MODULE C:

Section 1: Exercise for Osteoporosis; Too Fit to Fracture Overview

A Guide for an OSTEOPOROSIS EXERCISE ACTION PLAN.
Locate a Bone Fit trained instructor: https://www.bonehealthandosteoporosis.org/bonefit-find-a-professional/

Type	How often per week?	How hard should I work?	Examples and Comments
Strength Training	≥ 2 days a week	8-12 repetitions per exercise. Intensity of 5-8 on a 0-10 scale 0=rest,10=max	Min. 1 exercise each for: legs; arms; chest; shoulders; back. Use: exercise bands; weights, orbody weight against gravity. 1-3 sets/exercise. Train at ↓, intensity initially if: sedentary; conditions affecting activity; high fracture risk; strength training novice.
Balance Training	Daily for ≥ 15-20 min	Progress from "standing still"/static exercises to dynamic	Can do during daily walks or activities: Standing still: ↓base of support e.g., Semi-tandem stance,one-leg stand; shift weight between heels & toes while standing. Dynamic movements: Tai Chi; tandem walk, dancing
Aerobic Exercise	≥ 5 days perweek, ≥ 30min/day	Moderate- to vigorous-intensity	Do bouts of 10 minutes or more – accumulate 30min/day. On a 0-10 scale where 0=rest, and 10=max. effort, aim for intensity of 5-8.
Spine Sparing	During Daily Activities	Alignment more important than intensity	Modify activities that flex (bending forward) or twist the spine; most risky when rapid, repetitive, weighted, bending all the way forward, or twisting to the side.
Back Extensor Training	Daily for 5-10 min	Perform "holds" 3- 5 seconds	Use Bone Fit back extensor strengthening exercises

Other POSITIVE EFFECTS of Exercise on Osteoporosis:

- Exercise reduces the risk of falls and fractures in osteopenic women already at risk
- A 10-week comprehensive exercise & balance program reduced back pain, improved quality of life and balance (Lindsay, 2005) in post-menopausal women with vertebral fractures
- A 12-week home-based trunk strengthening program enhanced quality of life in postmenopausal osteoporotic & osteopenic women (Chien, 2005)
- A low-intensity back strengthening exercise program effectively improved quality of life in osteoporotic patients (Gillespie, 2009)
- A Cochrane review (Hongo, 2007) determined that multiple component group exercise, Tai Chi in a group, and individually prescribed multiple component home exercise all reduce the rates of falls and risk of falling.
- If the treatment goal is to prevent falls, a systematic review (Sherrington, 2008) indicates that the inclusion of balance retraining in an exercise program is important. Furthermore, the criterion for a minimal effective exercise dose would equate to a twice weekly program over 25 weeks. Lastly, the study revealed that exercise programs which did not include walking were more effective in prevention of falls. Therefore, walking programs should not be relied upon as a means to prevent falls.

Section 2: Exercise after a vertebral fracture

Exercises after a vertebral fracture

- The nature of “best exercises” still remains unclear
- Improvements in back extension strength, psychological symptoms, QOL have been noted
- These exercises may improve balance
- Improvements in pain is not a strong finding
- A trend towards improvement in vertebral morphometry has not been demonstrated strongly (Gold et al., 2004; Malmros et al., 1998; Papaioannou et al., 2003; Webber et al., 2003; Hongo et al., 2007)

Studies examining exercise for people with osteoporosis and vertebral fractures:

Evstigneeva et al. (2016)

Supervised group exercise – goal to increase mobility of t-spine and posture, strengthen lower extremities, abdomen, and back extensors – no flexion or axial loading

- 12 months, 2x/week, 40 minutes
- 78 women (38 control, 40 exercise) 50 years or older with osteoporosis, 1 vertebral fracture and chronic pain
- 2 vertebral and 2 non-vertebral fractures experienced in exercise group
- Improvement in pain, quality of life, balance, and physical function (sit to stand time)

Olsen and Berland (2014)

- Supervised group exercise - moderate intensity balance, walking, stair climbing, floor transfer, posture exercises
- 3 month, 2x/week, 60 minutes
- 87 (42 control, 47 exercise) women aged 60-83 years old with osteoporosis, history of one or more vertebral fractures
- Fear of falling and walking speed improved

Adverse Events HAVE been reported during these programs

- Fractured costal cartilage during prone exercise
- Fractured rib while rolling from supine to prone
- Metatarsal fracture when 2lb weight fell on foot
- Soft tissue pain (neck, back)
- Back pain, unspecified – 2/3 returned to exercise
- Pain during exercise, fall concerns (14/74)

(Gold et al., 2004; Hongo et al., 2007; Papaioannou et al., 2003)

Take-home message: No exercise is without risk, but in general, the research indicates: **DO:** extension (with care & appropriate positioning). Flexion rotation and side bending should be modified and done with care in daily activities (You will learn more about this in section 8).

Section 3: Exercise after a hip fracture

Cochrane review of mobilization strategies post osteoporotic hip-fracture suggested (Hadoll, 2007):

- There is insufficient evidence overall to establish the effectiveness of the reviewed mobilization strategies used in rehabilitation after hip fracture surgery (including physiotherapy, treadmill, resistance training & electrical stimulation)
- Limited number of trials, limited power
- Little information about persistence

Two positive RCT studies (Binder et al., 2004; Hauer et al., 2002):
Concluded that improved mobility occurred with intensive, supervised ongoing exercise/therapy, specifically with significant differences between the exercise and control groups in the following measurements:

- Improved walking velocity
- Less need of walking aid
- Improved measures on the Physical Performance Test
- Improved Stair climbing
- Increased leg extensor strength, decreased fear of falling, improved balance
- Interestingly, no change in BMD was found

Hip Fracture: Clinical Practice Guidelines (McDonough CM et al., 2021):

- Treatment must focus on structured exercise, including progressive high-intensity strength training, balance, weight bearing, and functional mobility training; exercises across the care continuum; interdisciplinary management; fall prevention; assessment for delirium; early assisted ambulation; daily physical therapy training (in hospital); and guidance on how to participate safely in physical activity

