conclusion: These results suggest that subjective ratings by care staff can be utilized to determine the risks of falls and fall-related fractures in the frail elderly, however, these preliminary results require confirmation in further prospective research.

Background

Falls and fall-related fractures are a common cause of disability in elderly people [1], and preventing falls is an urgent medical and social issue. Numerous studies have identified factors that predict an increased risk of falls, and many validated assessment tools have been developed to determine fall risks for elderly people [2,3]. Although falls can be caused by multiple factors, mobility impairments such as gait and balance disorders are among the most common predisposing conditions [4,5].

Our previous studies have identified the best mobility tests [6] and a physical performance test [7] for predicting falls in the elderly. These objective measurements can be

used to identify people who are appropriate for and who will gain benefit from targeted falls prevention interventions. However, we found that about half of the frail elderly subjects could not complete physical performance tests such as the functional reach test and tandem walk test [7]. In addition, cognitive impairment, particularly confusion, impaired orientation, and misperception of functional ability, is one of the most important risk factors for falls in elderly people [8,9] and is likely to be an important inclusion in a screening tool. Successful strategies for preventing falls in frail elderly people with cognitive impairments are yet to be identified conclusively [10] and appropriate screening tools for these individuals are needed.

Some subjective assessments by care staff have been developed for identifying fall risks in frail elderly adults [11-13]. In a residential facility, staff members possess knowledge of their residents' potential fall risk over a

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24-hour period, and this encompasses both predisposing and precipitating factors. Therefore, their global assessment of fall risk could have the highest predictive validity in relation to falls [13]. These global assessment scales are composed of one item, e.g. 'how do you judge the risk that Mr or Mrs x will fall within 6 months—high or low?' [11,13], which can be used easily in clinical settings, but a global assessment cannot identify specific fall risks and appropriate interventions in frail elderly persons who have multifactorial risks for falls. We determined seven specific tasks with high risks of falls based on a nationwide survey of falls in the frail elderly [7,14], and identified the relationship between these tasks and falls in our preliminary study [15]. However, it was not clear that these tasks were related independently with falls and fall-related fractures in a large population study.

The purpose of this study was to develop the subjective risk rating of specific tasks (SRRST) for screening for the risk of falls and fall-related fractures. Subjects were frail elderly people enrolled in the Tsukui Ordered Useful Care for Health (TOUCH) program which provides day-care services.

Methods

Participants

This study recruited 5,062 elderly participants (mean age, 82.6 ± 7.4 years) enrolled in the TOUCH program. To enrol in TOUCH, an individual must be aged 65 or older and have been certified as needing long-term care by the Japanese public long-term care insurance system [16]. The TOUCH sites are located throughout Japan and provide comprehensive, facility-based day-care services. TOUCH clients have some physical disability and frailty, as defined by the presence of weakness, reduced physical activity or slow gait, which is in accordance with the widely accepted definition of frailty [17]. We limited the participants of this study to those who were aged less than 65 years and who had missing value in measurements. Informed consent was obtained from all participants or a family member prior to their inclusion in the study and the Ethics Committee of the Tokyo Metropolitan Institute of Gerontology approved the study protocol.

Study procedures

This study was performed by cross-sectional design and falls and fall-related fractures were investigated retrospectively for a one-year period. Prior to the commencement of the study, all staff received a measurement manual which mentioned the correct protocols for administering all of the assessment measures included in the study.

Falls and fall-related fractures during the previous year

A fall was defined as "an event that resulted in a person coming to rest unintentionally on the ground or another

lower level that did not result from a major intrinsic event or an overwhelming hazard" [18,19]. Falls and fall-related fractures were measured retrospectively for a one-year period via a self-report questionnaire and care records. A caregiver or family member provided information on the participant's annual incidence of falls and fall-related fractures when the trained nurses or care workers recognized that a participant had problems recalling such events.

