



Otago exercise programme to prevent falls in older adults



A HOME-BASED, INDIVIDUALLY TAILORED STRENGTH AND BALANCE RETRAINING PROGRAMME

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Foreword

Falls are such common events for older people that it is easy to overlook their often very serious consequences for the person and their considerable cost to the country. Falls seem such simple events that the solutions might also appear to be simple. Unfortunately this is not so. Impaired strength and balance contribute to most falls. Improving stability requires a specific, fully tested and safe exercise programme and ongoing commitment by the older person.

In this manual we describe the practical implementation of a strength and balance retraining programme which, in a series of randomised and controlled trials, has been shown to reduce falls by over a third. It can be used alone or in conjunction with other fall prevention methods such as sleeping tablet reduction, improvement of vision and lighting, and advice on home safety.

The programme is the result of many years of research, first identifying risk factors for falls and then testing potential interventions. We would like to acknowledge all the members of the research teams involved and the support of our main funding bodies, ACC, the Health Research Council of New Zealand and the New Zealand Lottery Grants Board. We particularly wish to thank the many older participants, well over 2000, who have willingly given time and effort in the epidemiological and intervention studies.

We are confident that this manual will benefit older people both in New Zealand and overseas and make the contribution of so many participants, researchers and funders worthwhile.



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Summary of key points

PREVENTING FALLS IN OLDER PEOPLE

- Falls are common in people aged 65 years and older and are the leading cause of injury in this age group. They can have serious consequences, including trauma, pain, impaired function, loss of confidence in carrying out everyday activities, loss of independence and autonomy, and even death.
 - The economic costs of falls increase with fall frequency and falls are an independent predictor for admission to long-term care. Healthcare costs can be reduced if falls are reduced.
 - Strength, flexibility, balance and reaction time are considered the most readily modifiable risk factors for falls.
 - People, even in their 90s, can improve their strength and balance to achieve stability and avoid falls.
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OTAGO HOME EXERCISE PROGRAMME

- The programme was designed specifically to prevent falls. It consists of a set of leg muscle strengthening and balance retraining exercises progressing in difficulty, and a walking plan.
 - The exercises are individually prescribed and increase in difficulty during a series of five home visits by a trained instructor.
 - Each person receives a booklet with instructions for each exercise prescribed and ankle cuff weights (starting at 1kg) to provide resistance for the strengthening exercises.
 - The exercises take about 30 minutes to complete. Participants are expected to exercise three times a week and go for a walk at least twice a week.
 - To help them adhere to the programme, participants record the days they complete the programme and the instructor telephones them each month between home visits. Follow-up home visits are recommended every six months.
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THE RESEARCH EVIDENCE

- The Otago Exercise Programme was developed and tested in four controlled trials by a research team at the University of Otago Medical School, New Zealand, led by Professor John Campbell.
- The programme has been evaluated in both research and routine healthcare services in 1016 people aged 65 to 97 living at home.

- Overall the exercise programme was effective in reducing by 35% both the number of falls and the number of injuries resulting from falls. It was equally effective in men and women.
- The programme improved participants' strength and balance and maintained their confidence in carrying out everyday activities without falling.
- A physiotherapist, and nurses trained and supervised by a physiotherapist, successfully delivered the programme.
- The programme's cost effectiveness has been established in two routine healthcare settings.
- In terms of the number of fall injuries prevented, the programme had the greatest effect in high-risk groups: those over 80 years of age and those with a previous fall.

IMPLICATIONS OF THE RESEARCH

- Given that preventing morbidity is the primary purpose of funding healthcare services, there is good evidence to implement this programme to prevent falls and injuries.
- If resources are limited, the exercise programme should be offered first to those aged 80 and older who have fallen in the past year.
- Health professionals with no experience in prescribing exercise for older people will require training and supervision to deliver the programme.
- The programme has been tested as a stand-alone intervention but could be delivered as part of a multifactorial falls prevention programme.

PURPOSE OF THIS MANUAL

This manual:

- Is designed for health professionals and those managing healthcare services for older people
- Outlines the research evidence for the Otago Exercise Programme
- Provides the practical details needed for a health professional to prescribe the programme.

THE PROBLEM OF FALLS

Falls are a major public health problem because they are common in people aged 65 and older and are the leading cause of injury in this age group. Falls can have serious consequences: trauma, pain, impaired function, loss of confidence in carrying out everyday activities, loss of independence and autonomy, and even death.

Around one-third of generally healthy people aged 65 and older will have at least one fall each year, and a key concern is that the rate of falls and severity of the resulting complications increase dramatically with age.^{1,2} The majority of falls occur because of multiple interacting factors, but leg muscle weakness and impaired balance contribute to most falls.

The economic costs of falls increase with fall frequency and falls are an independent predictor for admission to long-term care.^{3,4} Therefore healthcare cost savings for both acute and long-term care can be expected if falls are reduced.

EXERCISE TO PREVENT FALLS

The frequency and serious consequences of falls in older people led the New Zealand Falls Prevention Research Group to develop and test programmes specifically designed to prevent falls.

One successful intervention, the Otago Exercise Programme, is a muscle strengthening and balance retraining programme delivered at home by a trained instructor. The rationale behind it is that muscle strength, flexibility, balance and reaction time are the risk factors for falls considered the most readily modified.

Both leg muscle strength and balance must be maintained above the threshold level required to achieve stability. Even people in their 90s can improve their strength and balance sufficiently to avoid falls.

Other potential benefits of moderate physical activity are lower death rates and improved physical health, physical function, health-related quality of life, sleep, and sense of wellbeing.⁵⁻⁷

PURPOSE OF THIS MANUAL

This manual was designed for health professionals and others working with older people or planning and managing healthcare services.

Firstly it outlines the research evidence showing that the Otago Exercise Programme is effective in reducing falls and injuries in older people living at home.

Secondly it provides all the details needed for a physiotherapist or other trained instructor to implement the programme immediately. The instructions and exercise sheets in Appendix 3 can be photocopied and made up into a booklet for each participant using a folder with clear pockets. Apart from ankle cuff weights to provide resistance for the strengthening exercises, no other equipment is needed.

Finally, the manual provides funders, managers and supervisors with information about the resources and practical details needed to implement the programme, identify those older people most likely to benefit from it, and therefore how to achieve the best value for money.

There is good research evidence that the Otago Exercise Programme reduces falls and injuries in older people living in the community.

The manual and programme are ready for implementation.

Summary of the research

PAST STUDIES showed that (1) poor strength and balance are risk factors for falls and injuries in older people and (2) strength and balance can be improved by specific exercises.

THE QUESTIONS Can a strength and balance retraining programme prescribed at home reduce falls and injuries in older people? Does the programme work when delivered from within usual healthcare practice?

THE OTAGO EXERCISE PROGRAMME is a set of leg muscle strengthening and balance retraining exercises designed specifically to prevent falls. It is individually prescribed and delivered at home by trained instructors.

FOUR CONTROLLED TRIALS assessed whether the programme reduced falls and injuries in community-living older people. 1016 women and men aged 65 to 97 were invited by their doctors to take part.

Overall the exercise programme reduced by 35% both the number of falls and the number of injuries resulting from falls. It was effective when delivered by a research physiotherapist and by trained nurses from a community home health service and primary healthcare practices.

WHO MAY BE AFFECTED BY THESE FINDINGS?

All older people living in the community.

CAVEATS It is not known whether prescribing alternative exercises, making fewer than four home visits, or implementing the programme in a group or institutional setting will be effective in reducing falls.

BOTTOM LINE Best value for money will be achieved if the programme is offered to those aged 80 and older who have fallen in the past year.

FIND THESE STUDIES Trial 1: Campbell AJ et al. *BMJ* 1997;315:1065-1069; Campbell AJ et al. *Age Ageing* 1999;28:513-518.

Trial 2: Campbell AJ et al. *J Am Geriatr Soc* 1999; 47:850-853.

Trial 3: Robertson MC et al. *BMJ* 2001;322: 697-701.

Trial 4: Robertson MC et al. *BMJ* 2001;322: 701-704.

Process and impact evaluation: Gardner MM et al. *Prev Med* 2002;34:546-553.

Meta-analysis of the four trials: Robertson MC et al. *J Am Geriatr Soc* 2002;50:905-911.

“How to do it”: Gardner MM et al. *Age Ageing* 2001;30:77-83.

The research evidence

The Otago Exercise Programme has been tested in four separate controlled trials of community-living people in nine cities and towns in New Zealand (see Table 1).⁸⁻¹² The 1016 participants in the trials (23% were men) were aged from 65 to 97 years and 810 (80%) were 80 or older. They were recruited through 64 primary care practices and the most common reason they gave for agreeing to take part was that their doctor had recommended the programme.

The participants had a wide range of physical health and function and 434 (43%) reported falling in the previous year. They were excluded only if they were unable to walk around their home, were receiving physiotherapy at the time, or were unable to understand the trial's requirements.

Falls were the main outcome in each trial and were defined as "unintentionally coming to rest on the ground, floor or other lower level". Falls were monitored using return-addressed, postage-paid, tear-off, monthly postcard calendars filled in daily by each participant.

This section summarises the main results from each of the four trials and a combined analysis which identified the subgroups most likely to benefit from the programme. It also gives a brief overview of the economic evaluations. The Otago Exercise Programme is described in detail in later sections of this manual and the text and exercise sheets for participants are provided in Appendix 3.

More details about the trials are available in the papers reporting the results⁸⁻¹², a process and impact evaluation¹³, comprehensive economic evaluations^{11 12 14} and a meta-analysis.¹⁵ The programme's efficacy is endorsed in a Cochrane Collaboration systematic review.¹⁶

TRIAL 1

The Otago Exercise Programme was first tested in a randomised controlled trial of women aged 80 years and older.⁸

Compared with an equal number of social visits, the exercise programme successfully reduced the risk of falling by 32% and the risk of a fall injury by 39% over one year. This trial was extended for a second year when telephone contact was maintained but no further home visits were made; the significant reduction in falls and injurious falls continued.⁹

TRIAL 2

A second randomised controlled trial tested two interventions to prevent falls in people aged 65 and older who regularly took psychotropic (sleeping) medication.¹⁰ The programmes were gradual withdrawal of psychotropic medication and the Otago Exercise Programme.

There was a 66% reduction in falls in those who withdrew from their medication compared with those continuing to take their original medication. However, one month after the trial's completion 47% (8 of 17) of participants who had their medication withdrawn had restarted it; permanent withdrawal is very difficult to achieve.

In this younger sample, there was no evidence that the Otago Exercise Programme reduced falls.

- In both Trial 1 and Trial 2, a physiotherapist delivered the exercise programme in a tightly controlled research setting.

In order to test the exercise programme in a “real life” situation, two further trials were run from routine healthcare service settings.

TRIAL 3

In this randomised controlled trial a community nurse in a home health service was trained to deliver the Otago Exercise Programme.¹¹ Participants were men and women aged 75 years and older.

After one year, falls were reduced by 46% compared with usual care, and fewer participants had a serious fall injury (that is, a fracture, admission to hospital or required stitches). An unexpected finding was that falls were reduced in those aged 80 and older, but there was no significant reduction in the 75 to 79 year olds.

TRIAL 4

The Otago Exercise Programme was tested again in people 80 and older in a community implementation trial.¹² A general practice nurse was trained to deliver the programme in each of three exercise centres and there were four control centres.

After one year falls were reduced by 30% compared with usual care, and injuries (moderate and serious combined) were reduced by 28%.

A process and impact evaluation showed that the programme was acceptable to older people and their doctors.¹³ Around 70% of the exercise participants were still exercising at the end of one year and 43% exercised each week as prescribed. Balance and strength improved by a similar amount in each exercise centre.

- These second two trials showed that it is feasible for nurses, trained and closely supervised by an experienced physiotherapist, to deliver the programme.

ECONOMIC EVALUATIONS

Comprehensive economic evaluations of the exercise programme have been carried out in three different settings.^{11 12 14}

The cost to the health system of introducing the programme to an existing health service was approximately NZ\$420 per person for the first year.* Cost items included the training course, time and transport costs for the home visits by the nurses delivering the programme, the ankle cuff weights used for muscle strengthening, and quality control visits by the supervising physiotherapist.

The cost of implementing a falls prevention programme is important but is not the only consideration. Also important are both the consequences of the programme, such as an increase or decrease in the use of other health-care resources, and the benefits in terms of the number of falls and injuries prevented. Cost effectiveness ratios, by combining the costs, consequences and benefits into a single measure, give an indication of value for money for comparison purposes.

In Trial 3, the exercise programme cost NZ\$1,803 per fall prevented, and in Trial 4, NZ\$1,519 per fall prevented. Programme implementation costs per injurious fall prevented were NZ\$3,404 and NZ\$7,471 in Trials 3 and 4 respectively.

In Trial 3, fewer participants in the exercise group were admitted to hospital as a result of an injury from a fall. Since the programme was more effective in those 80 and older, the result was a cost saving of NZ\$576 per fall prevented in this group when hospital cost savings were taken into account.

Overall, the average hospital cost per participant resulting from a fall was more than one-third less in the exercise group, however this difference was not statistically significant.

COMBINING THE RESULTS

A meta-analysis combined the data from all four trials.¹⁵

Overall the effect of the exercise programme was a 35% reduction in the number of falls and a 35% reduction in the number of fall-related injuries.

Combining the data was an opportunity to determine which subgroups in the trials benefited most from the exercise programme.

- The programme was more effective for those aged 80 and older than for the 65 to 79 year olds, especially in terms of injurious falls prevented. It may be that even small improvements in strength and balance in the older age group place them above the threshold needed for stability. In addition, those aged 80 and older fall more often so there are more falls to prevent.

* At 1998 prices less government goods and services tax.
In 1998 NZ\$1.00 = US\$0.54 and £0.32.

- Those with and without a previous fall benefited equally from the programme. However, those with a history of falling fall more frequently and again there are more falls to prevent.
- Both men and women benefited equally with an overall 35% reduction in falls.

The combination of the programme's effectiveness within the subgroups investigated and the fact that some subgroups fall more frequently resulted in the benefit in each subgroup shown in Table 2. In terms of the number of falls and injurious falls prevented by the exercise programme, those aged 80 and older and those with a previous fall benefited most.

Combining the results from the four trials highlighted the fact that the programme prevented the most falls and injuries in those aged 80 years who had fallen in the previous year.

Two simple physical assessments (the chair stand test and four-test balance scale) showed improved strength and balance in exercise group participants.

They also maintained confidence in being able to carry out daily activities without falling. This is important because people afraid of falling may become physically inactive, which will result in further declines in muscle strength and balance.

There were very few adverse events in the trials due to the exercise programme.

The Otago Exercise Programme is a safe, effective, practical, eminently feasible and low-cost falls prevention strategy from which our older citizens can benefit right now.