- Older adults with hip fracture should be treated in a multidisciplinary orthogeriatric program, which includes physical therapy and early mobilization. Physical therapists should contribute to interprofessional care to ensure that older adults with hip fracture are appropriately evaluated and treated for osteoporosis and risk of future fractures

<u>Hip Fractures – Mechanism</u>

- A fall from standing height can produce 10x the force required to fracture the hip of an older woman; yet, only 1% of falls in older women resulted in hip fracture.
- A sideways fall is the most likely fall type
- Lower extremity flexion combined with axial rotation lowered impact force

- Using the arm to break the fall decreased the risk of fracture
- Among long-term care residents who fell, falling sideways, lower BMD, taller height, lower BMI, and impaired mobility were predictors of hip fracture
- Fear of falling is associated with fall risk in older people

Exercise Recommendations: Physical Therapist Management of Patients With Suspected or Confirmed Osteoporosis: A Clinical Practice Guideline From the Academy of Geriatric Physical Therapy (Hartley, 2022):

• ***Postmenopausal Women*** - *Hip and the Femoral Neck:* long-duration exercise programs consisting of static weight-bearing exercises such as single-leg standing

• ***Postmenopausal Women*** - *Lumbar Spine:* walking, tai chi, progressive-resistance strength training (such as weight training), and different combinations of exercise types

• ***Premenopausal Women*** – *Femoral Neck:* high-impact exercise (such as jogging) and combining impact exercise (such as stair climbing) with progressive-resistance strength training (such as weight training)

• ***Premenopausal Women*** - *Lumbar Spine:* progressive-resistance strength training (such as weight training) alone or in combination with impact exercises (such as stair climbing or jogging)

• ***Men*** - insufficient evidence to make a recommendation for exercise for improving BMD in men

What were the characteristics of these two positive trials?

More recent work has revealed:

- Higher intensity, weight-bearing exercise are not better than lower intensity seated or lying exercises for mobility and balance (Moseley et al., 2009)
- Increased muscle strength and power with 2x/wk supervised resistance training for 12 wks (Portegijs et al., 2008)
- Arm ergometry + inpatient rehabilitation improved aerobic fitness, mobility and balance (Mendelsohn et al., 2008)

Section 4: What about walking?

Conflicting reviews on walking benefits

Study 1: Cochrane Review: Exercise for preventing and treating osteoporosis in postmenopausal women (Bonaiuti et al., 2002; Bonaiuiti et al., 2009)

- 3 studies utilizing walking programs
- Comparison to control groups
- Walking program: high intensity, 3x/wk, 30-45 minutes
- Analyzed results showed walking to have a positive effect on the BMD of spine 1.31[95%CI (-0.03 to 2.65)] and the hip 0.92 [95%CI(0.21 to1.64)]

Author's conclusion: Walking resulted in statistically significant improvements of BMD in lumbar spine and hip. The authors suggest that this program may be easiest, simplest and best program for implementation long-term.

Study 2: Meta-analysis of walking for preservation of bone mineral density in postmenopausal women(Martyn- St James et al., 2008)

- Meta-analysis carried out in line with Cochrane Collaboration guidelines
- 8 walking studies reviewed – 5 RCT studies and 3 non-randomized trials
- All utilized control groups
- Walking program amongst 8 studies varied (self-paced, brisk pace, pace based on heart rate, treadmill walking & outdoor walking)
- 8 showed relative change in lumbar spine BMD of 0.39%
- 5 studies examined femoral neck BMD – a relative change of 0.35%

Author's conclusions: Walking as a singular exercise intervention is not sufficient to preserve BMD at the spine or hip in post-menopausal women. The effects on BMD may be clinically too small to impact reduction of fractures.

Conclusion about walking for OP: The conflicting findings regarding bone density and walking should not discourage the inclusion of walking in persons with OP. Walking has many health benefits in general and for a client it may be an appropriate or convenient way to reach their aerobic exercise needs or improve dynamic balance or agility. Caution should be taken in prescribing brisk walking or jogging to those with issues of balance. Education to the client about the benefits of walking should focus on the overall benefit and not 'promise' to improve bone density.

Points to Ponder

Is improving BMD the only reason you would consider prescribing walking for your client? If you review research of the effect of prescription medications on BMD, the reports often demonstrate small changes in BMD but large increases in fracture risk reduction percentage. What does this suggest about focusing on BMD changes as the ultimate indicator of an intervention's success?

Section 5: What about high impact exercise?

The mechanostat theory (Frost et al., 1987) dictates that bone adaptation is a response system likened to a thermostat in which a set point, or minimum effective strain (MES), is determined by internal & external factors. Therefore, it responds to loads above or below these MES points with either bone formation or resorption. Simply put, load the bone above its natural MES, and it will adapt the bone to support the new demand; conversely, unload the bone (below its MES) and the BMD will decline to meet its new metabolic environment.

Animal studies have provided information regarding mechanical loading for optimal bone formation:

- Strain from loading must be of high magnitude.
- A high rate of strain provides a greater osteogenic stimulus than same peak strain achieved gradually.
- Bone adaptation is driven by unusual strain distributions and may stimulate an osteogenic response at a lower MES
- Cycles of loading are unimportant beyond a certain threshold (Kato et al., 2006; Moseley et al., 1998; Rubin et al., 1985

Human research of high-impact loading reveals:

- RCTs investigating brief, high-impact exercise in premenopausal women have shown significant improvements of hip and/or spine BMD (Bassey et al., 1994; Bassey et al., 1998; Kato et al., 2006; Vainionpaa et al., 2005; Winters-Stone et al., 2006)
- Similar programs applied to postmenopausal women do not show any significant trends to improving BMD (Bassey et al., 1998)

Bottom Line

Theoretically, brief, unique, high impact exercise should induce bone formation. Research supporting this theory exists in premenopausal women, however physiologic factors (i.e. hormonal, co-morbidities, aging) may prevent similar adaptions in older adults, and other factors (pain, restrictions with comorbidities, fear, etc.) may prevent the safe or successful implementation of high impact programs in older adults.