Subjective risk rating of specific tasks (SRRST)

The SRRST was conducted by day-centre staff who had nursing, allied health or similar qualifications, and they were familiar with their clients. The staff answered the questions of the SRRST based on the present status of the participants. The SRRST consisted of the following items: 1) "Do you feel there is a risk of falls when the client (Mr or Mrs X) is walking?"; 2) "Do you feel there is a risk of falls when the client is transferring in bed room, toilet, or bath room?"; 3) "Do you feel there is a risk of falls when the client is toileting?"; 4) "Do you feel there is a risk of falls when the client is ascending or descending stairs?"; 5) "Do you feel there is a risk of falls when the client is wandering?"; 6) "Do you feel there is risk of falls because the client exhibits risky behavior?"; 7) "Do you feel there is a risk of falls because the client is agitated?". The response to each item in the SRRST was designated as "yes" (1 point) or "no or not applicable" (0 points) [15]. The information of the SRRST and history of falls was obtained at the same time. Prior to the commencement of the study, three raters completed the SRRST twice at weekly intervals ($n = 4 \times 2 \times 30$), and test-retest and inter-rater (one physical therapist, one nurse, and two caregivers) reliability comparisons of total scores revealed intraclass correlation coefficients (ICCs) of 0.84 to 0.96 and 0.81, respectively [20].

Potential confounding factors of falls

With reference to previous studies [2,21-24], we selected two demographic variables, eight primary diseases or general health statuses, and two behavioural variables as possible confounding factors of falls (Table 1). The demographic variables were sex and age. Primary diseases or general health status were recorded by the care staff, who identified the chronic condition from care records or symptoms. The following diseases and general health status were included in the analysis: history of stroke with symptoms of hemiparesis, knee osteoarthritis with pain, Parkinson disease, dementia, poor vision, urinary incontinence or frequency, psychotropic use, and walking aid use. Absence of habitual exercise and daily use of slippers or sandals were investigated as behavioural variables.

Table 1 Number of participants with falls and fall-related fractures and odds ratios of potential risk factors

	Single fall		Recurrent falls		Fractures	
	Number (%)	Odds ratio (95% CI)	Number (%)	Odds ratio (95% CI)	Number (%)	Odds ratio (95% CI)
Subjective risk rating of specific tasks						
Risk of falls during walking, yes	1068 (41.5) [†]	2.21 (2.01-2.43)	633 (24.6) [†]	3.15 (2.71-3.66)	123 (4.8) [†]	1.83 (1.36-2.46)
Risk of falls during transferring, yes	823 (41.7) [†]	1.80 (1.66-1.96)	504 (25.5) [†]	2.43 (2.14-2.76)	103 (5.2) [†]	1.89 (1.43-2.51)
Risk of falls during toileting, yes	568 (42.9) [†]	1.66 (1.53-1.80)	361 (27.3) [†]	2.18 (1.93-2.47)	65 (4.9) [†]	1.49 (1.11-2.00)
Risk of falls during stair ascending/descending, yes	1140 (39.2) [†]	2.13 (1.93-2.36)	685 (23.6) [†]	3.55 (2.99-4.22)	139 (4.8) [†]	2.10 (1.53-2.90)
Risk of falls during wandering, yes	453 (44.9) [†]	1.68 (1.55-1.83)	289 (28.7) [†]	2.16 (1.90-2.44)	66 (6.5) [†]	2.18 (1.63-2.91)
Risk of falls because of risky behaviors, yes	672 (41.6) [†]	1.66 (1.53-1.80)	424 (26.3) [†]	2.24 (1.98-2.54)	79 (4.9) [†]	1.55 (1.17-2.06)
Risk of falls because of agitation, yes	479 (45.0) [†]	1.70 (1.57-1.85)	316 (29.7) [†]	2.32 (2.05-2.62)	55 (5.2) [†]	1.55 (1.14-2.11)
Potential confounding factors						
Age, years [‡]	82.9 ± 7.5		83.0 ± 7.5		84.3 ± 6.9 [†]	
Falls or fractures	82.5 ± 7.4		82.6 ± 7.4		82.6 ± 7.4	
No falls or fractures						
Sex, female	1062 (30.1)	0.97 (0.89-1.06)	560 (15.8)	0.90 (0.79-1.03)	151 (4.3) [†]	1.77 (1.24-2.52)
Stroke, yes	345 (32.0)	1.07 (0.97-1.18)	175 (16.2)	0.99 (0.85-1.16)	41 (3.8)	1.03 (0.74-1.45)
Knee osteoarthritis and pain, yes	659 (36.7) [†]	1.36 (1.26-1.48)	362 (20.1) [†]	1.41 (1.25-1.60)	77 (4.3)	1.26 (0.95-1.67)
Dementia, yes	670 (34.3) [†]	1.23 (1.13-1.34)	387 (19.8) [†]	1.40 (1.23-1.58)	80 (4.1)	1.18 (0.89-1.57)
Poor vision, yes	239 (37.9) [†]	1.30 (1.16-1.45)	131 (20.8)*	1.32 (1.12-1.56)	26 (4.1)	1.13 (0.74-1.73)
Parkinson disease, yes	163 (44.7) [†]	1.53 (1.35-1.73)	104 (28.5) [†]	1.85 (1.55-2.20)	16 (4.4)	1.20 (0.73-1.98)
Use of psychotropics, yes	525 (37.0) [†]	1.33 (1.22-1.45)	283 (19.9) [†]	1.33 (1.17-1.52)	57 (4.0)	1.12 (0.82-1.51)
Urinary incontinence or frequency, yes	702 (36.2) [†]	1.35 (1.25-1.47)	403 (20.8) [†]	1.53 (1.35-1.73)	82 (4.2)	1.24 (0.94-1.65)
Absence of habitual exercise, yes	975 (33.7) [†]	1.31 (1.20-1.43)	561 (19.4) [†]	1.58 (1.38-1.81)	110 (3.8)	1.06 (0.80-1.41)
Use of slippers or sandals, yes	415 (36.3) [†]	1.27 (1.16-1.39)	185 (16.2)	0.99 (0.85-1.14)	63 (5.5) [†]	1.73 (1.28-2.32)
Use of walking aid, yes	887 (36.7) [†]	1.49 (1.37-1.63)	492 (20.3) [†]	1.60 (1.41-1.82)	109 (4.5) [†]	1.51 (1.14-2.01)