TABLE 1 SUMMARY OF THE FOUR TRIALS*

Trial features	Trial 1 Dunedin Study A ^{8,9}	Trial 2 Dunedin Study B ¹⁰	Trial 3 West Auckland trial ¹¹	Trial 4 Southern New Zealand trial ¹²
Trial sample	Women aged ≥80	Women and men aged ≥65 currently taking psychotropic medication	Women and men aged ≥75	Women and men aged ≥80
Sample size	Year 1: 233 Year 2: 152	93	240	450
Trial design	Randomised controlled trial	Randomised controlled trial; 2 x 2 factorial design (4 groups)	Randomised controlled trial	3 exercise centres, 4 control centres
Interventions	(1) Exercise programme (n=116) versus (2) Social visits and usual care (n=117)	(1) Exercise programme (2) Gradual withdrawal of psychotropic (sleeping) medication—a double blind intervention	(1) Exercise programme (n=121) versus (2) Usual care (n=119)	(1) Exercise programme (n=330) versus (2) Usual care (n=120)
Exercise instructor	Physiotherapist	Physiotherapist	Community nurse	General practice nurses
Number of home visits	4	4	5	5
Setting	Research	Research	Community health service	General practices
Fall events monitored	2 years	44 weeks	1 year	1 year
Key results	Exercise programme reduced falls by 32% in year 1 For those who kept exercising, benefit continued in year 2	Falls reduced by 66% in those who withdrew from psychotropic medication Exercise programme did not reduce risk of falling	Exercise programme reduced falls by 46%	Exercise programme reduced falls by 30%

*Adapted from Robertson MC et al. *J Am Geriatr Soc* 2002;50:905-911¹⁵

TABLE 2 ◀ COMBINED ANALYSIS OF THE FOUR TRIALS: NUMBER OF FALL EVENTS PREVENTED IN SUBGROUPS*

Subgroup	Falls prevented per 100 person years	Injurious falls prevented per 100 person years
Aged ≥80, fall(s) in previous year	54.0	28.8
Fall(s) in previous year	44.3	20.9
Aged ≥80	40.8	20.1
All participants (aged 65 to 97 years)	33.9	15.8
Aged ≥80, no fall in previous year	25.8	11.6
No fall in previous year	23.6	11.0
Aged 65 to 79	5.4	-2.3

*From Robertson MC et al. *J Am Geriatr Soc* 2002;50:905-911¹⁵

Guide to implementation of the programme

The Otago Exercise Programme is a set of muscle strengthening and balance retraining exercises delivered during four or five home visits by a trained instructor. The main features of the programme are listed in Table 3.

This section contains guidelines for a physiotherapist or trained instructor when delivering the programme to older people living at home. A “How to do it” paper has also been published.¹⁷

PROGRAMME SCHEDULE

- Visit the person four or five times to individually prescribe and develop the flexibility exercises, the strength and balance exercises listed in Table 4, and a walking plan. In the trials, home visits were made at weeks one, two, four and eight, and after six months (see Table 3.1).
- Allow one hour for the first home visit and approximately 30 minutes for subsequent visits.
- The programme always starts with five minutes of gentle warm-up with the same five flexibility exercises (provided in Appendix 3).
- The exercises (flexibility, strengthening, balance) will take approximately 30 minutes to complete and should be done three times a week, with rest days between.
- Advise the person to walk for up to 30 minutes at least twice a week if safe.

- Between home visits telephone the person to check on progress, advise on any problems, and maintain motivation.
- Calendars or diaries can be used to monitor exercise compliance and any falls.

Use the text and illustrated instructions for each exercise in Appendix 3 to make up an instruction booklet for each participant.

THE FIRST HOME VISIT

On the first visit (1) establish a good working relationship with the participant, (2) explain the rationale for the programme, (3) take a clinical history and assess the factors that will influence safety and adherence to the programme, (4) make baseline strength and balance measurements, (5) prescribe a set of exercises and encourage the person to become familiar with the instructions for each exercise, and (6) if possible, introduce a safe walking plan.

Lower limb muscle strength and balance can be assessed using two simple tests: the chair stand test and the four-test balance scale (see Appendix 1).^{18 19} These tests are simple, valid and reliable, and require no special equipment apart from a stopwatch. They will give an indication of any impairments the older person may have and will also provide a useful reference for gauging future improvements.

Assess baseline strength and balance, and determine the appropriate exercises and the appropriate level at which the person can start the programme (the exercises are listed in Table 4).

THE STRENGTH AND BALANCE EXERCISES

The strengthening exercises focus on major lower limb muscles:

- Knee flexors, knee extensors and hip abductors, which are particularly important for functional movements and walking
- Ankle dorsiflexor and plantarflexor muscles, which are particularly important for recovering balance.

Ankle cuff weights provide resistance to the knee flexors, knee extensors and hip abductors; the ankle dorsiflexors and plantarflexors are strengthened using body weight alone.

The balance exercises are dynamic as opposed to static. They can help to maintain balance but will also improve the recovery of balance.

During home visits prescribe each person a set of exercises that suits overall health and ability, and aim to increase the difficulty of the exercises at subsequent visits.

THE WALKING PLAN

Advise the person to include walking in the exercise programme to help increase physical capacity. Note that walking will not on its own result in a reduction in falls.

- Participants should aim for up to 30 minutes, walking at their usual pace, at least twice a week, if safe.
- The walking can be broken up into shorter sessions, for example three 10-minute sessions.

Use the chart provided in Appendix 2 to record the exercises and levels prescribed at each home visit and the time the person will walk.

EXERCISE PROGRAMME PRESCRIPTION

TECHNIQUE

Demonstrate, explain and closely observe the person performing the exercises, ensuring that the person:

- Completes five minutes of gentle warm-up (flexibility) exercises first
- Has appropriately tailored exercises
- Is happy to continue the exercises unsupervised between visits.

STRENGTHENING EXERCISES

- The starting level is determined by the amount of ankle cuff weight the person can use to perform 8 to 10 good quality repetitions before fatigue. This needs to be assessed for each muscle group on each leg. People aged 80 and older will usually start with 1kg to 2kg. In the trials, participants used up to 8kg.
- Note: starting light initially will minimise both muscle soreness and compliance problems.

For the strengthening exercises ensure that:

- The person uses ankle cuff weights where possible
- There is minimal substitution of other muscle groups
- The person uses the correct breathing technique (inhale before a lift, exhale during, and inhale while lowering the lift)

- The person does the exercises slowly (two to three seconds to lift the weight, four to five seconds to lower the weight) through the functional range of active joint movement
- The person takes a one to two minute rest between sets
- Apart from the “front knee strengthening” exercise, which is done sitting, all strengthening exercises are performed standing (this aids balance as well as strength)
- The exercises are of moderate intensity; the person should not get unduly tired.

BALANCE RETRAINING EXERCISES

- Observe the person during the holding version of each balance exercise and be confident he or she can recover balance using lower body strategies (as opposed to grabbing with their arms) before prescribing the exercise without support.
- Not everyone will start at the first level or be prescribed all the balance exercises. Unstable people may initially need a wider base of support.

For the balance exercises ensure that:

- The person’s eyes stay looking ahead
- The person knows that it is fine to make lower limb balance adjustments, such as a recovery step, while doing the exercise.

PROGRAMME RESOURCES

Each person receives:

- A booklet with illustrations and instructions in large print for the exercises currently prescribed in their individualised programme
- One or more ankle cuff weights, which must be easy to take on and off.
Note: the weight of the ankle cuff will need to be increased as strength improves
- A calendar or diary to monitor exercises and record any falls.

The exercise instructor has:

- A stopwatch for the assessments
- A copy of Table 4, which lists the exercises and lists progressions
- Photocopies of the booklet text and instructions for each exercise at each level, ready to place in a folder for the person as each exercise is prescribed at the appropriate level. These are provided in Appendix 3
- A chart to record the strengthening and balance exercises and levels prescribed for each person at each visit (provided in Appendix 2).

PROGRESSIONS IN FOLLOW-UP VISITS

STRENGTHENING EXERCISES

- Increase strengthening exercises by adding additional ankle cuff weights or increasing the number of sets performed, according to Table 4.
- As a guide, the participant should be able to complete two sets of 10 before progressing to the next level of the exercise.
- Weigh the benefits of using heavier weights against the potential risk of adverse side effects (injury, cardiovascular events, non-compliance).

BALANCE RETRAINING EXERCISES

- Balance exercises progress from holding on to a stable structure to performing the exercise independent of support.
- Levels of exercise progress according to Table 4.

ADDITIONAL SAFETY MEASURES

- Advise people with rheumatoid arthritis, osteoarthritis or other painful conditions to work in a pain-free range.
- Advise the person to stop exercising and contact the doctor if dizziness, chest pain and/or shortness of breath occurs while exercising, or muscle pain that doesn't cease.

- If there is a fall, advise the person to see the doctor and to consider other successful injury prevention strategies, for example hip protector pads.
- If illness interrupts maintenance of the exercise programme the person should contact the instructor before starting again.

MAINTAIN TO SUSTAIN

The exercises must be maintained to sustain the benefits.

Strategies to help achieve this are:

- Start the programme slowly and set realistic progressions
- Provide ongoing support and motivation including telephone contact between home visits
- Provide booster visits as necessary, particularly if the programme needs to be restarted or modified after a short-term illness
- Encourage walking and other physical activities (note walking will not lower the risk of falls on its own)
- Combine with group programmes, for example meet once a week with friends to reinforce the programme
- Involve family members
- Involve the person's doctor.

MONITORING

Some simple measures can be used to monitor the programme's success:

- Calendars can be completed each month to document any falls. The circumstances of falls can be followed up in phone interviews. A calendar or diary can be used to monitor compliance with the exercise programme
- Simple strength and balance tests (such as the four-test balance scale and the chair stand test) can be repeated periodically and progress assessed against the initial assessment.

TABLE 3 MAIN FEATURES OF THE OTAGO EXERCISE PROGRAMME

	Strengthening	Balance retraining	Walking
Activities	5 leg muscle strengthening exercises, with up to 4 levels of difficulty*	12 balance retraining exercises, with up to 4 levels of difficulty*	Advice about walking
Assessment	The amount of weight in ankle cuff should allow 8–10 repetitions before fatigue	Set each exercise at a level that the person can safely perform unsupervised	Discuss present walking activities
Intensity	Moderate	Moderate	Usual pace with usual walking aid
Progressions*	Increase to 2 sets of repetitions. Increase the weight of the ankle cuff	From supported exercise to unsupported exercise	
Frequency	At least 3 times a week, with rest day between	At least 3 times a week	At least 2 times a week
Duration	Approximately 30 minutes to do the flexibility, strength and balance exercises; exercises can be divided up over the day		30 minutes; can be broken down to three 10-minute walks throughout the day

*The exercises at each level of difficulty are shown in Table 4

TABLE 3.1 OTAGO EXERCISE PROGRAMME SCHEDULE

Month			1	2	3	4	5	6	< Monthly >	12
Week	1	2	4	8						
Home exercise visits	X	X	X	X				X		X
Telephone follow-up					X	X	X		X	
Monitoring of exercises completed			X	X	X	X	X	X	X	X
Monitoring of any falls			X	X	X	X	X	X	X	X

TABLE 4 ▶ LEVELS AND NUMBER OF REPETITIONS FOR THE STRENGTHENING AND BALANCE RETRAINING EXERCISES

Strengthening exercises			
	ALL 4 LEVELS		
1	Knee extensor (front knee strength)	Ankle cuff weights are used to provide resistance to the muscles and 10 repetitions of each exercise are carried out	
2	Knee flexor (back knee strength)		
3	Hip abductor (side hip strength)		
		LEVEL C	LEVEL D
4	Ankle plantarflexors (calf raises)	10 repetitions, hold support, repeat	10 repetitions, no support, repeat
5	Ankle dorsiflexors (toe raises)	10 repetitions, hold support, repeat	10 repetitions, no support, repeat

Balance retraining exercises				
	LEVEL A	LEVEL B	LEVEL C	LEVEL D
1	Knee bends 10 repetitions Hold support	i) 10 repetitions, no support or ii) 10 repetitions, hold support, repeat	10 repetitions No support, repeat	3 x 10 repetitions No support
2	Backwards walking	10 steps, 4 times Hold support		10 steps, 4 times No support
3	Walking and turning around	Walk and turn around (make figure of 8) twice Use walking aid	Walk and turn around (make figure of 8) twice No support	
4	Sideways walking	10 steps, 4 times Use walking aid	10 steps, 4 times No support	
5	Tandem stance (heel toe stand) 10 seconds Hold support	10 seconds No support		
6	Tandem walk (heel toe walk)		Walk 10 steps Hold support, repeat	Walk 10 steps No support, repeat
7	One leg stand	10 seconds, hold support	10 seconds, no hold	30 seconds, no hold
8	Heel walking		10 steps, 4 times Hold support	10 steps, 4 times No support
9	Toe walk		10 steps, 4 times Hold support	10 steps, 4 times No support
10	Heel toe walking backwards			Walk 10 steps No support, repeat
11	Sit to stand 5 stands, 2 hands for support	i) 5 stands, one hand or ii) 10 stands, 2 hands for support	i) 10 stands, no support or ii) 10 stands, 1 hand for support, repeat	10 stands, no support Repeat
12	Stair walking	As instructed	As instructed	As instructed, repeat

Practical implications of the research

The research reported in this manual adds to the growing body of evidence that falls and resulting injuries can be prevented.

Since older people who fall are more likely to shift to long-term care, preventing falls will help maintain independence for older people living in the community. Falls prevention programmes have the potential to save hospital admission and long-term care costs, the major costs associated with fall-related injuries.

Unfortunately many falls prevention programmes are run in the community regardless of any evidence of effectiveness. Some trials have shown particular interventions to be ineffective in reducing falls and injuries, or even harmful.¹⁶

The Otago Exercise Programme has been tested in four controlled trials and shown to reduce falls and injuries in older people living at home particularly in those 80 and older.

No other falls prevention programme has been tested in such a comprehensive way. Another strength of the evidence is that the programme has been tested beyond a research setting and has proven appropriate and effective when delivered from routine healthcare practice.

Given that prevention of morbidity is the primary purpose of funding healthcare services, there is good evidence to implement this programme to prevent falls and injuries in older people.

This section outlines some practical points to consider when implementing the research findings.

EXERCISE INSTRUCTOR TRAINING

The programme worked in reducing falls and injuries when delivered by a physiotherapist, or nurses who attended a one-week training course and were supervised during the trials by a physiotherapist.

Exercise instructor training should outline the research evidence and rationale for the programme and give clear guidelines for delivery. It should also extend to supervision and ongoing support while implementing the programme.

The instructor must be able to:

- Clearly explain the rationale and benefits of the programme to participants
- Assess the participants and individually tailor the programme to meet variations in physical capacity and health
- Ensure participants can perform the exercises safely and confidently, with correct movement patterns

- Advise on safety precautions for physical impairments such as arthritis or joint replacements
- Monitor the programme and provide appropriate advice and progressions based on the participants' responses to the exercises
- Adapt the programme as necessary after periods of illness
- Provide support and motivation to each participant.

Adequate supervision of the instructor by a physiotherapist is required, especially instructors with no prior experience in exercise prescription to older people.

The supervisor should:

- Be available by telephone to answer questions and to give advice and encouragement to the instructor
- Periodically carry out site visits to ensure the quality of the programme prescription is maintained. If the instructor is a physiotherapist, peer review will suffice.