LIFTMOR trial, Watson et al. (2018)

- Supervised group exercise, high intensity resistance training (deadlift, overhead press, back squat) at 80-85% 1RM (5 sets of 5 reps) + impact loading (jumping chin ups with drop landing)
- 8 months, 2x/week, 30 minutes
- 101 (52 control, 49 exercise) healthy older adults with osteoporosis and no underlying musculoskeletal or cardiovascular comorbidities (excluded people with a recent fracture)
- 1 participant reported low back strain, but did not withdraw from the study
- Found improved lumbar spine and femoral neck BMD compared to control group, and improved lower extremity and back extensor strength, TUG, five time sit to stand, and functional reach test
- BUT did not measure vertebral fractures post and excluded people with a recent fracture –silent could have occurred throughout program

Section 6: Strength training – how to do it

Overview of Too Fit to Fracture Recommendations for Strength

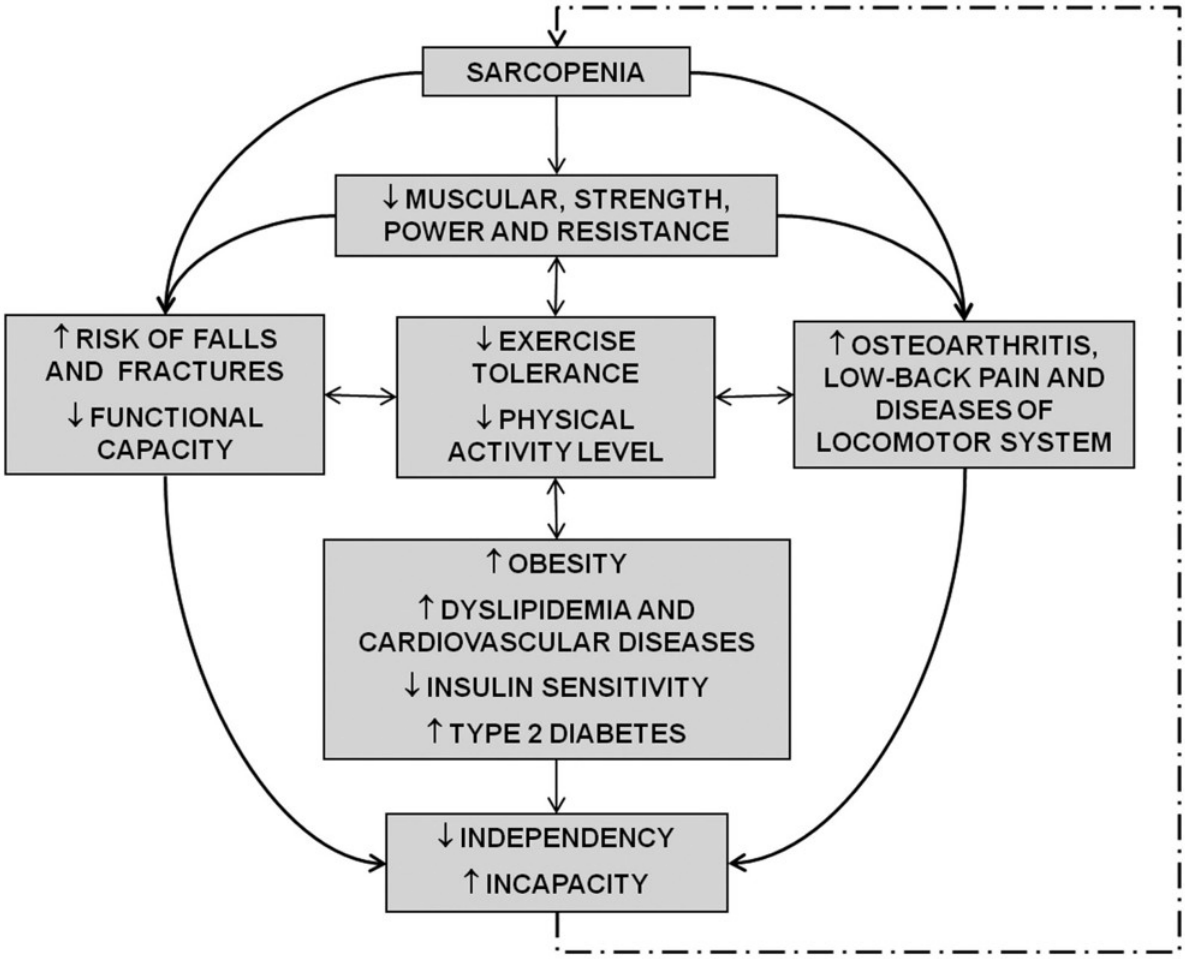
Type	How often per week?	How hard should I work?	Examples and Comments
Strength Training	≥ 2 days a week	8-12 repetitions per exercise Intensity of 5-8 On a 0-10 scale 0=rest, 10=max	Min. 1 exercise each for: legs; arms; chest; shoulders; back. Use: exercise bands; weights, or body weight against gravity. 1-3 sets/exercise. Train at ↓, intensity initially if: sedentary; conditionsaffecting activity; high fracture risk; strength training novice

Effects of Aging on MSK System & Sarcopenia Development Model

Effects of Aging on MSK System

- Muscle mass decreases – with changes occurring as early as age 30
- **Sarcopenia:** age-related loss of skeletal muscle mass with decrease of strength, aerobic capacity and functional capacity. Physical inactivity contributes to decreased muscle mass.
- Loss of elastic properties of elastic tissues makes it more difficult for repair and recovery.

Sarcopenia Development Model



Strength Training Prescription: Establishing a Baseline

- A common method to determine how hard someone should be working is to figure out their 1-repetition maximum (1RM): this is the maximum load they can work to do one good repetition before failure (e.g., cannot do any more with good form).
- A 1RM may not be a feasible for your exercise scenario. You could instead use a 10RM (repetition maximum). Like the 1-rep max, this is a load where the person can perform 10 repetitions before failure. A 10 RM is about 80% of a 1RM.
- If the person can do 20 repetitions before failure (i.e., their 20RM) then they are working at less than 60% of their 1RM.