*p < .05, †p < .01, ‡Mean ± standard deviation.

Statistical analysis

Each SRRST item and potential confounding factor was compared between the participants with and without a single fall, recurrent falls, and fall-related fractures using *t*-tests for age and chi-square tests for categorical variables. Odds ratios (ORs) of potential risk factors were also calculated for categorical variables.

Multiple logistic regression analysis was performed to explore the independent associations between total SRRST score and falls and fall-related fractures with potential confounding factors. Multiple logistic regression models included total SRRST score as an independent variable, which was categorized into no risk (0 point), low risk (1 to 2 points), moderate risk (3 to 4 points), and high risk (≥ 5 points). The SRRST categories were assessed by their P-values for trend and were used to calculate the OR and 95% confidence interval (95% CI) relative to the category of 'no risk' for each higher category. Covariates were added sequentially to the logistic model to evaluate the associations at different levels of adjustment. Model 1 included the SRRST category plus age and sex, and model 2 included the model 1 variables plus other

possible confounding factors. The participants were divided into dependent walking and independent walking groups for subgroup analysis. Logistic regression analysis (model 2) was performed in each group. The validity of the model was quantified using the C-Index and Hosmer-Lemeshow statistic for goodness of fit. Sensitivity and specificity statistics were used to determine the ability of classification in the SRRST. Sensitivity and specificity for falls and fall-related fractures were calculated in each SRRST score. Cut-points for maximizing the sensitivity and specificity for each score were determined using the closest-to-(0, 1) criterion [25]. All data management and statistical computations were performed using the SPSS 17.0 software package (SPSS Inc., Chicago, IL, USA).

Results

The participants were recruited from 88 TOUCH demonstration sites (35% of all sites) and completed the investigation. About 65% of the TOUCH sites (about 19,800 elderly people) could not complete the investigation. Table 2 shows the characteristics of the participants (Table 2).