PROGRAMME PRESCRIPTION AND IMPLEMENTATION

Activities common to older people such as walking and gardening are not associated with gains in muscle strength or with halting of the muscle atrophy associated with ageing. Personalised strength and balance retraining exercises are required, and will possibly be a new concept for older people.

The gains in strength and balance in trials testing the Otago Exercise Programme were achieved by individually prescribing exercises. Ankle cuff weights were necessary to provide resistance and all the exercises (except for the knee extensors) were performed standing.

In the trials, the programme's effectiveness was established with a series of four or five home visits. Fewer home visits may result in a lack of progression or alternatively rapid progressions in the level of exercise difficulty, which may decrease compliance or increase the risk of injury.

It is not known whether the programme, if modified, will achieve the required gains in strength and balance to reduce falls.

Cautionary notes:

- Promoting activity and independence has certain risks associated with it. Although there were very few adverse events in the research trials as a result of the exercise programme, it is important to be aware that the programme does require an increase in physical activities such as daily walks, presenting increased opportunities for falling.
- It is advisable to contact the person's doctor and seek a medical clearance and any other significant health-related history before initiating the programme.

TARGETING

Participants in randomised controlled trials are usually selected using strict criteria and their compliance is often above average. The participants in the trials testing the Otago Exercise Programme had a wide range of physical abilities and the programme significantly reduced falls and injuries, even though strict compliance with the exercises prescribed was around 43%.

The results of the trials are relevant to all older people living in the community who are able to understand and follow the instructions for the exercises, and who are able to exercise safely on their own.

The controlled trials did indicate an overall 35% reduction in fall rates in participants aged 65 and older who live at home.

However, the research indicated that the high-risk groups who will benefit most are easy to identify: those aged 80 and older and those who have fallen previously.

With increasing age there is a progressive loss of muscle strength and stability, but the weakness needs to reach a certain threshold before daily functions are affected. It is possible that, when the person is near this threshold, even small gains in strength and balance can lead to a significant improvement in stability.

COST OF THE PROGRAMME

The costs of implementing the programme will vary depending on factors such as the geographic spread of participants, whether training and supervision of the instructor are available in the same centre, the cost of ankle cuff weights that are easy to put on, whether office accommodation is available, and the expectations of the funder.

In the research trials, each exercise instructor worked half time on average for 18 months to recruit and deliver the programme for one year to around 100 people. Following the initial series of home visits the benefits of the programme were sustained with very little extra resource; this was shown when Trial 1 was extended over a two-year period.

The research showed that best value for money will be achieved if the programme is first offered to those 80 and older living in the community reporting a fall in the previous year.

CONTEXT

The Otago Exercise Programme has not been tested in a context other than the home-based community setting.

The programme will be suitable for some institutionalised older people, but those in long-term care are frailer and cognitive impairment and dementia are common.

Those who attend a group exercise programme may be younger and less frail than the participants in the trials.

It is not known whether implementing the programme in a group or long-term care setting will be effective in reducing falls and injuries.

The programme was tested as a stand-alone intervention, but could be combined with other falls prevention strategies delivered to older people living at home.

Although tested as a stand-alone intervention the Otago Exercise Programme could be delivered as part of a multifactorial falls prevention programme.

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CHAIR STAND TEST

- Use a straight-backed firm chair with no armrests.
- Place the chair with a wall behind for safety.
- Instruct the person to stand up and sit down as quickly as possible five times with the arms folded.
- Using a stopwatch, record in seconds the time taken to stand up and sit down five times.
- Allow a maximum of two minutes to complete the test.

Scoring unsuccessful/successful; time taken in seconds.

Reference: Guralnik JM et al. *J Gerontol Med Sci* 1994;49:M85-94.

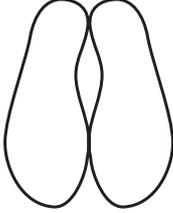
FOUR-TEST BALANCE SCALE

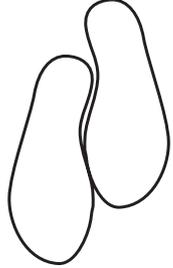
- Includes four timed static balance tasks of increasing difficulty that are completed without assistive devices (see figure opposite for position of feet).
- No practices are allowed before each task.
- The test is carried out in bare feet.
- The assessor can help the person to assume each foot position, then the person should indicate when ready to begin unaided.
- If the person cannot assume the position, do not continue (failed task).
- The person must hold each position for 10 seconds before progressing to the next task.
- Timing is stopped if:
 - The person moves their feet from the proper position
 - The assessor provides support to prevent a fall
 - The person touches the wall or external object for support.

Scoring feet together stand unsuccessful/highest level task successful or see Rossiter-Fornoff JE et al. *J Gerontol Med Sci* 1995;50A:M291-297.

THE FOUR-TEST BALANCE SCALE STANDS*

- 1 FEET TOGETHER STAND**


- 2 SEMI-TANDEM STAND**

 - The person chooses which foot is placed in front
 - Hold for 10 seconds
- 3 TANDEM STAND**

 - The person chooses which foot is placed in front
 - Hold for 10 seconds
- 4 ONE LEG STAND**

 - The person chooses which foot to stand on
 - Timing starts as soon as the person raises one foot off the ground
 - We chose to extend the maximum length of time of the one leg stand test from 10 seconds to 30 seconds to lessen the ceiling effects of this test

*From Gardner MM et al. *Age Ageing* 2001;30:77-83

APPENDIX 2 EXERCISE PRESCRIPTION CHART

Name	Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	Visit 6
Date						
1 Head movements						
2 Neck movements						
3 Back extension						
4 Trunk movements						
5 Ankle movements						
* LEVEL						
1 Front knee strengthen (kg)						
2 Back knee strengthen (kg)						
3 Side hip strengthen (kg)						
4 Calf raises						
5 Toe raises						
1 Knee bends						
2 Backwards walk						
3 Walk and turn						
4 Sideways walk						
5 Heel toe stand						
6 Heel toe walk						
7 One leg stand						
8 Heel walking						
9 Toe walking						
10 Heel toe walk backwards						
11 Sit to stand						
12 Stair walking (number)						
Walking time (minutes)						

* see Table 4, page 19 for level of difficulty A to D; if an exercise is not prescribed put a dash (-)

Otago exercise programme to prevent falls activity booklet

- Monitor your progress using a calendar or diary
- When you have completed your exercises write an “E” for that day on your calendar
- When you have gone for a walk write a “W” for that day on your calendar

THIS EXERCISE PROGRAMME WAS DESIGNED BY MELINDA GARDNER, RESEARCH PHYSIOTHERAPIST
NEW ZEALAND FALLS PREVENTION RESEARCH GROUP FEBRUARY 2001

Welcome to the programme! The exercise programme that you will undertake has been designed specifically for you.

The benefits of exercise are plentiful. By maintaining your programme, you can improve:

- Balance
- Muscle strength
- General fitness
- General well-being.

You need to do the prescribed exercises three times each week. You can divide the exercises up. They do not all have to be done at the same time.

Between each set of exercises take three deep breaths or more.

You may feel a bit stiff after you first start to exercise. This is quite normal. It is because you are using muscles which may not be used to the exercise. It is important that you keep on exercising. The stiffness will leave as your body becomes more familiar with the exercise.

Safety

Never exercise holding on to an object which may move, for example a chair. Always use the side of something stable like a bench or solid table unless otherwise instructed.

If illness stops you from maintaining the exercise programme contact your instructor before starting again.

Contact your doctor if while exercising you experience...

- Dizziness
- Chest pain
- Shortness of breath (you are unable to speak because you are short of breath).

If you have any questions about the exercise programme please do not hesitate to telephone me:

Day to day

Did you know that you can improve your general fitness simply by being more active in your day-to-day life?

32

Here are some examples of activities to build into your day:

- Walk instead of driving to the shops
- Walk to talk to a neighbour instead of phoning
- Take the stairs rather than the lift or escalator
- Get off the bus a block early and walk home
- When visitors and family arrive, go for a walk with them before having a cup of tea
- Garden when the weather permits
- Stand to fold washing.

Walking

Walking is an excellent way to enhance your general fitness.

Try going for a walk on the days between your exercises.

Try to increase the distance you walk and the time you spend walking. Take advantage of fine weather to go walking.

TIPS FOR WALKING

- Wear comfortable shoes and clothing.
- Start with a warm-up – marching on the spot for two minutes.

WHEN YOU WALK

- The shoulders are relaxed and the arms gently swing.
- Look ahead, not down.
- With each step the heel lands first, then you push off on the toes.
- Finish with a warm-down – marching on the spot for two minutes.
- Enjoy yourself!

Head movements

- Stand up tall and look ahead
- Slowly turn your head as far as you can to the right
- Slowly turn your head as far as you can to the left
- Repeat five times to each side



Neck movements

- Stand up tall and look ahead
- Place one hand on your chin
- Guide your head straight back
- Repeat five times



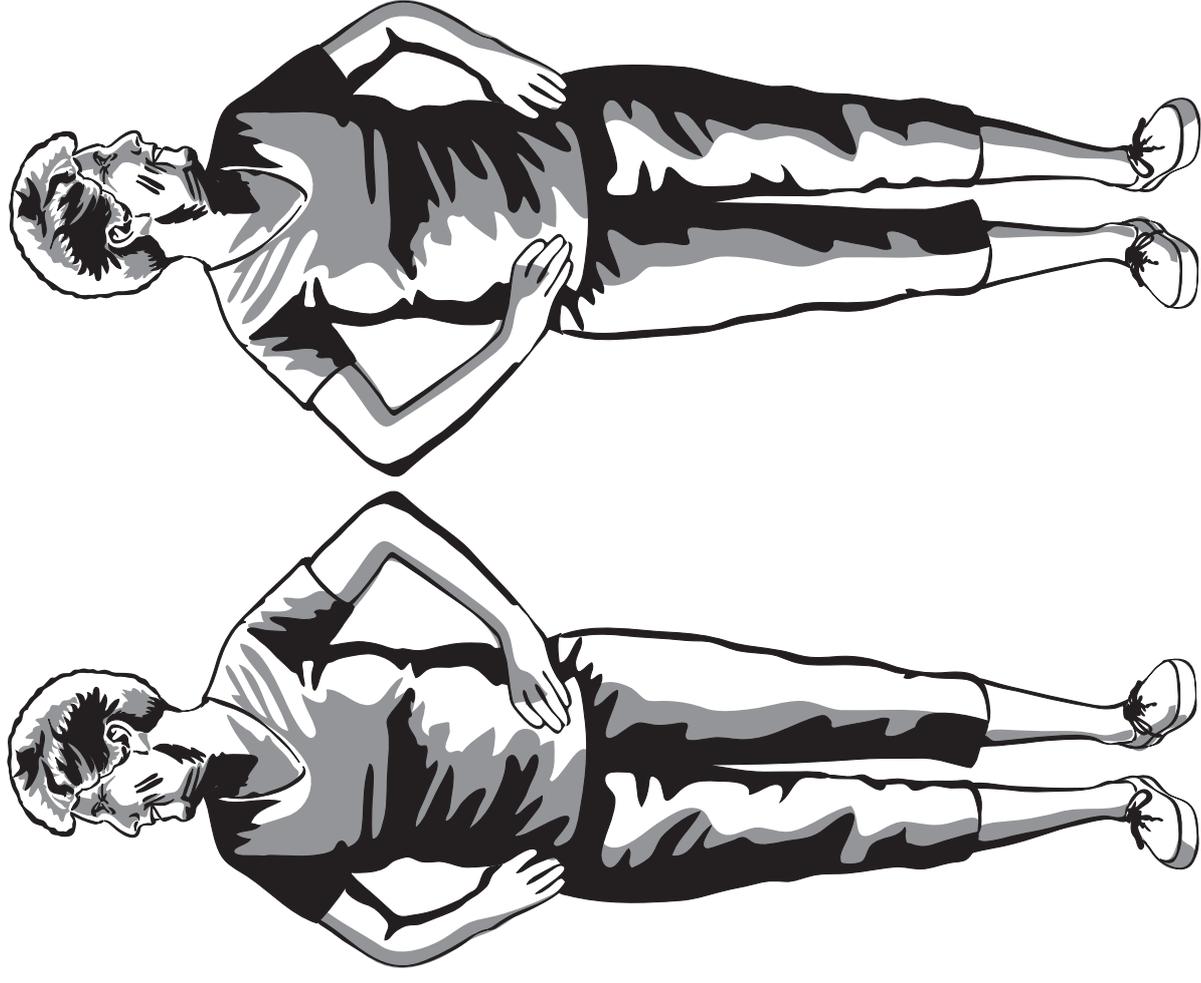
Back extension

- Stand up tall with the feet shoulder-width apart
- Place the hands on the small of the back
- Gently arch back
- Repeat five times



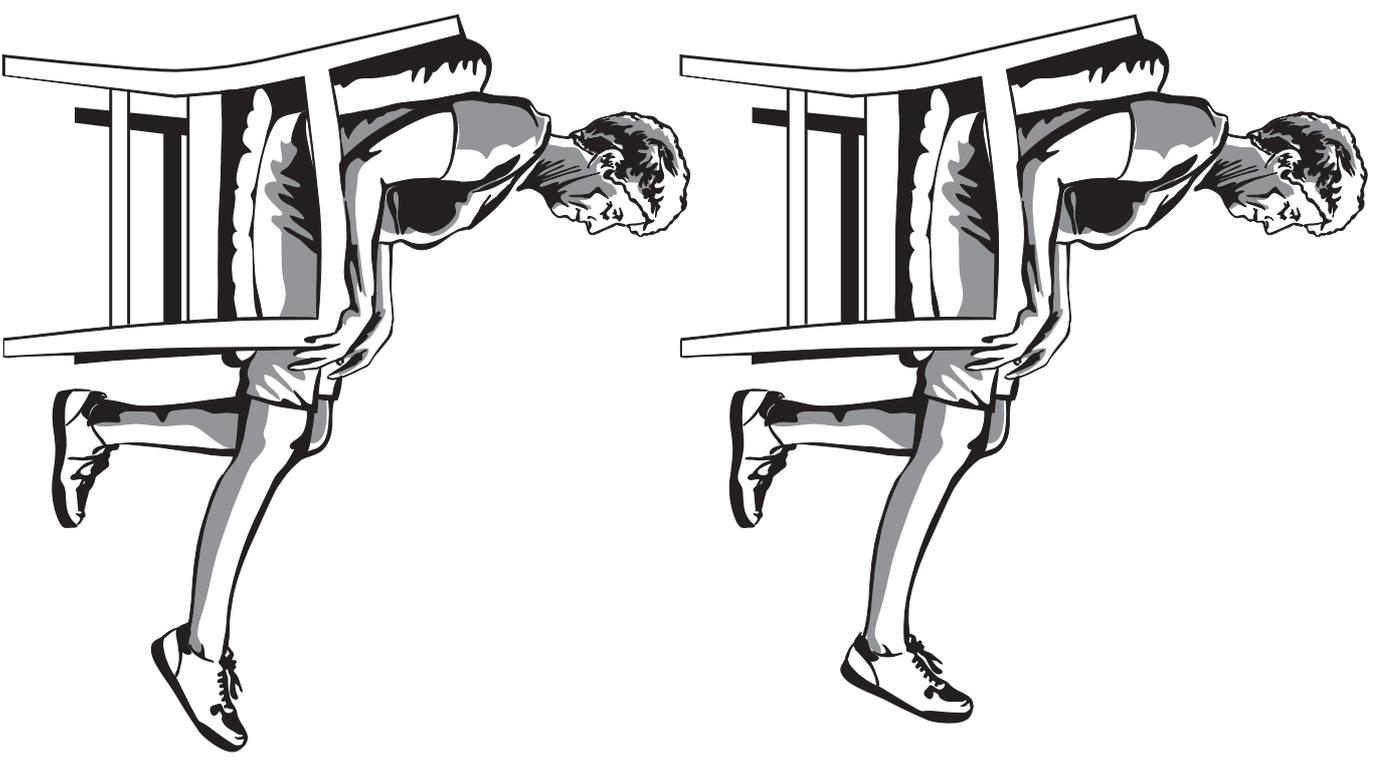
Trunk movements

- ▶ Stand up tall and place your hands on your hips
- ▶ Do not move your hips
- ▶ Turn as far as you can to the right, comfortably
- ▶ Turn as far as you can to the left, comfortably
- ▶ Repeat five times to each side



Ankle movements

- Either stand or sit
- Point the foot down then pull the foot back towards you
- Repeat 10 times for each foot



Getting stronger by using weights

Strengthening your muscles is essential for maintaining healthy bones and muscles necessary for walking and being independent in your daily activities.