NOTE: Depending on the exercise, you might not need to use weights to determine their rep max. For example, if you are assessing baseline leg strength you could ask the person to stand up and sit down out of a chair without using their arms as many times as they can.

Remember – intensity is relative to the person's abilities NOT to a set weight. If the person asks "How much can I lift?" it really depends on their baseline ability (i.e., their 1 or 10RM).

Also remember – re-assess baseline frequently, it will change as the person's strength improves and so too should the intensity of their strength exercises.

General Strength Training – What Intensity & Progression

Intensity

- 60% of 1RM is the MINIMUM overload necessary for muscle adaptation in untrained people
- Remember from the previous section – a 20RM is less than 60% - that means if the person can do more than 20 repetitions before failure they are not working hard enough to see strength changes.
- This is a RPE (rate of perceived exertion) of 12-13/20 (or 15 reps before form deteriorates)
- Greater strength effects with 80% 1RM (= RPE of 15-17/20 or 10 reps before form deteriorates)
- SETS – at least 1, more is better but be careful about form
- REPS – determined based on your desired intensity
- Frequency – 2-3 x/week with 24-48 hours of rest between sessions of the SAME muscle group
- Duration – 12-16 weeks

Progression

MUST occur

- Can increase weight or reps, multiple exercises for same muscle group
- Continually reassess 10RM – if they can do 12-15 reps then increase load 2-10%

A Quick Word on Power Training

Power training is actually quite important for completing functional movements in daily life such as getting out of a chair quickly, crossing the street or climbing stairs.

- Once they can perform 2 sets with good form and no pain, then incorporate POWER training:
    - Quick concentric and slow eccentric movements
    - Start at 20%1RM progress as tolerated to 60% 1RM

Section 7: Balance training – how to do it

Overview of Too Fit to Fracture Recommendations for Balance

Type	How often per week?	How hard should I work?	Examples and Comments
Balance Training	Daily for ≥15-20min	Progress from "standing still" exercises" to dynamic	Can do during daily walks or activities: Standing still: ↓, base of support e.g., Semi-tandem stance, one-leg stand; shift weight between heels & toes while standing Dynamic movements: Tai Chi; tandem walk, dancing

Falling – Facts & Falls Prevention

- Researchers have demonstrated that individuals who fall to the side (onto the greater trochanter, for example) are 6-20 times more likely to sustain a fracture compared to other fallers.
- Other research using computer models have concluded that falling on the hip laterally with the leg internally rotated results in a high possibility of fracture as the femoral neck is weakest to posterolateral blow.
- Previous long-term care study presented at National Falls Conference revealed that falls in long-term care facilities occurred largely because of poor response time to protective arm movement & arm weakness.

Falls Prevention

Updated systematic review of falls prevention (Sherrington et al., 2016) gives 9 best practice recommendations:

1. Exercise must provide a high challenge to balance
    a. Choose exercises that safely: reduce base of support, displace center of gravity andcontrol body position in standing, and progress to standing without using arms for support (or reduce reliance on upper limbs)
2. Exercise must be of sufficient dose (approx. 3 hrs. weekly)
3. Ongoing exercise is necessary
4. Falls prevention exercise should be targeted at the general public as well as those at high risk
5. Falls prevention exercise can be done at home or in group exercise
6. Walking retraining can be included in addition to balance retraining, but high-risk individuals should NOT be prescribed brisk walking
7. Strength training may be included in addition to balance exercises
8. Exercise providers should make referrals for other at-risk factors to be addressed
9. Exercise as a single intervention doesn't prevent falls in all populations. Exercise should be delivered to patients with co-morbidities by providers with particular expertise.

Hill & Stairs

Going Up Hills

Do not lean forward too far - it is natural to lean forward somewhat when going uphill but try to minimize this tendency, thus avoiding forward flexion. Actively use the legs more to push up the hill.

Going Down Hills

Lean back slightly while going downhill and control the descent with the thigh muscles.

Going Up & Down Steps

Upon stepping up onto a step, actively push body up with the muscles of that leg. Everyone tends to favor one leg over the other so make sure to practice the pushing up with each leg. Keep upper body lengthened, chest up, as you go up the steps. Avoid going down steps sideways if possible. Practice descending the stairs leading with different legs each time.