Table 2 Characteristics (number and percent) of the participants (n = 5,062)

Age*	83 (41)
Women	3,541 (70.0)
Single fall during a one-year period	1,536 (30.3)
Recurrent falls during a one-year period	828 (16.4)
Fall-related fracture during a one-year period	188 (3.7)
Femoral fracture	74 (1.5)
Fracture of the skull, trunk, pelvic, and lower legs	68 (1.3)
Fracture of the arms	46 (0.9)
Stroke	1,077 (21.3)
Knee osteoarthritis with pain	1,798 (35.5)
Dementia	1,953 (38.6)
Poor vision	630 (12.4)
Parkinson disease	365 (7.2)
Use of psychotropics	1,420 (28.1)
Urinary incontinence or frequency	1,941 (38.3)
Absence of habitual exercise	2,889 (57.1)
Use of slippers and sandals	1,144 (22.6)
Use of a walking aid	2,418 (47.8)
Mobility status	
Independent gait	2,930 (57.9)
Independent transfers	953 (18.8)
Independent sit up	589 (11.6)
Dependent sit up	590 (11.7)

* median (range).

Number of participants with falls and fall-related fractures

Of the 5,062 elderly people, 1536 (30.3%) reported a single fall in the previous year, 828 (16.4%) had recurrent falls, and 188 (3.7%) experienced fall-related fractures. Of the participants with fractures, 74 (39.4%) had a femoral fracture, 68 (36.2%) participants had a fracture of the skull, trunk, pelvic, or lower leg, and 46 (24.5%) experienced a fracture of the arm.

Comparison between participants with and without falls and fall-related fractures

All SRRST items showed significant differences between those with and without a fall, recurrent falls, and fall-related fractures. In terms of potential confounding variables, there were significant differences for all except history of stroke when single fallers and non fallers were compared. When recurrent fallers were compared with non-recurrent fallers there was a significant difference for all potential confounders except for history of stroke and daily use of slippers or sandals. Compared with participants without fractures, those with fractures were significantly more likely to report daily use of slippers or sandals or use of walking aids (Table 1).

Among the SRRST items, ORs of the participants with risk to those without risk were 1.66 to 2.21 for a single fall, 2.16 to 3.55 for recurrent falls, and 1.49 to 2.18 for

fall-related fractures. The ORs of significant confounders were 1.23 to 1.53 for a single fall, 1.32 to 1.85 for recurrent falls, and 1.51 to 1.73 for fall-related fractures. The highest ORs for a single fall, recurrent falls, and fall-related fractures were recognized for the SRRST items of risk of falls during walking, stair ascending/descending, and wandering, respectively (Table 1).

Risk factors for falls

The multiple logistic regression models showed significant relationships between falls and fall-related fractures and SRRST categories (Table 3). Participants who had higher fall risk on the SRRST had higher rates of falling and fall-related fractures (Figure 1). In model 1, which adjusted for age and sex, the OR for a single fall, recurrent falls, and fall-related fractures increased as the SRRST score increased, and P for trend of all models showed significance. The ORs of the high-risk group compared with the no-risk group were 7.56 (95% confidence interval (95% CI); 6.07-9.42) for single fall; 17.71 (95% CI; 12.32-25.45) for recurrent falls, and 4.65 (95% CI; 2.73-7.94) for fall-related fractures (P for trend < 0.01). The results remained essentially unchanged after controlling for other confounders (Table 3, model 2). The highest ORs of factors related to single fall, recurrent falls, and fall-related fractures were for the high-risk group in the SRRST in all logistic models. The p-values of the Hosmer-Lemeshow statistics were > 0.05 in both logistic models (p = 0.12-0.72) and the C-index showed moderate model-fit in nearly all cases (0.67-0.74). In the subgroup analysis, the significant odds ratios remained essentially the same in the dependent walking and independent walking groups, with the exception of fall-related fracture. Regarding fall-related fractures in the dependent walking group, there were no significant odds ratios when the low and moderate risk groups were compared to the no-risk group of the SRRST (Figure 2).