You should aim to do the strengthening exercises three times a week with a rest day between.

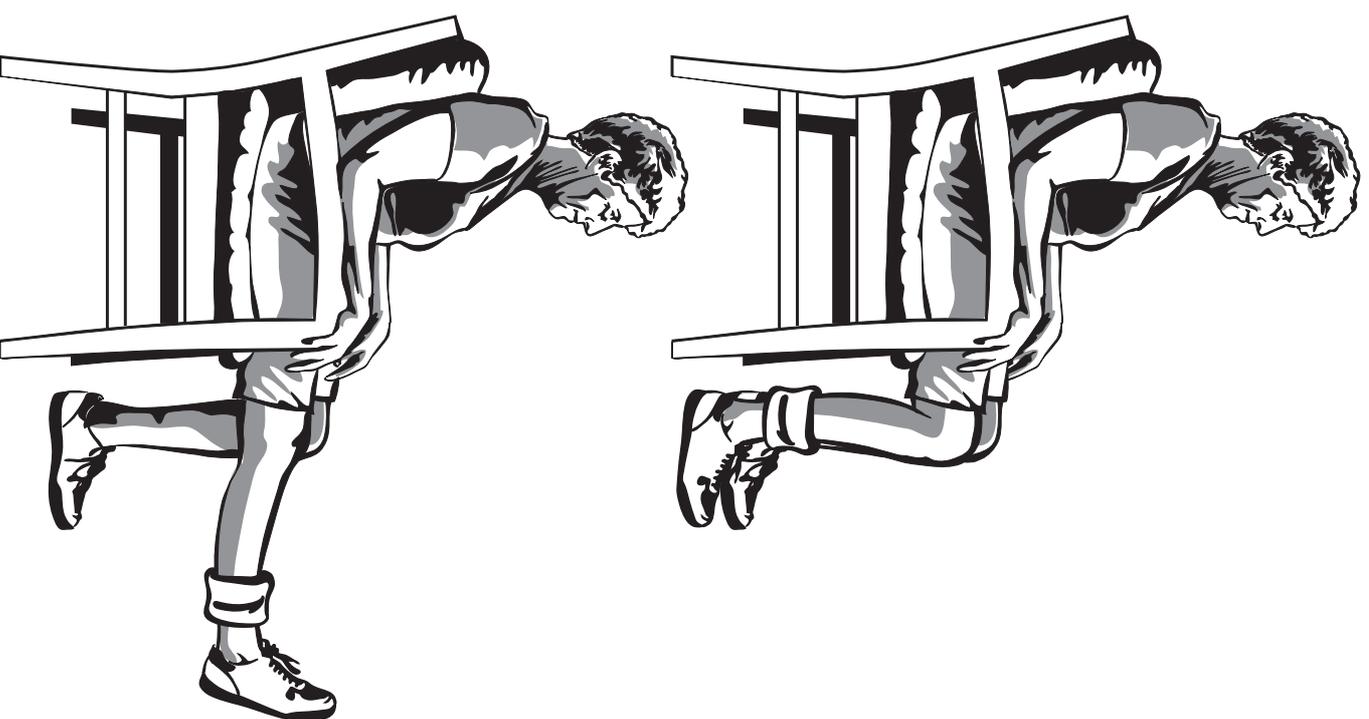
Lift the weight slowly through the entire range of movement.

Never hold your breath while lifting. Inhale before lifting, exhale while lifting and inhale again while lowering the weight.

You may feel a bit stiff after you first start to exercise. This is quite normal. It is because you are using muscles which may not be used to the exercise. It is important that you keep exercising. The stiffness will leave as your body becomes more familiar with the exercise.

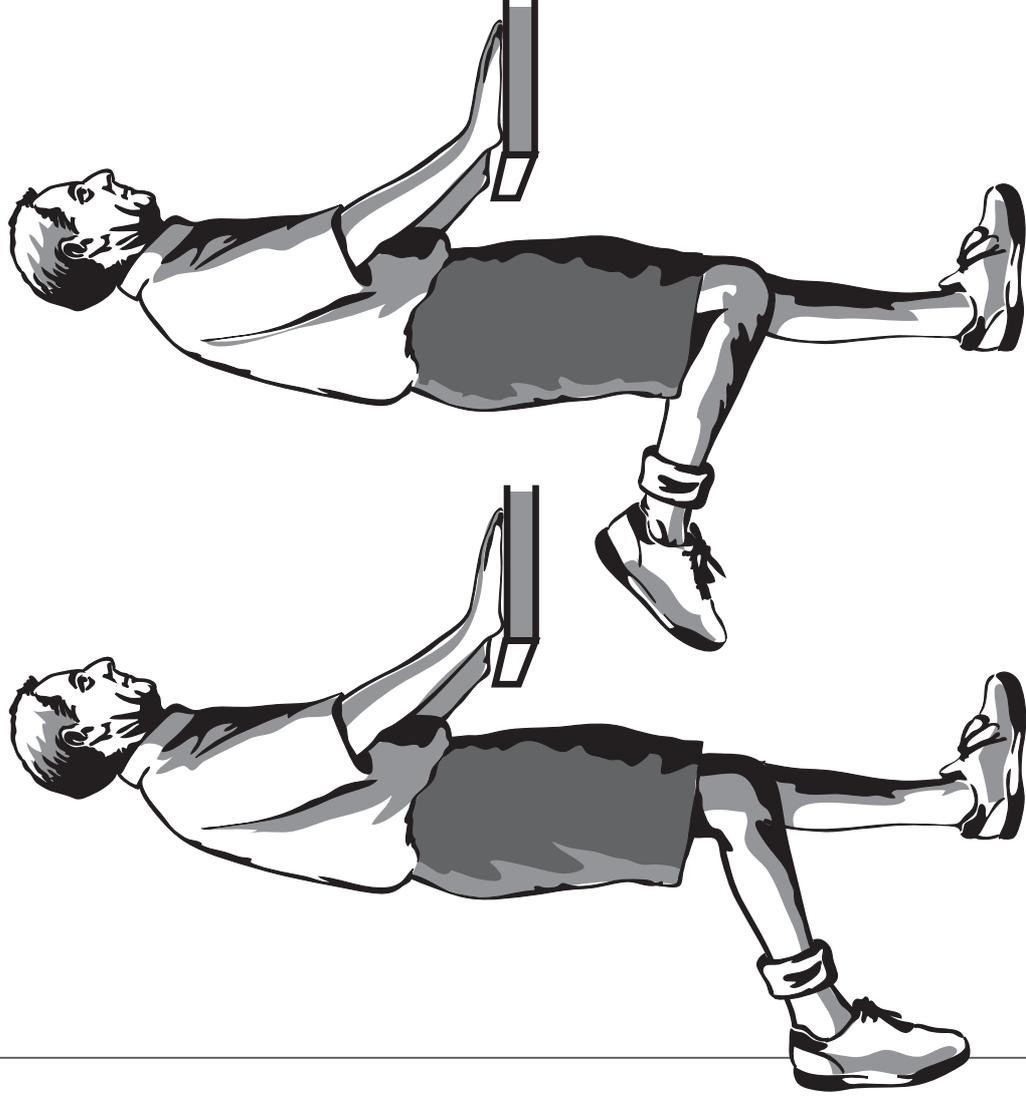
Front knee strengthening exercise

- You could do this exercise while you are watching TV
- Strap the weight on to your ankle
- Sit on a chair with your back well supported
- Straighten the leg out
- Lower the leg
- Repeat times
- Strap the weight on to the other ankle
- Repeat this exercise times



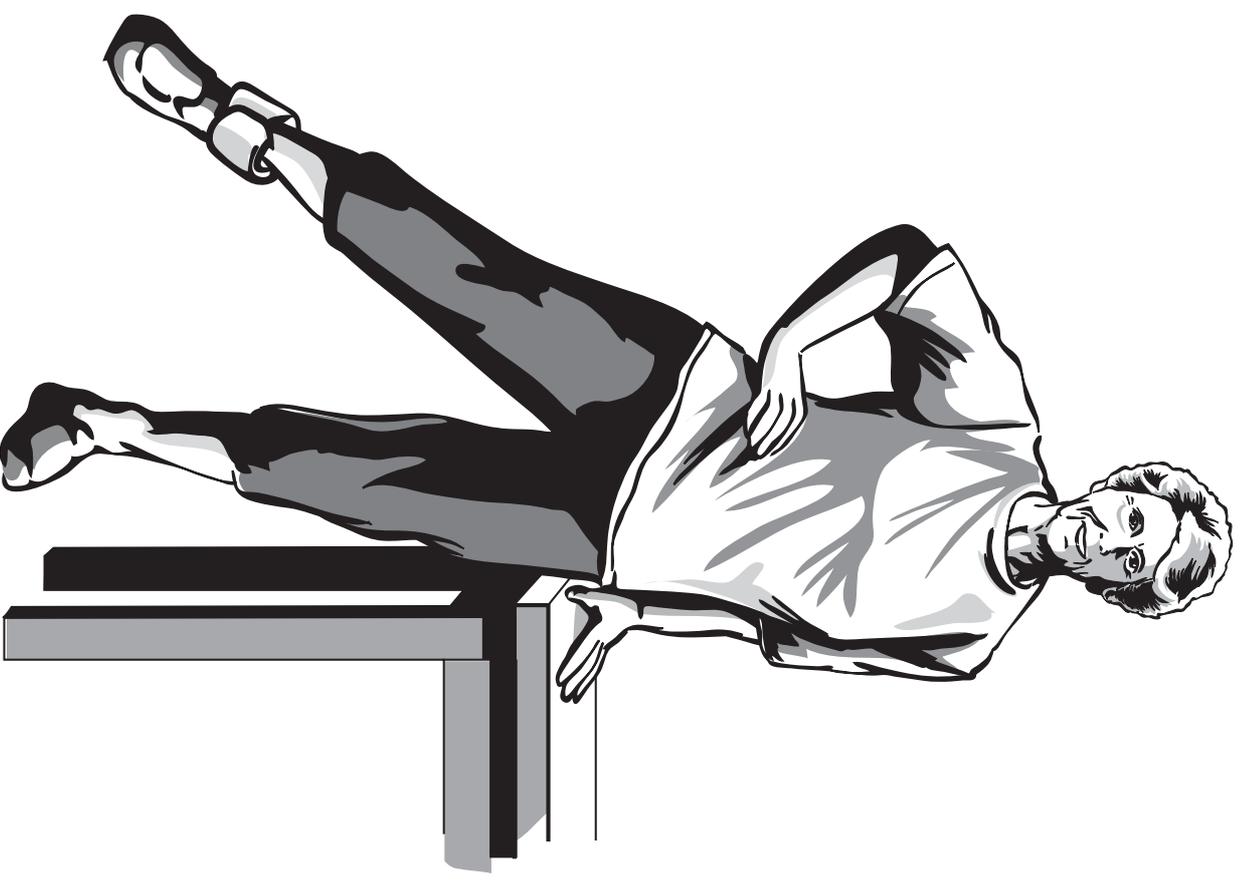
Back knee strengthening exercise

- ▶ Strap the weight on to your ankle
- ▶ Stand up tall facing the bench with both hands on the bench
- ▶ Bend the knee, bringing the foot towards your bottom
- ▶ Return to the starting position
- ▶ Repeat ○ times
- ▶ Strap the weight on to the other ankle
- ▶ Repeat this exercise ○ times



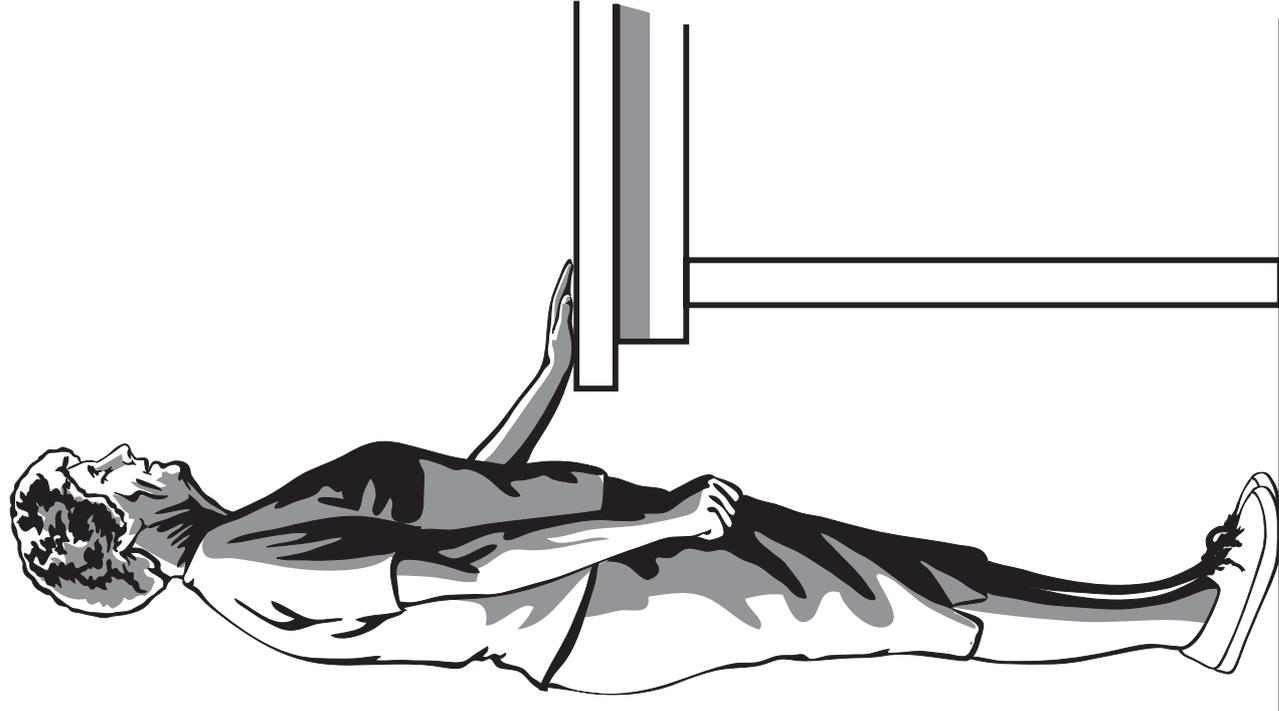
Side hip strengthening exercise

- Strap the weight on to your ankle
- Stand up tall beside the bench
- Hold on to the bench
- Keep the exercising leg straight and the foot straight forward
- Lift the leg out to the side and return
- Repeat ○ times
- Strap the weight on to the other ankle
- Turn around
- Repeat this exercise ○ times