Pole Walking & Urban Trekking

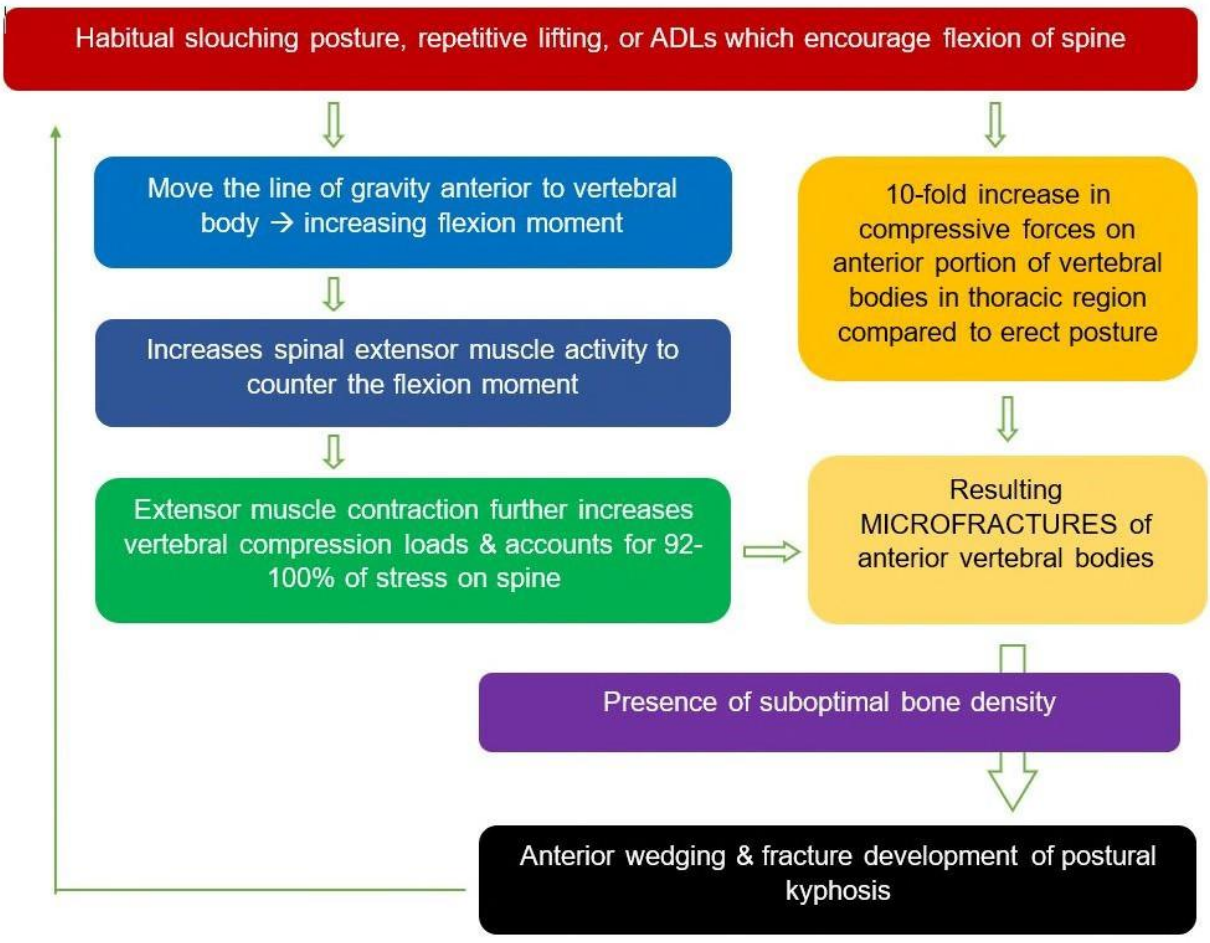
- In general, poles promote a more upright posture and weight bearing on the upper extremities, afford some relief of weight bearing on the lower extremities and also (because of the active use of the arms) increase the cardiac effort.
- In general, a walking pole with the following features is going to be safer for someone who has balance issues, a previous/current fracture, had previous falls or is at a high risk of future fractures:
    - Wide base (like a cane)
    - Adjustable via button lock (not twist to tighten)
    - No wrist straps
    - Ergonomically formed handle
- You can learn more about pole walking here: **https://urbanpoling.com/**

Section 8: Postural training – how to do it

Overview of Too Fit to Fracture Recommendations for Posture

Type	How often per week?	How hard should I work?	Examples and Comments
Spine Sparing	During Daily Activities	Alignment more important than intensity.	Modify activities that flex (bending forward) or twist the spine; most risky when rapid, repetitive, weighted, bending all the way forward, or twisting to the side. Videos: www.osteoporosis.ca/after-the-fracture/videos/

Below is a flow chart which summarizes a number of studies looking at the biomechanical relationships of the spine in different alignment. Note that as posture is altered, loading to the spine is impacted greatly and under conditions of suboptimal bone density, fracturing can occur and ultimately feed forward into more postural changes, load alterations and more fractures.



What about changing posture?

Briggs et al.,(2004, 2006) have stated in their research that it is important for therapists' treatment plans to include specific strengthening modalities to reduce vertebral loading and that interventions aimed at minimizing thoracic kyphosis may do this.

Authors investigating vertebral bone failure under compressive forces have shown that recovery of cancellous bone height is possible following removal of forces (Fyhrie et al., 1994). The research was conducted in lab conditions with short-term compressive forces of very high loads to vertebral cancellous bone, with a resulting 94% recovery of bone height following removal of the loads. The authors suggest this recovery mechanism inherent with cancellous bone may be the key in allowing a damaged vertebrae/articular joints to regain original shape (and height!) with little loss of function. There hasn't been conclusive research on long-term osteoporotic fractures with respect to potential recovery of vertebral height through a similar mechanism.

However, it would stand to reason that unloading activities such as active extension, postural correction and/or avoiding/adapting ADLs which are flexion-based, can reduce compressive loads which MAY prevent further fractures.

Research Summary #1

An osteoporotic vertebral fracture may simply be a 'weak' vertebral bone being loaded during activities of daily living*

Research Summary #2

Reduction or avoidance of anterior compressive forces in the presence of damaged or at risk vertebrae at the very least prevents further damage.

MODIFYING ACTIVITIES OF DAILY LIVING

Think of how many times a golfer picks up a ball from the turf in a round of golf. How do they protect their back from repetitive bending? They use a 'Golfer's Reach'

This can be an effective way to retrieve objects from the ground, however, it requires a stable object to hold onto (like counter, cane/walking pole) and **good basic balance**.

If utilized properly, a MODIFIED Golfer's Reach, can be an effective posture for many other activities of daily living that may be performed with a flexed back or slouching posture (think of self-care tasks, household duties, work tasks, and many other everyday movements).

End-range trunk rotation & forward bending:

Instead of	Do
Trunk rotation machine or twisting movements for abs	Side plank on wall or floor

Instead of	Do
Yoga/Pilates movements that involve flexion	Supported flexion, not to end-range e.g. modified downward dog with hip hinge and chair

Precarious Balancing

Instead of	Do
Standing on a chair	Use a step stool with a wide base of support and non-slip materials on the stepping surface and interface with floor.

FRONT & SIDE PLANK

Osteoporosis Canada
Ostéoporose Canada
UNIVERSITY OF WATERLOO

1. Stand at the centre of the mat.
2. Bring one foot forward, keeping your head and back in alignment and come into lunge position, lowering the back knee to the floor.
3. Bring other knee onto floor.
4. Hinging at the hips, reach forward to place one hand on the floor.
5. Place the other hand on the floor.
6. Place elbows on the floor one at a time.