Sensitivity and specificity

Table 4 shows the sensitivity and specificity of each SRRST score for falls and fall-related fractures. Cut-points for maximizing the sensitivity and specificity were 2/3 point in all of a single fall, recurrent falls and fall-related fractures. Sensitivity and specificity of 2/3 cut-point in a single fall, recurrent falls and fall-related fractures were 0.66 and 0.63, 0.75 and 0.60, and 0.68 and 0.55, respectively.

Discussion

There are many distinct and multifactorial causes for falls in elderly people, including low muscle strength, balance and gait disturbances, cognitive function decline, environmental hazards, and low or high activity levels. Objective measures such as physical tests can provide

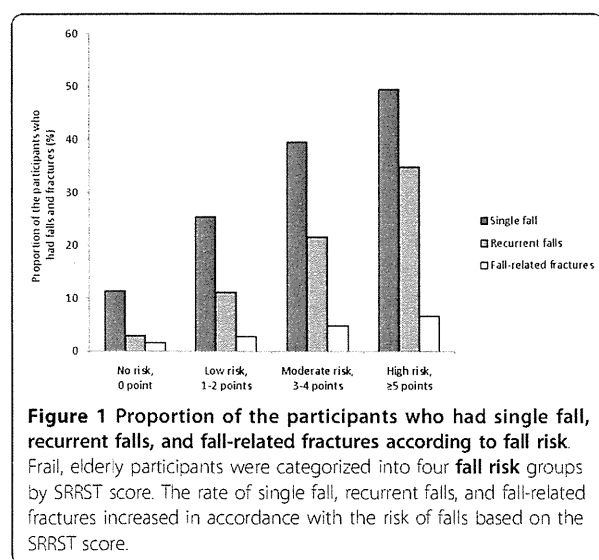
Table 3 Odds ratios for falls and fall-related fractures by SRRST category and confounders

	Single fall		Recurrent falls		Fractures	
	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)	Model 1 Odds ratio (95% CI)	Model 2 Odds ratio (95% CI)
Subjective risk rating of specific tasks						
No risk, 0 points	1.00 [‡]	1.00 [‡]	1.00 [‡]	1.00 [‡]	1.00 [‡]	1.00 [‡]
Low risk, 1-2 points	2.65 (2.14-3.28) [‡]	2.40 (1.94-2.98) [‡]	4.17 (2.88-6.06) [‡]	3.88 (2.67-5.64) [‡]	1.80 (1.03-3.15)*	1.77 (1.01-3.12)*
Moderate risk, 3-4 points	5.06 (4.11-6.23) [‡]	4.21 (3.39-5.23) [‡]	9.11 (6.36-13.05) [‡]	7.94 (5.5-11.47) [‡]	3.24 (1.91-5.48) [‡]	3.22 (1.86-5.57) [‡]
High risk, ≥ 5 points	7.56 (6.07-9.42) [‡]	6.15 (4.85-7.8) [‡]	17.71 (12.32-25.45) [‡]	15.04 (10.29-22) [‡]	4.65 (2.73-7.94) [‡]	5.05 (2.83-9.03) [‡]
P for trend	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Potential confounding factors						
Age, years	1.01 (1.00-1.01)	1.01 (1.00-1.02)	1.01 (0.99-1.02)	1.00 (0.99-1.02)	1.02 (1.00-1.05)*	1.03 (1.01-1.05)*
Sex, female	0.97 (0.84-1.11)	0.94 (0.81-1.09)	0.91 (0.77-1.08)	0.89 (0.74-1.06)	1.72 (1.19-2.50) [‡]	1.76 (1.20-2.58) [‡]
History of stroke with symptoms of hemiparesis		1.04 (0.88-1.22)		0.88 (0.72-1.08)		1.32 (0.91-1.93)
Knee osteoarthritis with pain		1.28 (1.12-1.47) [‡]		1.31 (1.11-1.54) [‡]		1.00 (0.73-1.37)
Parkinson disease		1.44 (1.14-1.81) [‡]		1.51 (1.16-1.96) [‡]		1.10 (0.64-1.88)
Dementia		0.93 (0.81-1.08)		0.95 (0.80-1.14)		0.87 (0.62-1.22)
Poor vision		1.05 (0.87-1.27)		1.00 (0.80-1.25)		0.87 (0.56-1.34)
Urinary incontinence or frequency		1.09 (0.95-1.26)		1.06 (0.89-1.26)		0.96 (0.69-1.34)
Use of psychotropics		1.22 (1.06-1.40) [‡]		1.07 (0.90-1.28)		0.95 (0.68-1.32)
Use of walking aid		1.20 (1.05-1.38) [‡]		1.14 (0.96-1.35)		1.07 (0.78-1.47)
Absence of habitual exercise		1.04 (0.90-1.19)		1.15 (0.96-1.37)		0.81 (0.59-1.12)
Daily use of slippers or sandals		1.23 (1.06-1.43) [‡]		0.81 (0.67-0.98)*		1.67 (1.21-2.30) [‡]
C-index, value (95% CI)	0.68 (0.66-0.70) [‡]	0.70 (0.68-0.71) [‡]	0.72 (0.71-0.74) [‡]	0.74 (0.72-0.75) [‡]	0.67 (0.63-0.71) [‡]	0.69 (0.65-0.73) [‡]
Hosmer-Lemeshow test, p value	0.51	0.48	0.72	0.57	0.72	0.12

*p < .05, †p < .01.

[‡]Odds ratios in the SRRST category were calculated in the low, moderate, and high risk relative to the no risk.

accurate information in accordance with the task tested, but predictive validity of these tests are inadequate in



frail elderly people with multiple risks of falls. This may be explained by the multifactorial nature of falls, which makes the notion of a single screening tool with excellent predictive accuracy an unrealistic goal. Nordin (2008) reported that staff members' assessment of their residents' fall risk as well as history of previous falls appeared superior to performance-based measures of falls in frail elderly people [13]. We therefore examined the utility of an objective assessment tool to identify useful measures for screening frail elderly people for fall risk.

In the comparative analysis, when compared with non-fallers, participants who had experienced falling were more likely to have a fall risk (with the exception of history of stroke and use of slippers and sandals). In contrast, when compared with those without fall-related fractures, participants who had fall-related fractures did not show significant differences in many potential confounding factors, although all SRRST items showed significant differences. These results suggest that the subjective assessment used in the SRRST was useful to examine the risk of fractures in the frail elderly.

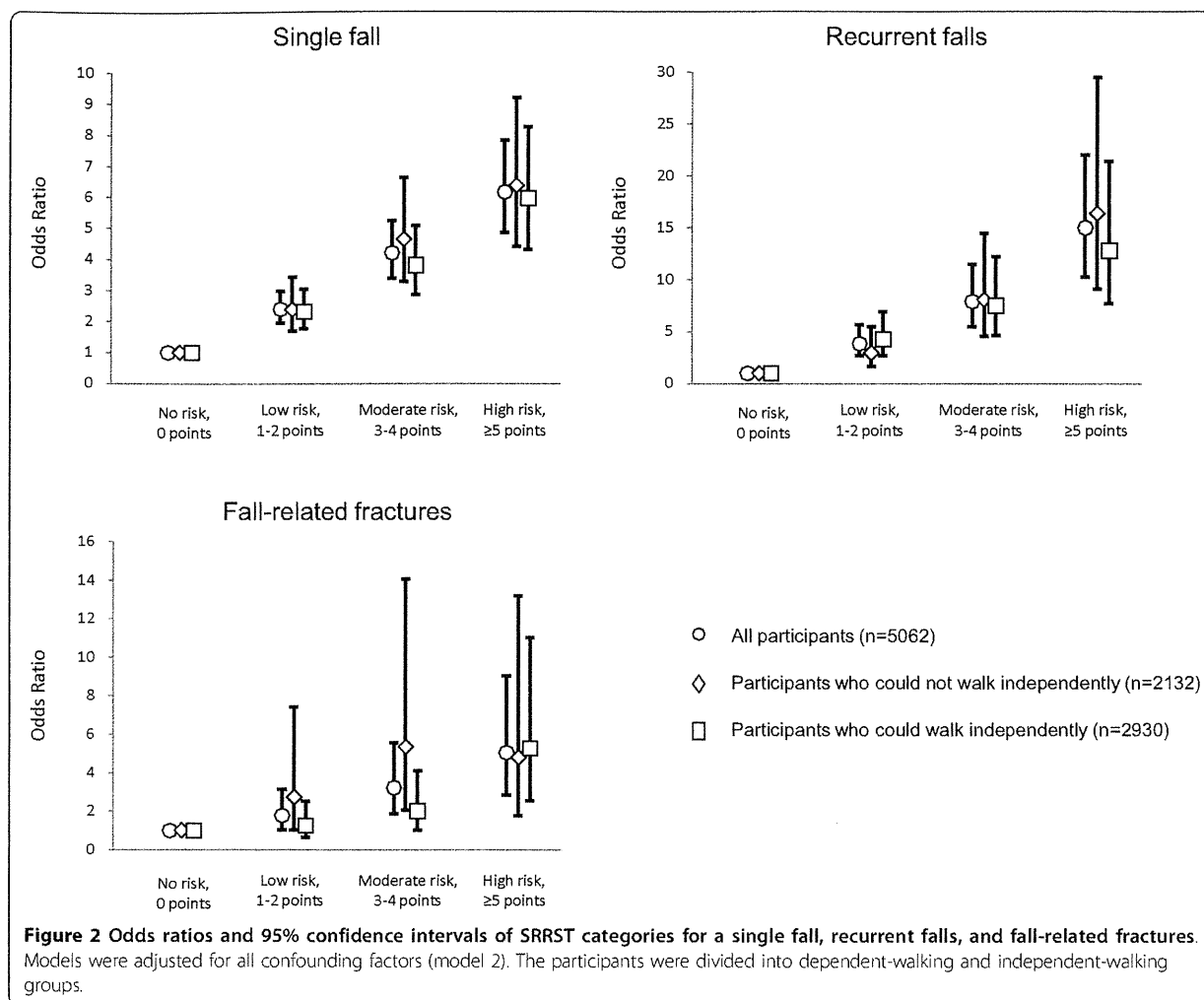


Table 4 Sensitivity and specificity of SRRST scores for falls and fall-related fractures

SRRST score	Single fall		Recurrent falls		Fractures	
	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)	Sensitivity (95% CI)	Specificity (95% CI)
0/1 point	0.91 (0.90 to 0.92)	0.30 (0.29 to 0.32)	0.96 (0.94 to 0.97)	0.28 (0.26 to 0.29)	0.90 (0.85 to 0.94)	0.24 (0.23 to 0.26)
1/2 point	0.80 (0.78 to 0.82)	0.47 (0.45 to 0.49)	0.87 (0.85 to 0.90)	0.44 (0.42 to 0.45)	0.79 (0.72 to 0.84)	0.39 (0.38 to 0.41)
2/3 point	0.66 (0.63 to 0.68)	0.63 (0.61 to 0.64)	0.75 (0.72 to 0.78)	0.60 (0.58 to 0.61)	0.68 (0.61 to 0.74)	0.55 (0.53 to 0.56)
3/4 point	0.48 (0.46 to 0.51)	0.76 (0.75 to 0.78)	0.58 (0.55 to 0.62)	0.74 (0.73 to 0.76)	0.50 (0.43 to 0.57)	0.70 (0.68 to 0.71)
4/5 point	0.30 (0.28 to 0.32)	0.87 (0.86 to 0.88)	0.39 (0.36 to 0.42)	0.86 (0.85 to 0.87)	0.32 (0.26 to 0.39)	0.82 (0.81 to 0.83)
5/6 point	0.14 (0.13 to 0.16)	0.94 (0.93 to 0.95)	0.22 (0.20 to 0.25)	0.93 (0.92 to 0.94)	0.13 (0.09 to 0.19)	0.91 (0.90 to 0.92)
6/7 point	0.07 (0.06 to 0.09)	0.97 (0.97 to 0.98)	0.10 (0.08 to 0.12)	0.97 (0.96 to 0.97)	0.02 (0.01 to 0.05)	0.96 (0.95 to 0.96)

Multiple regression models revealed that the SRRST score was associated with falling as well as fall-related fracture, even when adjusted for many confounding factors. Odds ratios were markedly higher for recurrent falls than for single fall and fall-related fractures. A previous study suggested that infrequent or isolated falls are more unpredictable events than multiple falls and less likely to result from underlying neurologic or musculoskeletal problems [18]. The incidence of fall-related fractures is also influenced by low bone density which was not measured in this study [26-28]. These factors may have weakened the relationships between the SRRST and a single fall and fall-related fractures. Higher odds ratios, however, remained between the SRRST and history of falling and fractures than previously reported odds ratios calculated from the cut-off points of objective performance tests in frail elderly people who participated in the TOUCH [7]. Cut-points for maximizing the sensitivity and specificity were 2/3 point in all of a single fall, recurrent falls and fall-related fractures. Care providers may require attention to risk of falls and fall-related fractures in the frail elderly adults who have a score 3 points and over in the SRRST.

Why did staff assessments show close relationships with falls and fall-related fractures? Falling is induced by multidimensional factors, and the primary cause of falling may vary among frail elderly adults who have many risk factors for falls. Thus, it is difficult to determine the primary risks for falls in all frail elderly adults using objective measures that can identify only specific issues. In contrast, subjective evaluations can determine combined risks of falling based on various information such as physical functions, daily activity status, and risky behaviors, although these evaluations cannot give clear, specific and objective risks for falling. The combined information is important for identifying risks of falls and preventing falls in frail elderly people, because correct risk-assessments by care staff may lead to successful assessment and interventions for preventing falls [29,30]. We reported previously that an intervention study using supervision technique based on the assessment of fall-risk behaviors can reduce the risk of falling in institutionalized elderly people [31]. Thus, we considered that the assessment and intervention used in the SRRST may be useful for preventing falls in frail elderly people. Furthermore, the SRRST has the strength of being designed for frail elderly people. Although risk factors for falls differ between elderly adults who can and cannot stand unaided [32], nearly all risks identified by the SRRST showed significant odds ratios for falls and fall-related fractures in the dependent walking and independent walking groups. Future research should include a prospective measurement of falls in order to more accurately determine the validity of the SRRST for this

population and perform an intervention study to reveal the effects of the SRRST on intervention.

One of the limitations of our study is that we performed a cross-sectional study and analysed retrospectively recalled falls. This is known to be a less accurate measure than prospectively recalled falls [33]. It is possible that underreporting of falls by participants may have led an underestimation of the rates of falls. Therefore, further investigation of the validity of these tests in predicting falls in frail elderly people using a prospective study design is recommended. Second, the investigations of the SRRST and history of falls were investigated at the same time. Thus, the information of the history of falls might affect subjective judgments of the testers. However, correct judgments of the SRRST may require multidimensional information included the history of falls in the elderly adults and testers, i.e. care providers, may know history of falls of their clients through daily care. In other words, testers who had information of falls history in the subjects could measure correctly the risk of falls using the SRRST.

Conclusion

In conclusion, this study developed the SRRST as a subjective assessment for identifying risk of falls in the frail elderly people. Numerous studies developed fall risk assessment tools which evaluate using objective physical or cognitive measurements [2]. Unfortunately, some frail elderly adults cannot perform objective assessments to screen fall risks although these assessment tools may judge almost frail elderly as high risk individuals and identify multiple risks for falling [7]. The SRRST can evaluate easily the specific fall risks and have high feasibility in the elderly. This study provides the evidence that subjective assessment by staff was associated with risk of falling and fall-related fractures in frail elderly people. We encourage providing a fall prevention strategy to the frail elderly who had some risks for falls in your subjective judgments. Future research need to determine the predictive validity of incidence of falls and fractures in the frail elderly people.

Abbreviations

SRRST: Subjective Risk Rating of Specific Tasks; TOUCH: Tsukui Ordered Useful Care for Health; ICC: intraclass correlation coefficient; OR: Odds Ratio; 95% CI: 95% confidence interval.

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