Calf raises – hold support

- ▶ Stand up tall facing the bench
- ▶ Hold on and look ahead
- ▶ The feet are shoulder-width apart
- ▶ Come up onto your toes
- ▶ Lower the heels to the ground
- ▶ Repeat this exercise 20 times



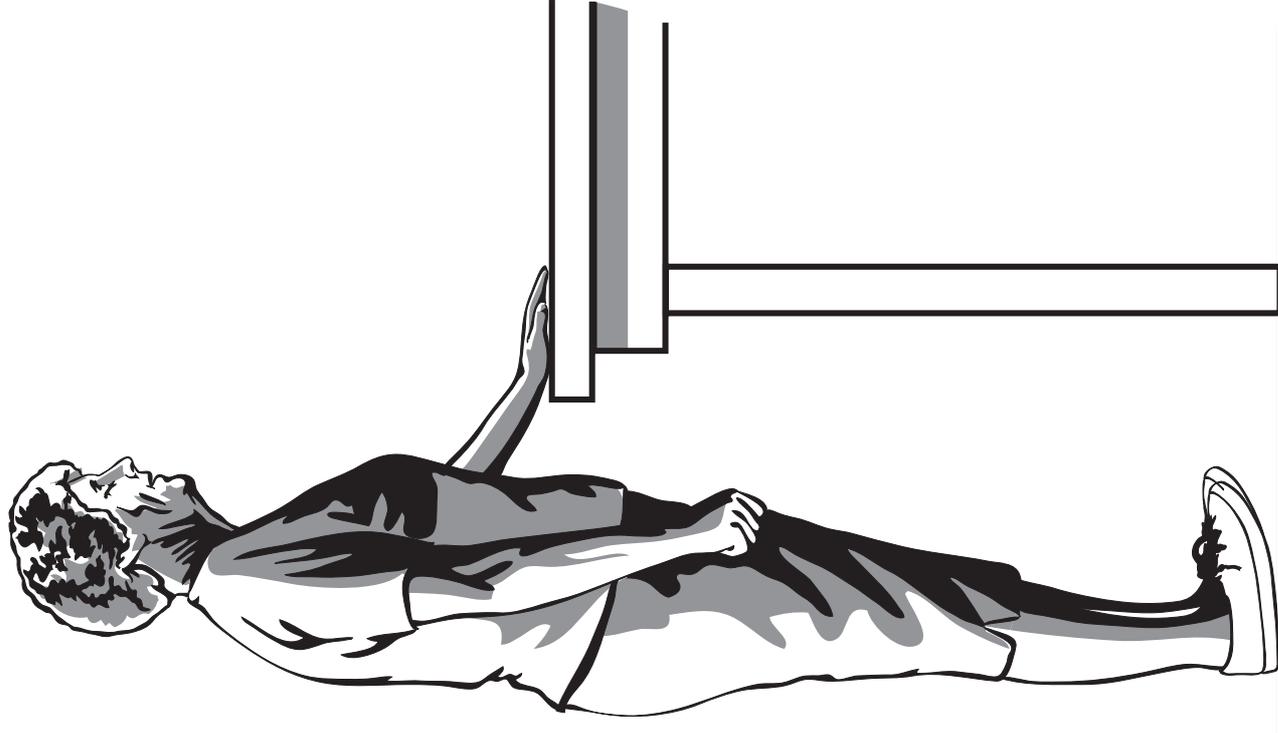
Calf raises – no support

- Stand up tall and look ahead
- The feet are shoulder-width apart
- Come up onto your toes
- Lower the heels to the ground
- Repeat this exercise 20 times



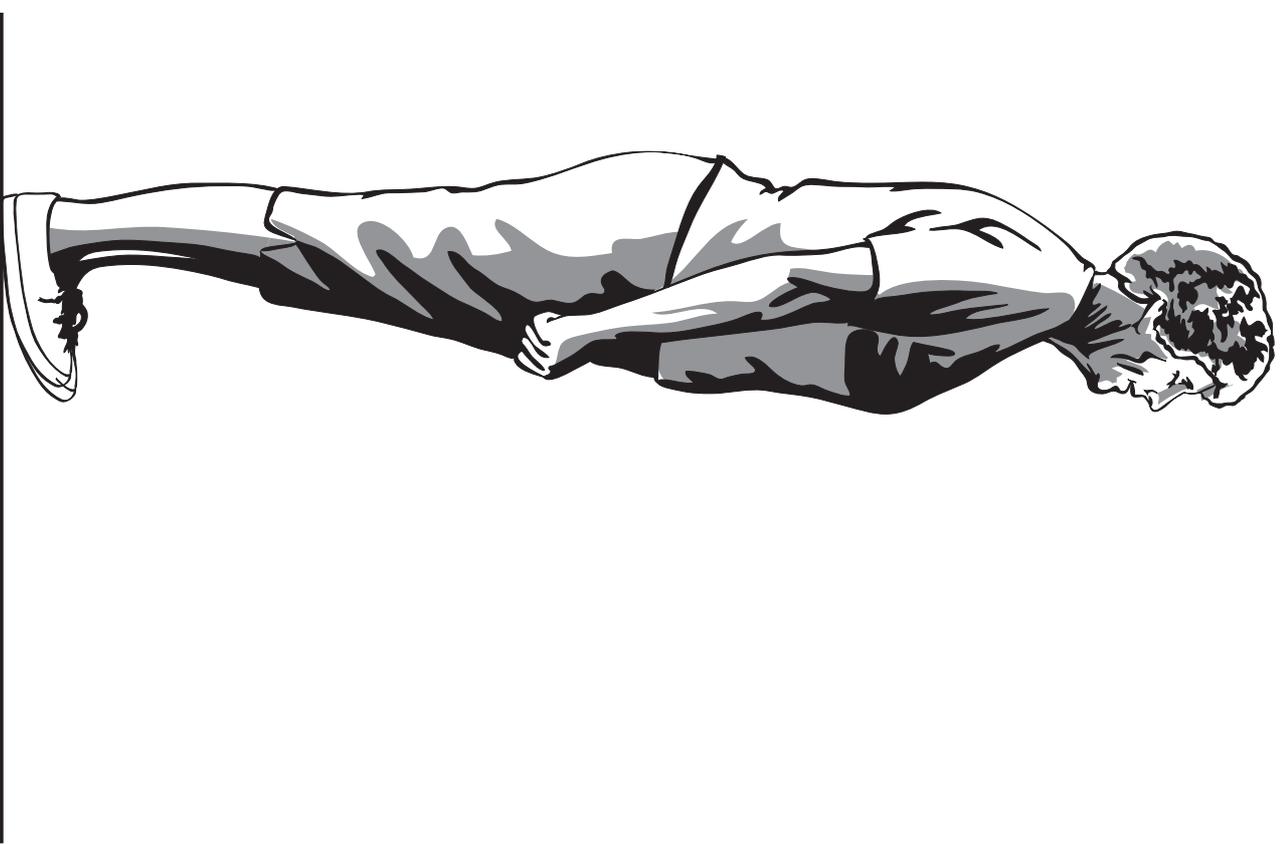
Toe raises – hold support

- ▶ Stand up tall beside the bench
- ▶ Hold on and look ahead
- ▶ The feet are shoulder-width apart
- ▶ Come back onto the heels, raising the front foot off the floor
- ▶ Lower the feet to the ground
- ▶ Repeat this exercise 20 times



Toe raises – no support

- Stand up tall and look ahead
- The feet are shoulder-width apart
- Come back onto the heels, raising the front foot off the floor
- Lower the feet to the ground
- Repeat this exercise 20 times



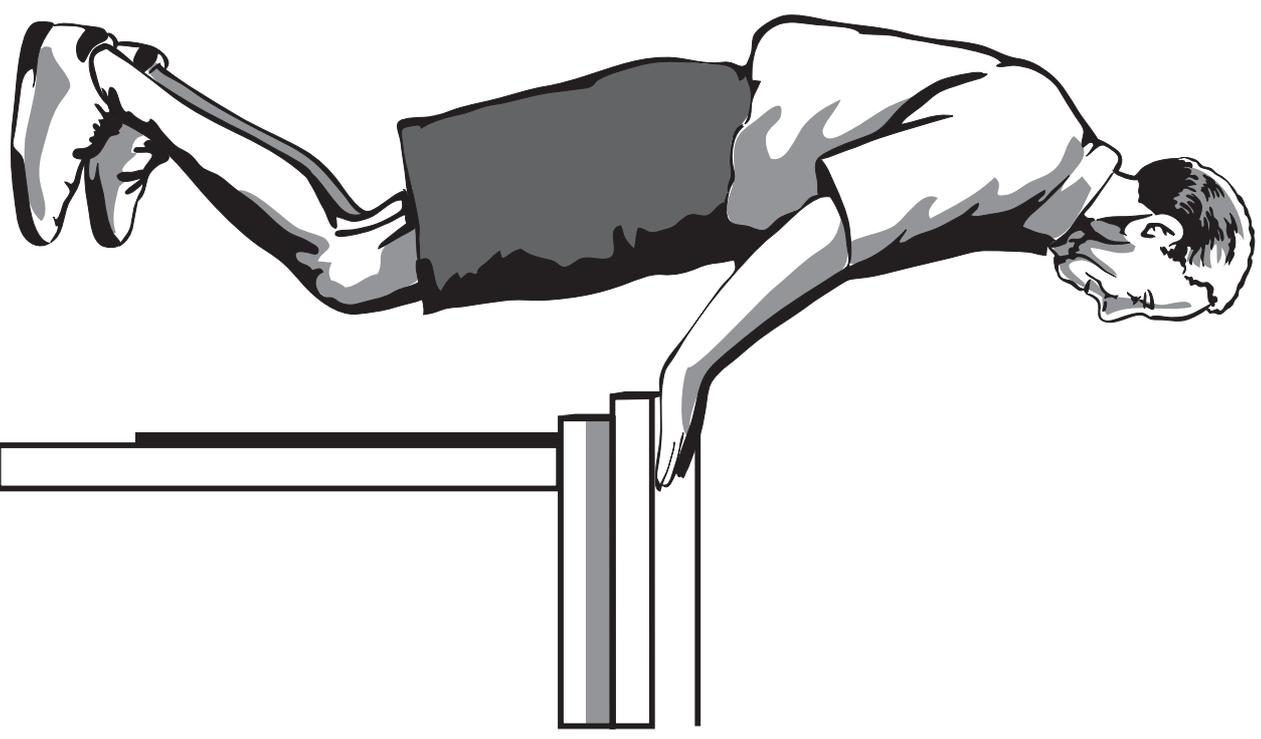
Balance

Balance is important for everyday activities.

The following quick balance exercises could be done every day.

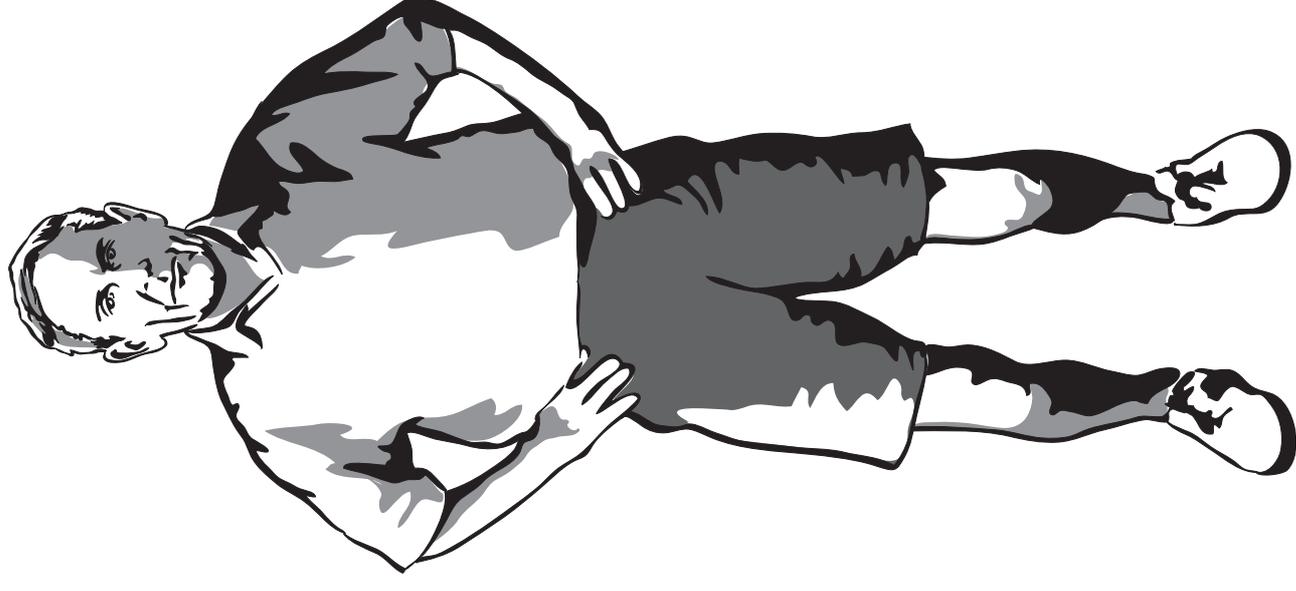
Knee bends – hold support

- Stand up tall facing the bench with both hands on the bench
- Place your feet shoulder-width apart
- Squat down half way, bending your knees
- The knees go over the toes
- When you feel your heels start to lift, straighten up
- Repeat  times



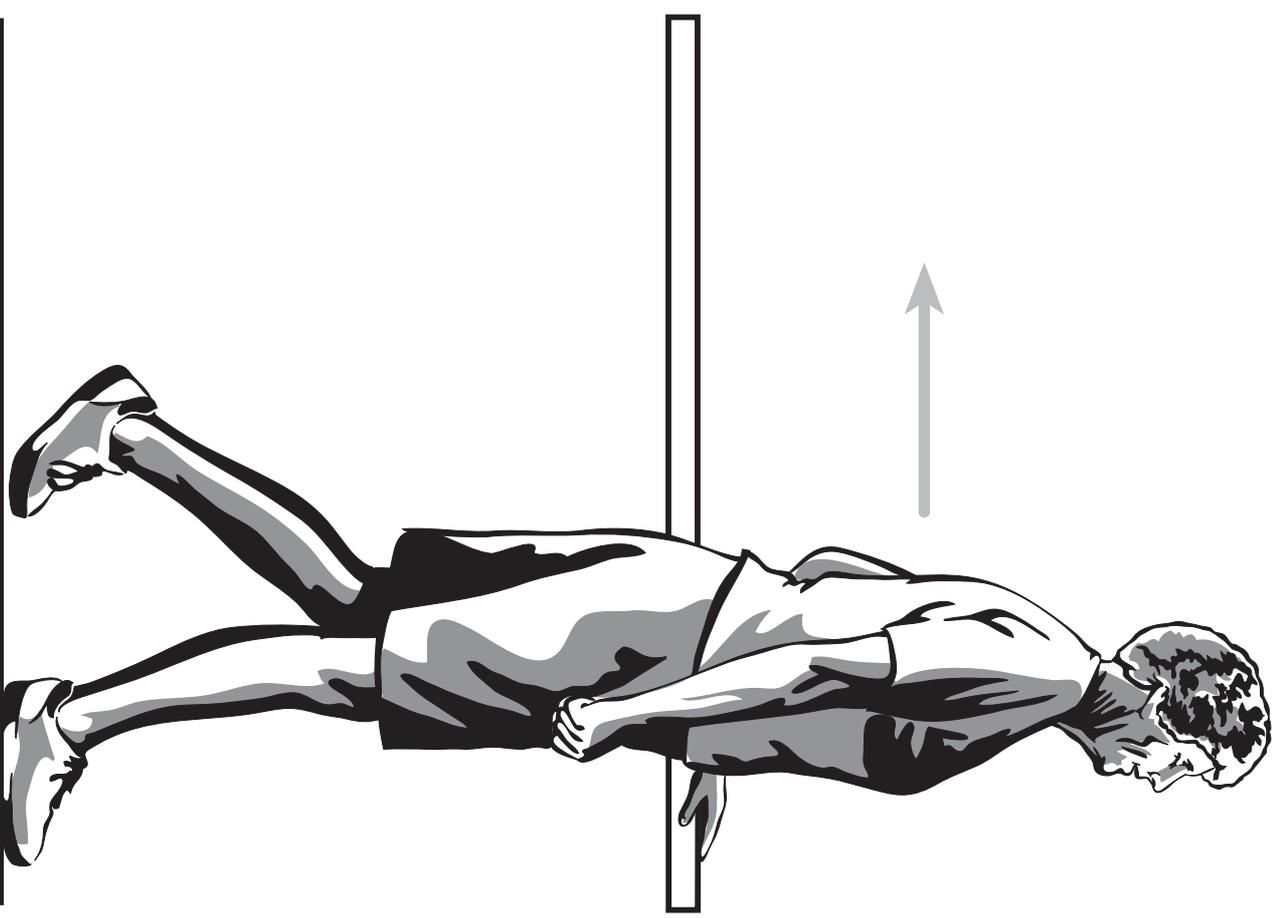
Knee bends – no support

- Stand up tall and look ahead
- Place your feet shoulder-width apart
- Squat down half way, bending your knees
- The knees go over the toes
- When you feel your heels start to lift, straighten up
- Repeat ○ times



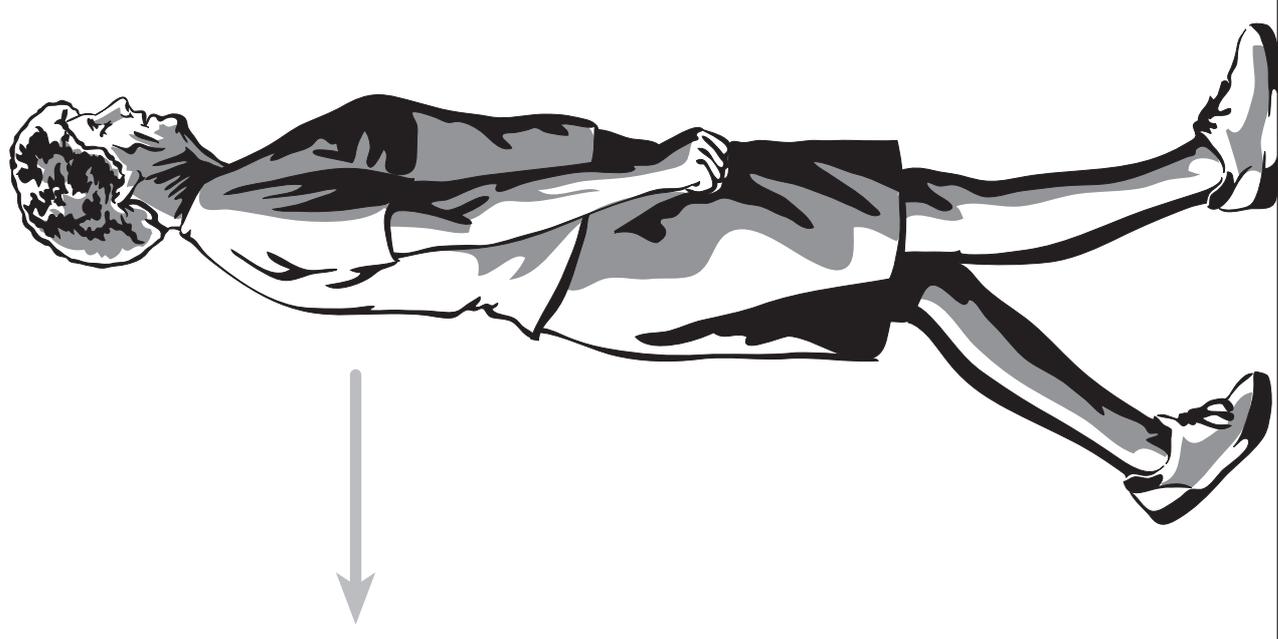
Backwards walking – hold support

- Stand up tall and hold on to the bench
- Walk backwards 10 steps
- Turn around and hold on with the other hand
- Walk backwards 10 steps to the beginning
- Repeat this exercise



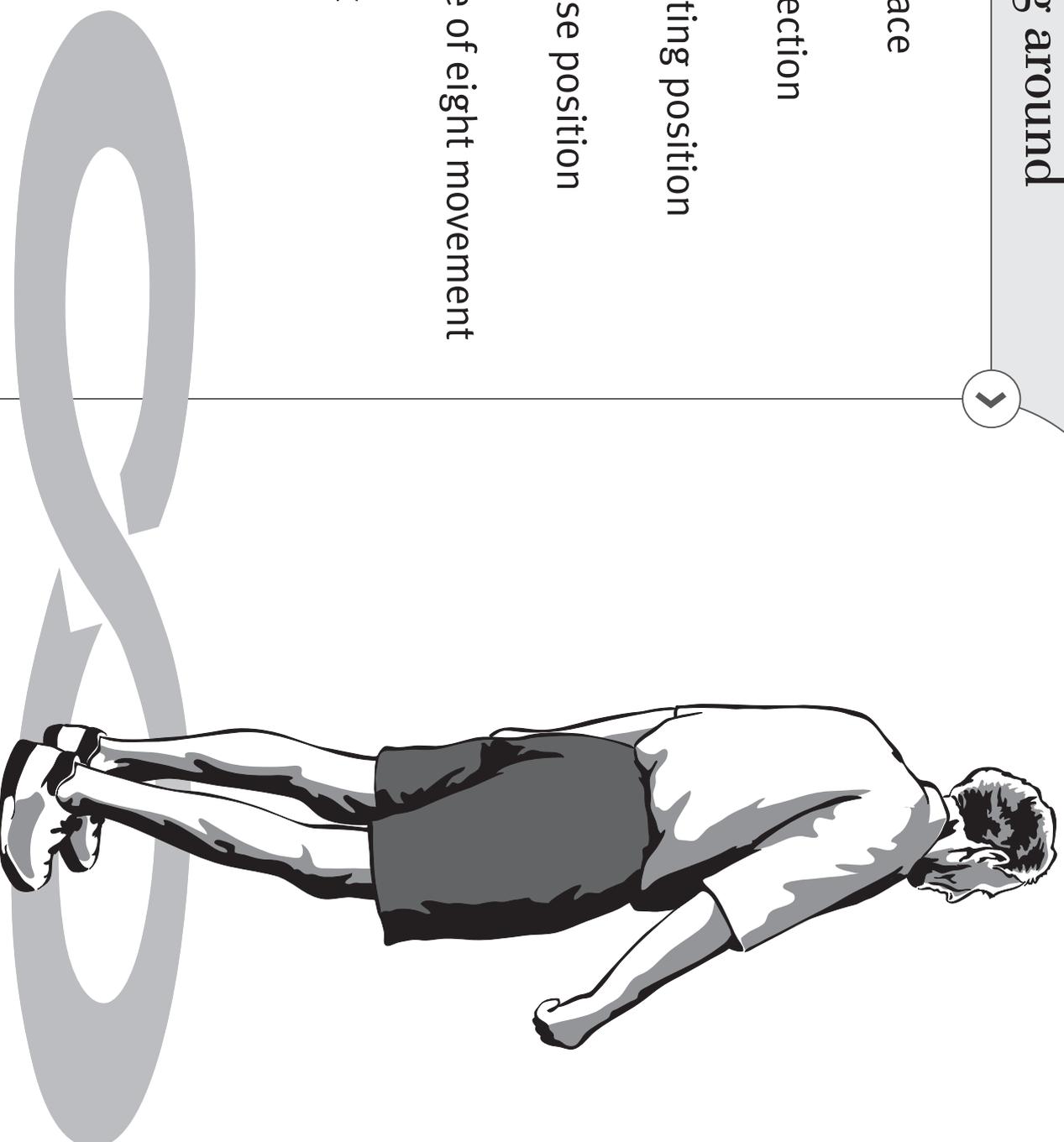
Backwards walking – no support

- Stand up tall and look ahead
- Walk backwards for 10 steps
- Turn around
- Walk backwards 10 steps to the beginning
- Repeat



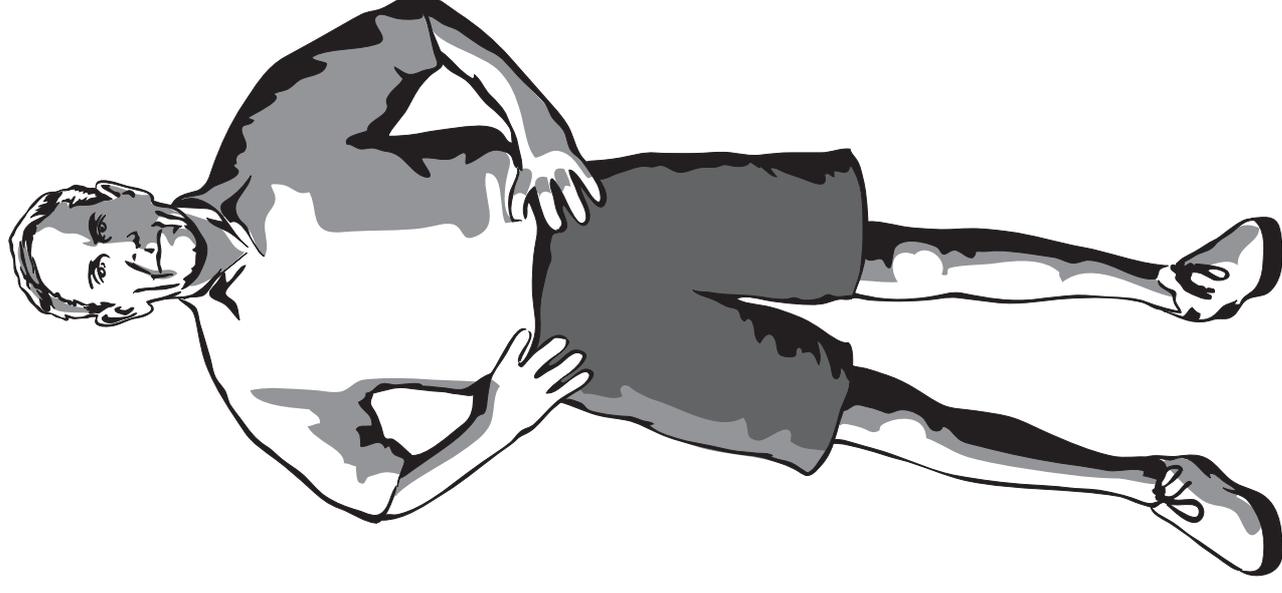
Walking and turning around

- Walk at your regular pace
- Turn in a clockwise direction
- Walk back to your starting position
- Turn in an anti-clockwise position
- The exercise is a figure of eight movement
- Repeat this movement



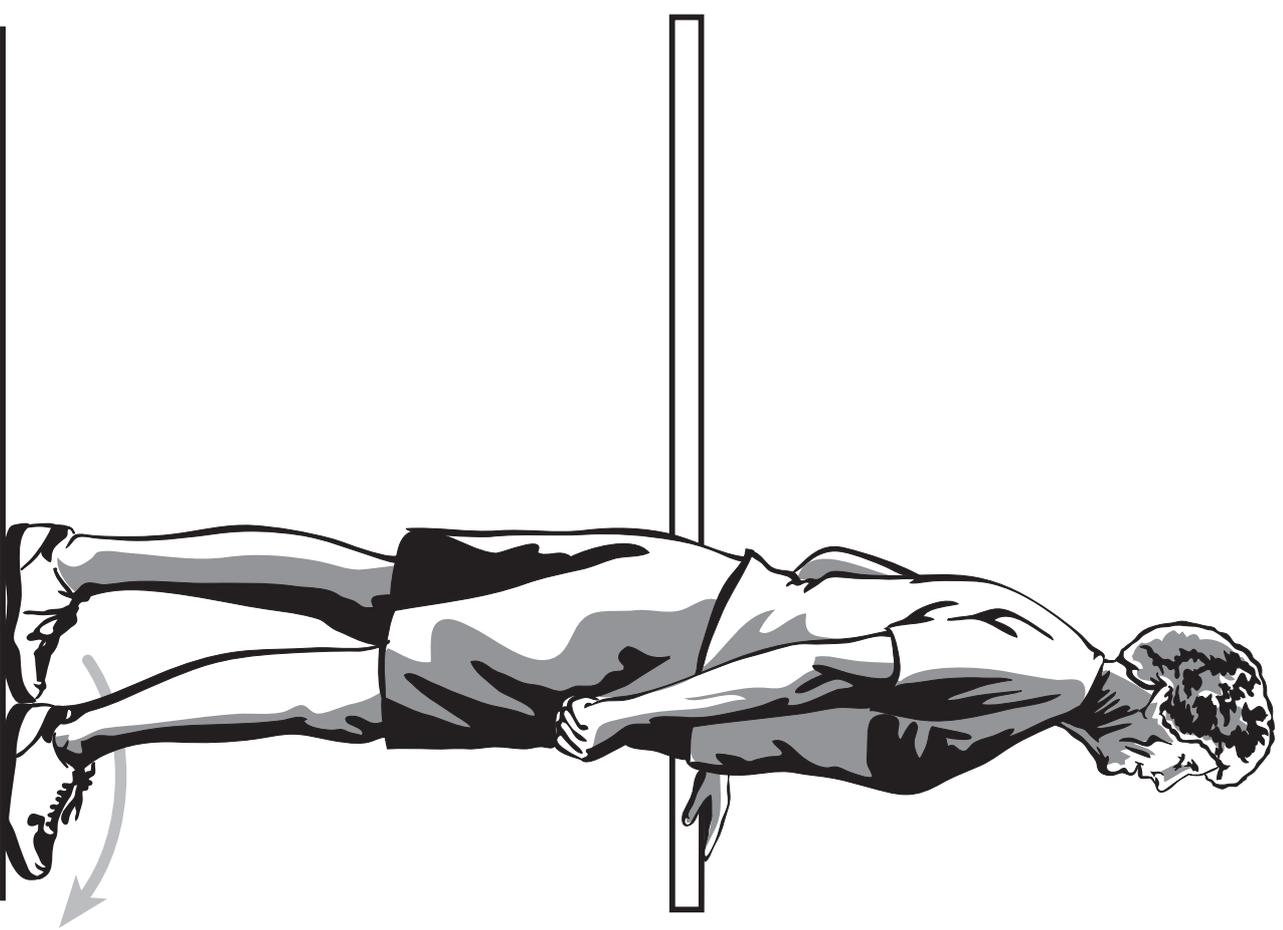
Sideways walking

- Stand up tall and place your hands on your hips
- Take 10 side steps to the right
- Take 10 side steps to the left
- Repeat



Heel toe standing – hold support

- Stand up tall beside the bench
- Hold on to the bench and look ahead
- Place one foot directly in front of the other foot so the feet form a straight line
- Hold this position for 10 seconds
- Change position and place the foot behind directly in front
- Hold this position for 10 seconds



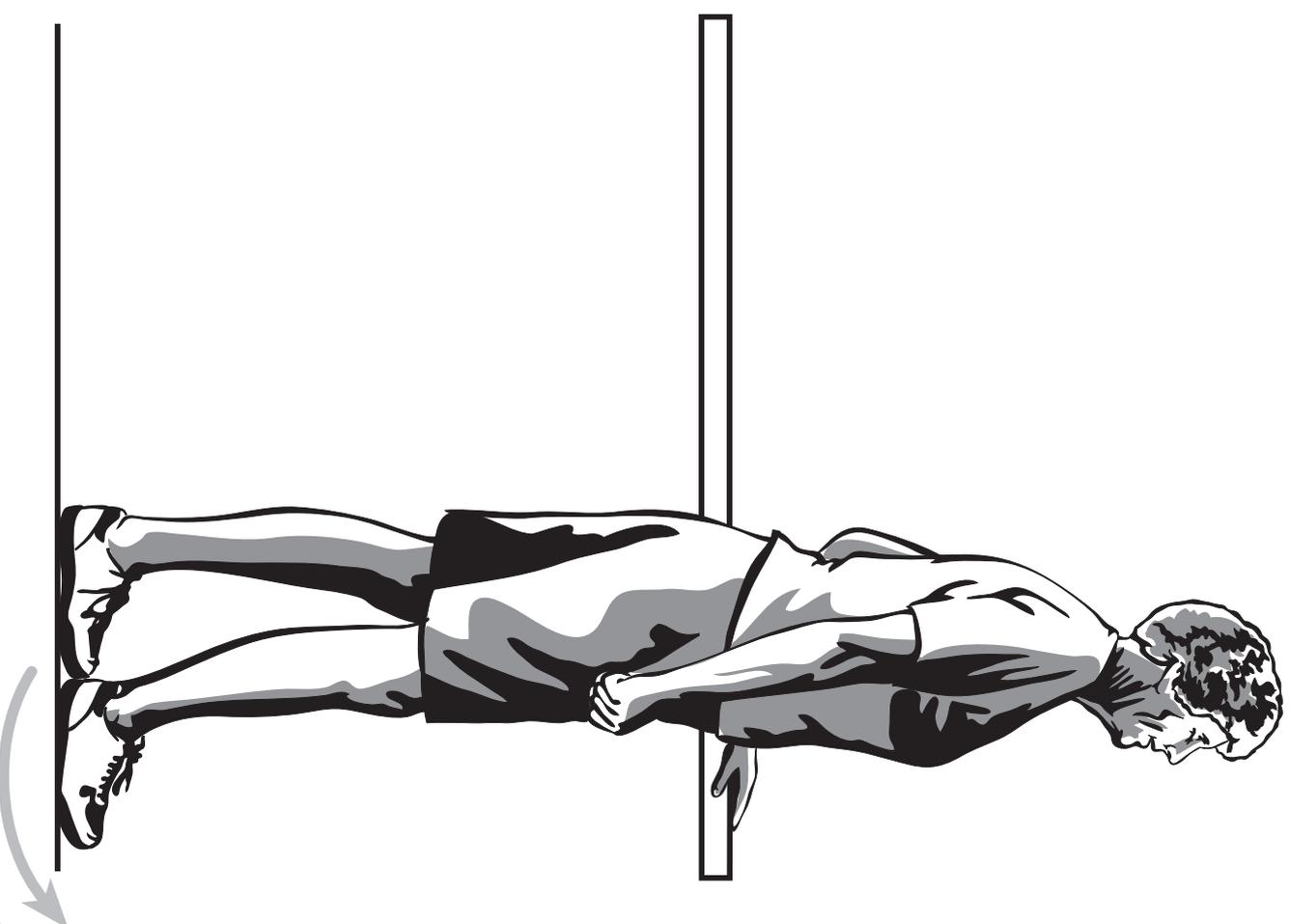
Heel toe standing – no support

- Stand up tall and look ahead
- Place one foot directly in front of the other so they form a straight line
- Hold this position for 10 seconds
- Change position and place the foot behind directly in front
- Hold this position for 10 seconds



Heel toe walking – hold support

- Stand up tall beside the bench
- Hold on and look ahead
- Place one foot directly in front of the other so they form a straight line
- Place the foot behind directly in front
- Repeat for 10 more steps
- Turn around
- Repeat the exercise



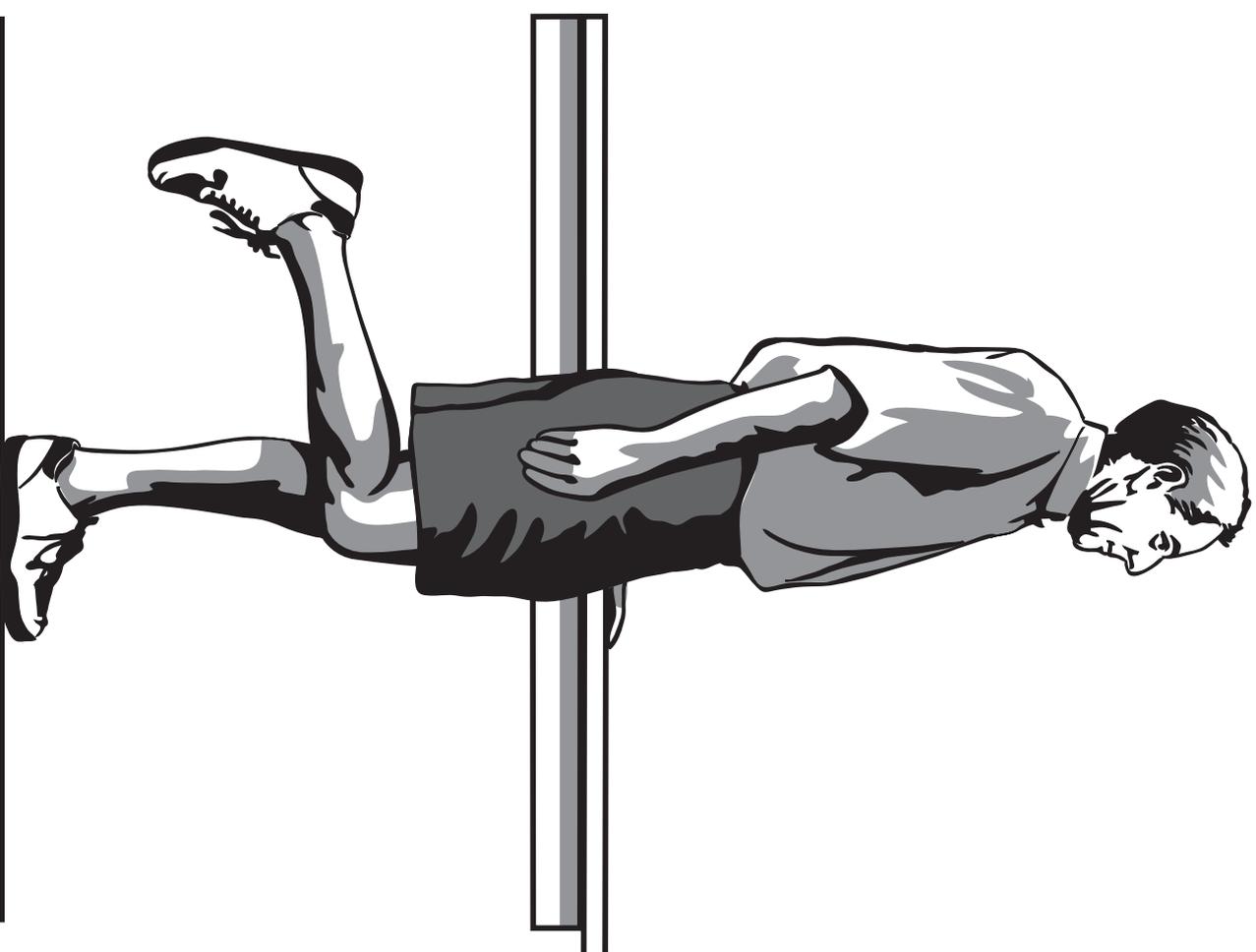
Heel toe walking – no support

- Stand up tall and look ahead
- Place one foot directly in front of the other so they form a straight line
- Place the foot behind directly in front
- Repeat for 10 more steps
- Turn around
- Repeat the exercise



One leg stand – hold support

- Stand up tall beside the bench
- Hold on and look ahead
- Stand on one leg
- Try to hold this position for 10 seconds
- Stand on the other leg
- Try to hold this position for 10 seconds



One leg stand – no support

- Stand on one leg
- Try to hold this position for 10 seconds
- Stand on the other leg
- Try to hold this position for 10 seconds



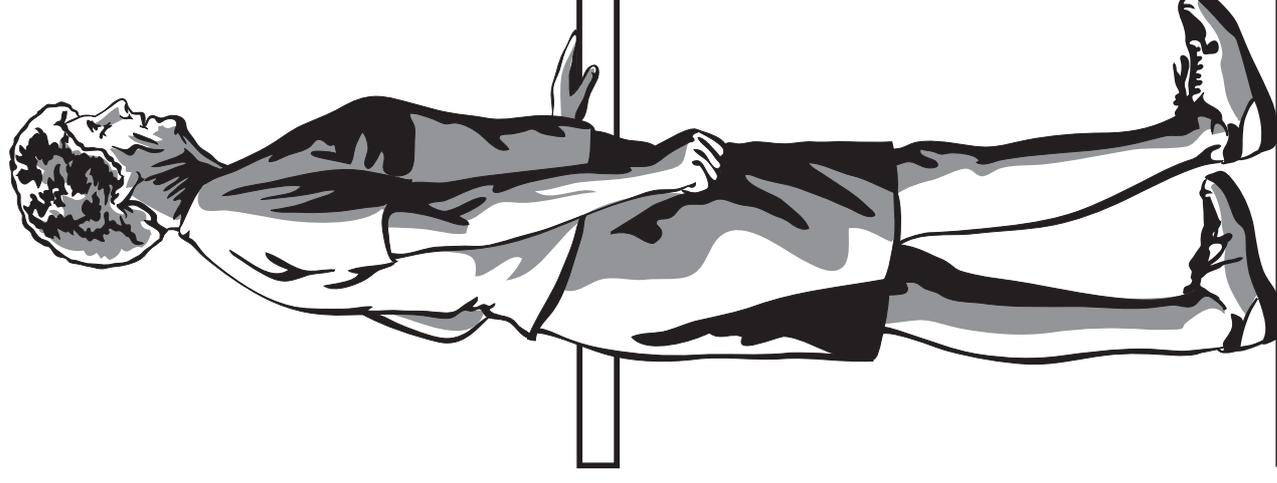
One leg stand – no support

- Stand on one leg
- Try to hold this position for up to 30 seconds
- Stand on the other leg
- Try to hold this position for up to 30 seconds



Heel walking – hold support

- Stand up tall beside the bench
- Hold on and look ahead
- Come back onto the heels, raising the front foot off the floor
- Walk 10 steps on your heels
- Lower the feet to the ground and turn around
- Walk 10 steps on your heels
- Repeat



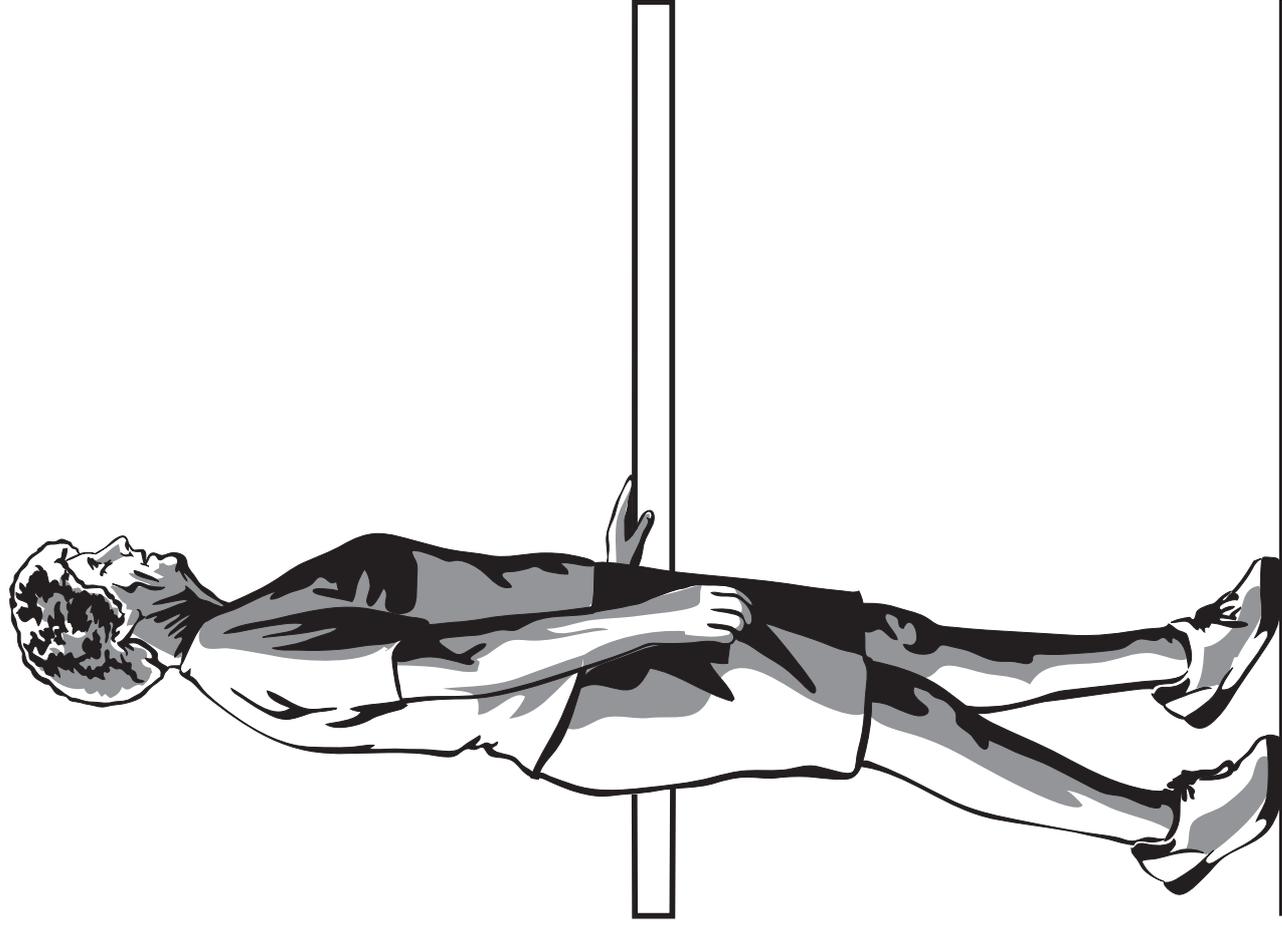
Heel walking – no support

- Stand up tall and look ahead
- Come back onto the heels, raising the front foot off the floor
- Walk 10 steps on your heels
- Lower the feet to the ground and turn around
- Walk 10 steps on your heels
- Repeat



Toe walking – hold support

- Stand up tall beside the bench
- Hold on and look ahead
- Come up onto your toes
- Walk 10 steps on your toes
- Lower the heels to the ground and turn around
- Walk 10 steps on your toes
- Repeat



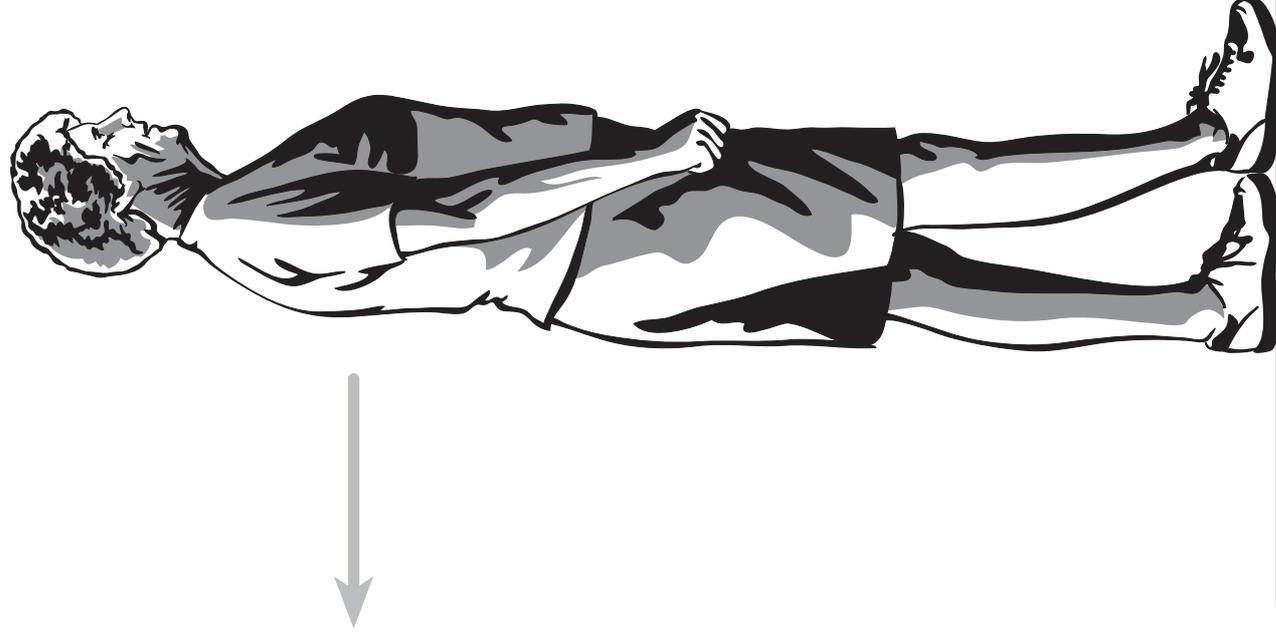
Toe walking – no support

- Stand up tall and look ahead
- Come up onto your toes
- Walk 10 steps on your toes
- Lower the heels to the ground and turn around
- Walk 10 steps on your toes
- Repeat



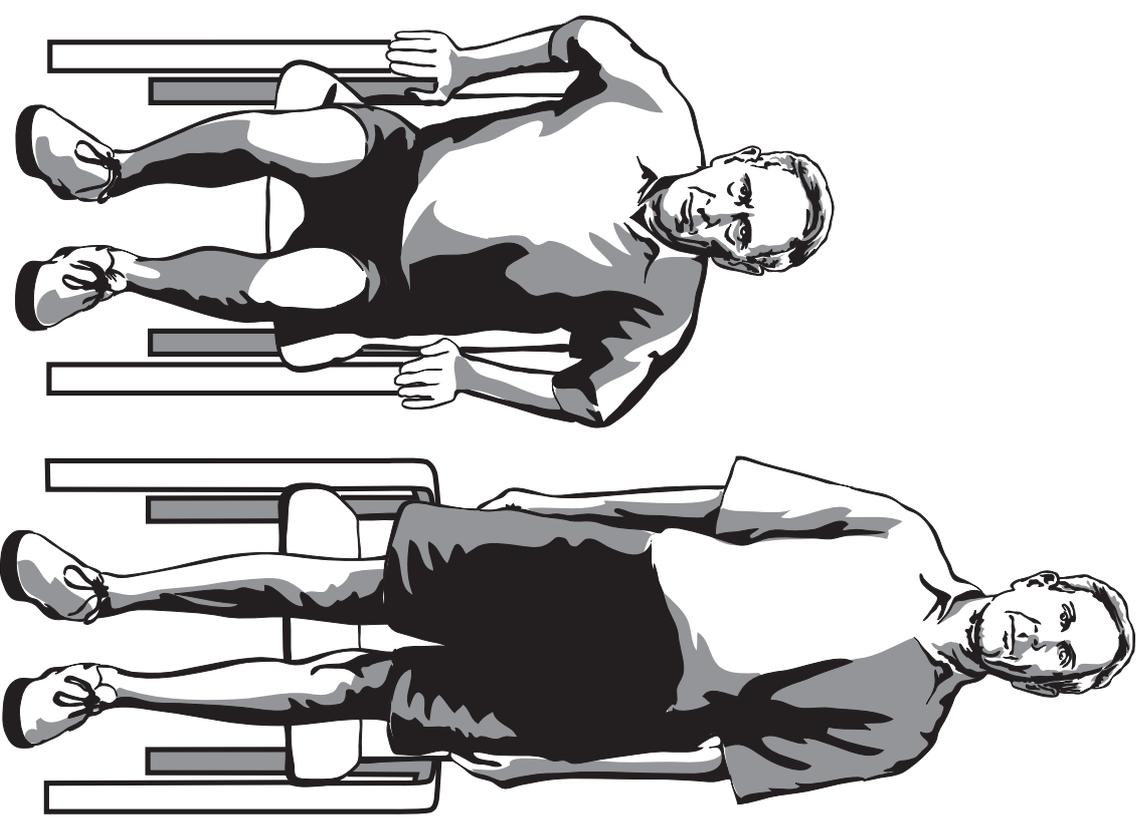
Heel toe walking backwards

- Stand up tall and look ahead
- Place one foot directly behind the other foot
- Place the foot in front directly behind
- Repeat for 10 more steps
- Turn around
- Repeat the exercise



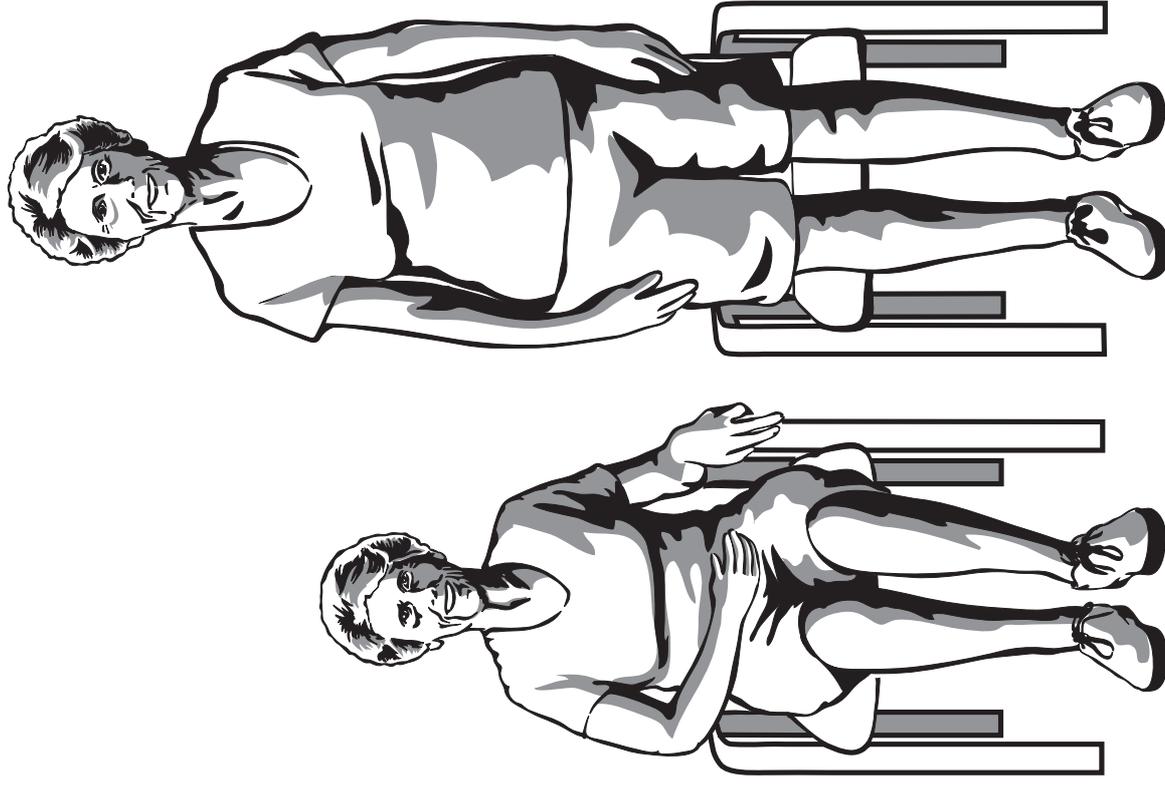
Sit to stand – two hands

- You could do this exercise while you watch TV
- Sit on a chair which is not too low
- Place the feet behind the knees
- Lean forwards over your knees
- Push off with both hands to stand up
- Repeat ○ times



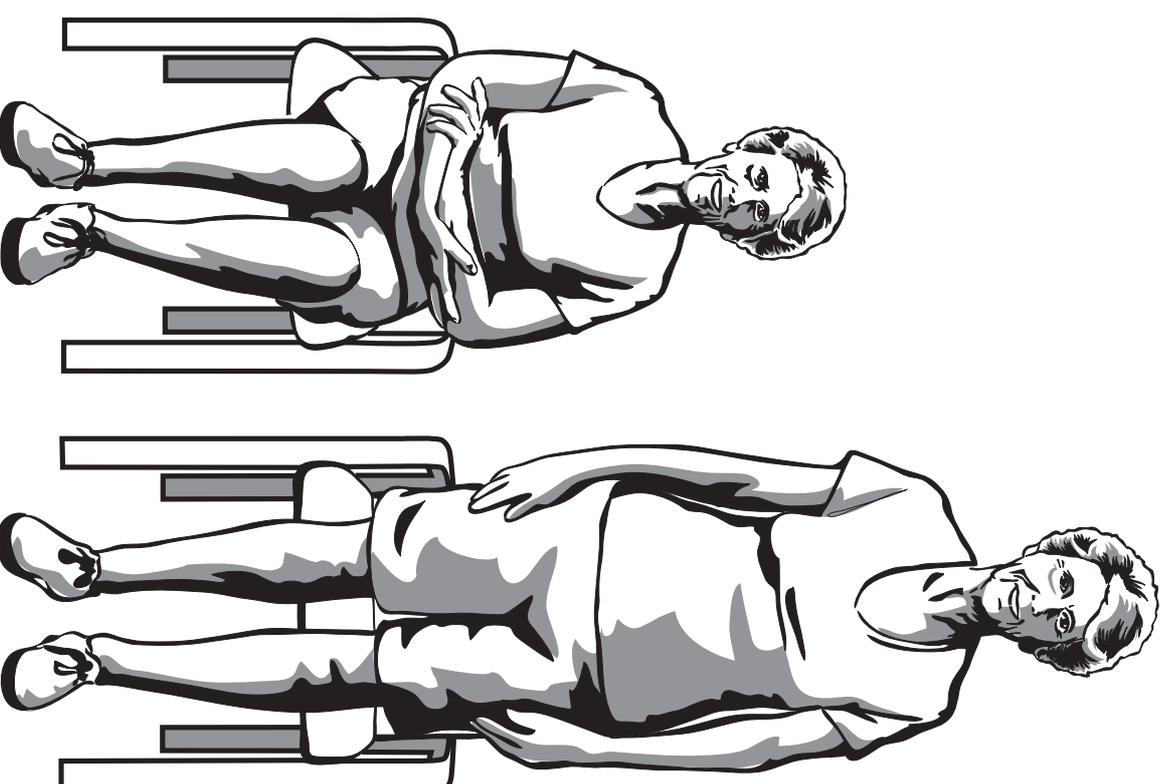
Sit to stand – one hand

- ▶ You could do this exercise while you watch TV
- ▶ Sit on a chair which is not too low
- ▶ Place the feet behind the knees
- ▶ Lean forwards over the knees
- ▶ Use one hand to help you stand up
- ▶ Repeat ○ times



Sit to stand – no hands

- You could do this exercise while you watch TV
- Sit on a chair which is not too low
- Place the feet behind the knees
- Lean forwards over the knees
- Stand up without using your hands
- Repeat  times



Stair walking

- ▶ Hold on to the hand-rail for this exercise
- ▶ Go up and down the stairs for ○ steps