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PERFORM _____ REPETITIONS • PERFORM _____ SETS

FRONT & SIDE PLANK

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...Continued.

7. Move from your knees to toes if possible, making sure that your body is in alignment.
8. Hold this position.

Transfer to Side Plank

1. Go through steps 1-6 from "Front Plank".
2. Once you are on your elbows, turn so you are lying on your hip, with one elbow on the floor, and the other hand resting on your top hip.

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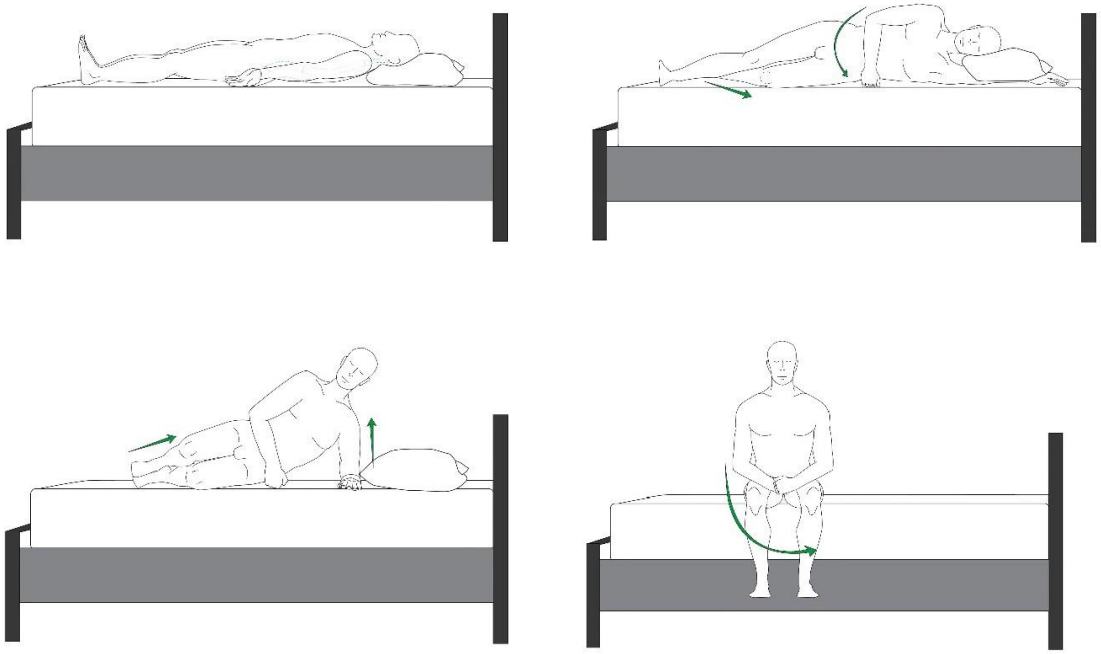
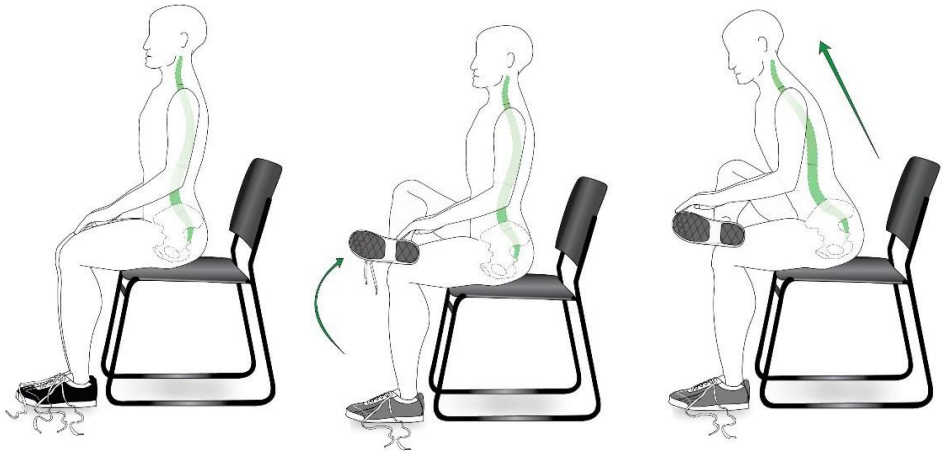
PERFORM _____ REPETITIONS • PERFORM _____ SETS

EXAMPLES OF ACTIVITIES OF DAILY LIVING

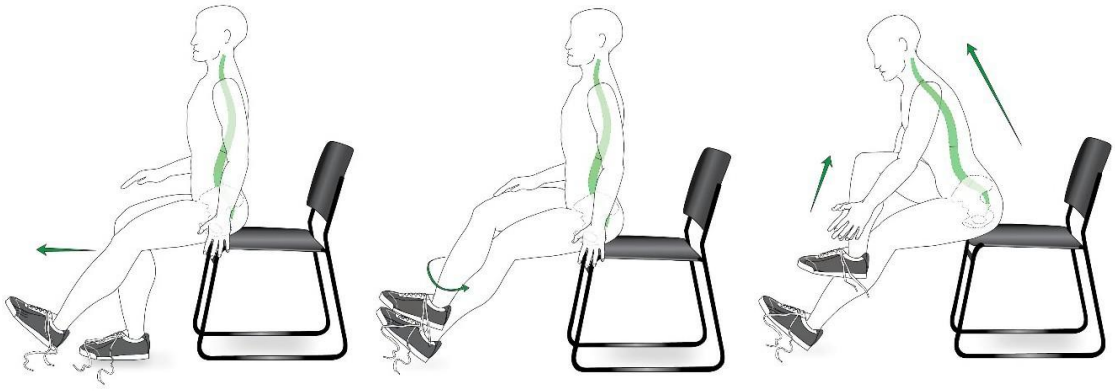
RISING FROM BED:



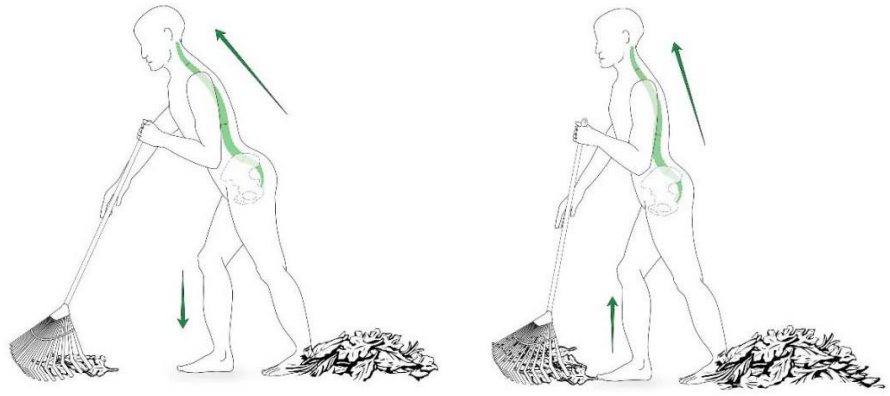
TYING SHOES:

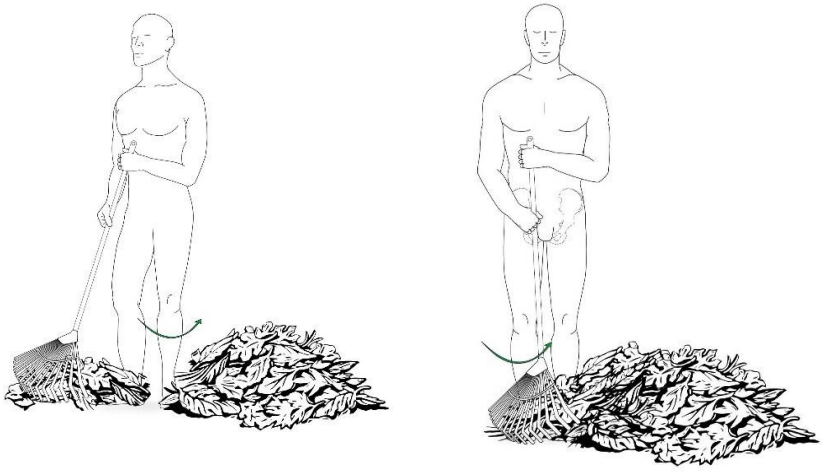


TYING SHOES (LIMITED HIP/KNEE RANGE):

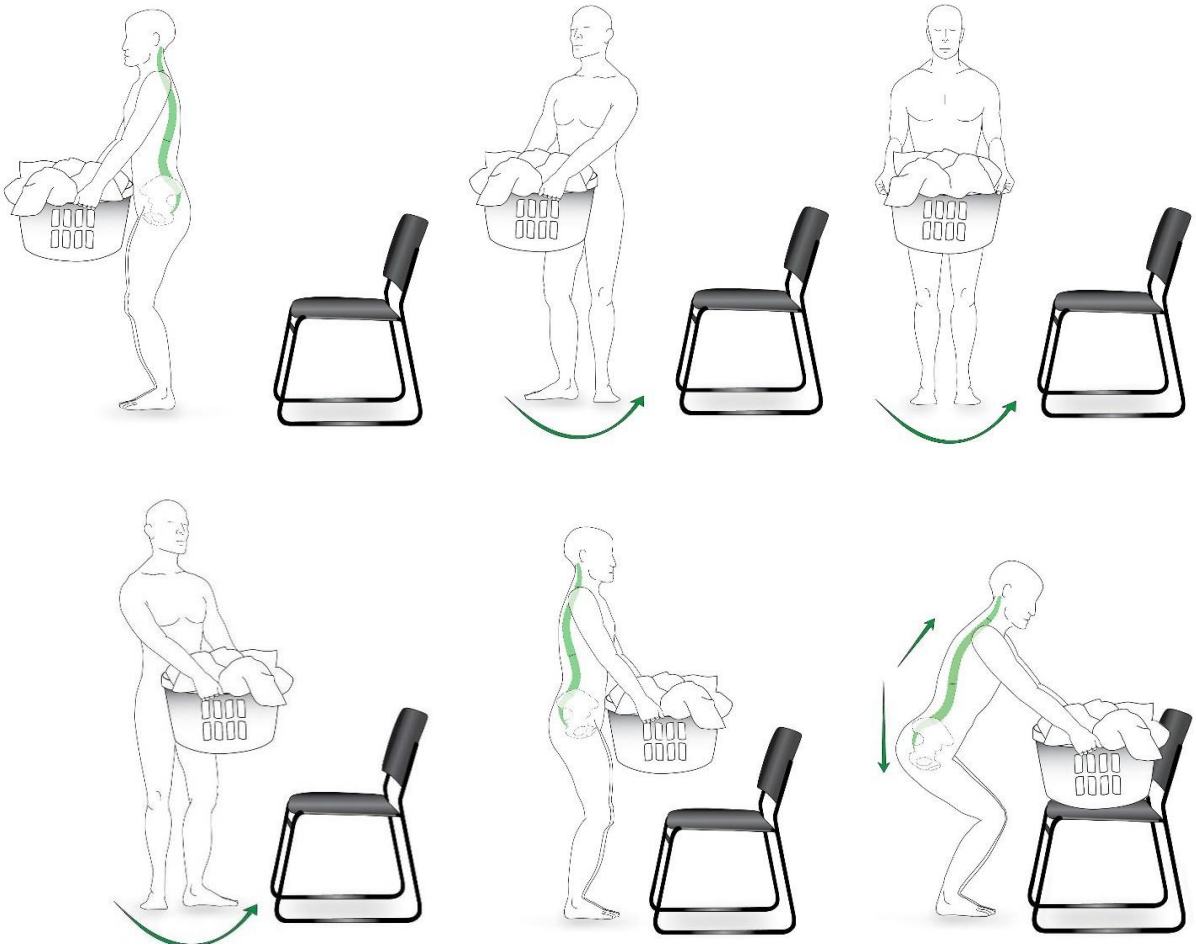


RAKING LEAVES:

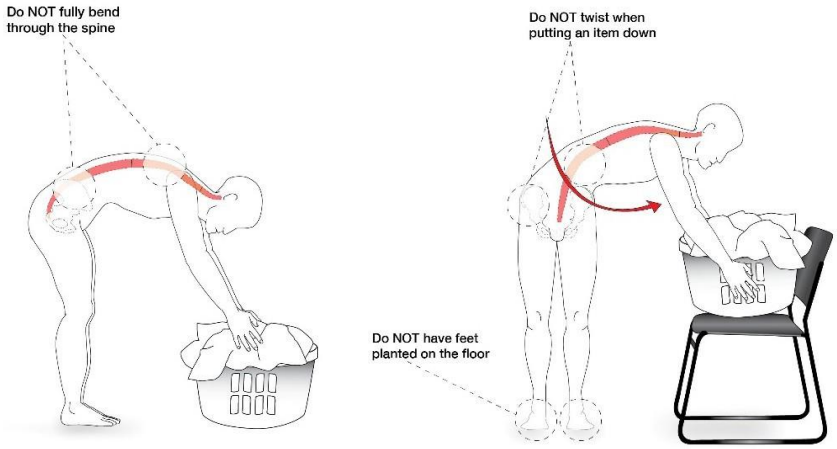




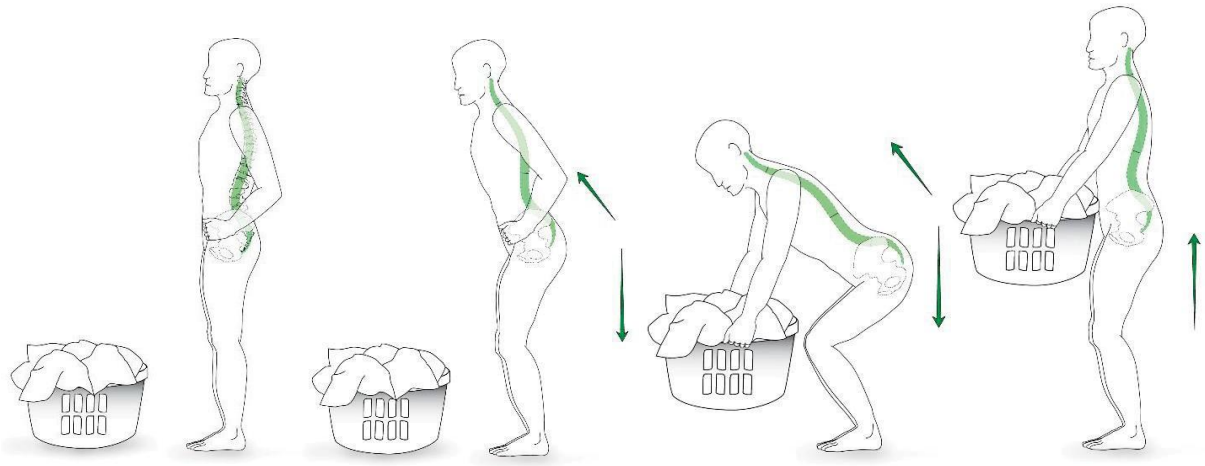
MOVING AN OBJECT:



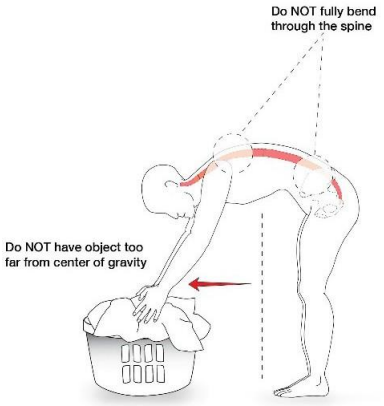
How **not** to move an object



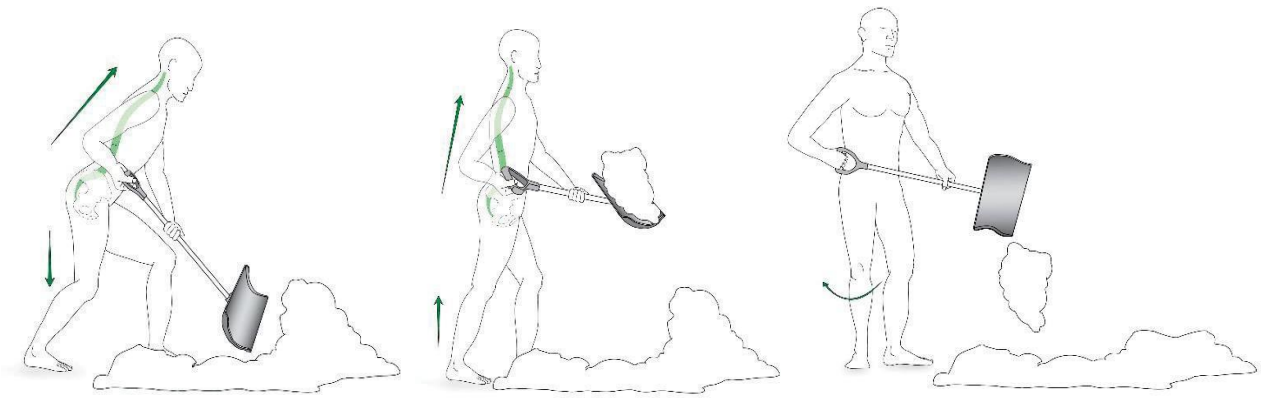
PICKING UP AN OBJECT:



How **NOT** to pick up an object



SHOVELLING SNOW:



USING HIP HINGE FOR ACTIVITIES OF DAILY LIFE: