Musculoskeletal Fitness Assessment & Flexibility

Muscle FYI

- 600 muscles are used by the body to work, play sports and do ADL's
- Skeletal muscle is the most abundant tissue
  - 23% of the female body weight
  - 40% of the male body weight
- Muscles are very responsive to use and disuse

Muscle Fitness - is the integrated status of muscular strength and muscular endurance.

- Fitness depends on 3 basic components:
  - **Muscle strength** - the maximal force that a muscle can generate at a given velocity. (isometric, isotonic, isokinetic)
  - **Muscle endurance** - the ability of a muscle to make repeated contractions or to resist muscular fatigue.
  - **Flexibility** – functional capacity of the joints to move through a full range of motion (ROM). (dynamic, static)

Health and Fitness Benefits: Comparison

VARIABLE	AEROBIC EXERCISE	RESISTANCE EXERCISE
Resting BP	↓↓	↔↓
HDL-C	↑↑	↔↑
Insulin	↑↑	↑
Body fat %	↓↓	↓
Bone mineral	↑	↑↑↑
Strength	↔↑	↑↑↑
Function—age	↑↑	↑↑↑
VO_{2max}	↑↑↑	↔↑

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Tests that measure the 3 elements of muscle fitness

- Strength ?
- Endurance?
- Flexibility

Fitness Assessment

Muscle Strength Tests

- **Strength – greatest amount lifted**
- 1 RM bench press test
- Hand grip dynamometer
- Push-ups
- Curl-ups
- Pull-ups
- Dips
- Leg Presses
- Leg extensions
- Lat pull downs

Muscle Endurance Tests

- **Endurance – number of successful lifts until exhaustion**
- YMCA bench press
- 1 minute Sit-ups
- Curl-ups
- Dips
- Pull-ups

Flexibility Tests

- **Flexibility**
- Sit and reach
- Shoulder flexibility test
- Trunk rotation test
- Chair stand
- Back ROM test
- Goniometer testing

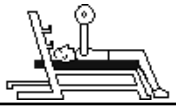
ESTIMATE 1-RM FROM SUBMAXIMAL ENDURANCE TESTS

- 1 RM = Weight lifted (lb)/[1.0278- reps to fatigue x 0.0278]
- NOT TO EXCEED 10 REP'S TO FATIGUE
- Example: A client completes 7 rep's of a bench press exercise using 100lb dumbell
  1-RM = 100lbs/[1.0278-7x0.0278]
  1-RM = 120lbs (54.5kg)

1-RM bench press

1. The subject performs a light warm-up of 5 to 10 repetitions at 40% to 60% of perceived maximum (i.e., light to moderate effort).
2. After a 1 min rest with light stretching, the subject performs 3 to 5 repetitions at 60% to 80% of perceived maximum (i.e., moderate to hard effort).
3. The subject attempts a 1RM lift. If the lift is successful, a rest of 3 to 5 min is taken. The goal is to find the 1RM within 3 to 5 maximal efforts.
4. The 1RM is reported as the weight of the last successfully completed lift.
5. Strength ratio = best lift /body wgt
6. Compare with norms for strength to body mass (Append A Table 35) for gender and age

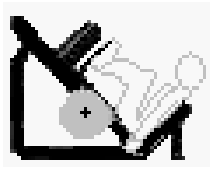
Caution! Make sure you are spotting the person performing the press! Provide a warm up prior to the lift Use proper breathing technique to avoid a Valsalva



Leg Press

1. Have the participant warm up by completing 5-10 reps at 40-60% of estimated 1-RM
2. During a 1 minute rest, have the client stretch the muscle group. This is followed by 3-5 minutes of the exercise at 60-80% of the estimated 1-RM
3. Increase the weight conservatively and have the client attemp the 1-RM lift. If the lift is successful, the client should rest 3-5 minutes before attempting the next weight increment. Follow this procedure until the client fails to complete the lift. The 1-RM is usually achieved within 3-5 trials, depending on the fitness level of the client
4. Record the 1-RM value as the maximum weight lifted for the last successful trial
5. Determine the leg press weight ratio

   LPWR = Weight pushed/Body weight
6. Check the score on page 618 Table 35 or 36b



Supervise the subject for signs of fatigue and terminate the activity if the lift becomes too difficult for the individual

Grip Strength

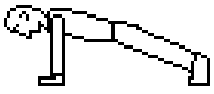
1. **Adjust the dynamometer to the grip and place in the hand to be tested. Second joint should be snugly under the handle**
2. **Assume a slightly bent forward position with the hand to be tested out in front of you . Hand and arm free of the body. Arm slightly bent**
3. **Perform and 'ALL OUT" grip effort for 2-3 seconds. No swinging, stomping, pumping of the arm or feet is allowed. The dial can be visual for motivational purposes**
4. **The sum of the score of the test in both hands, based on the best of 3 trials is recorded (mm)**
5. **Table 30 Appendix A in your text will provide the normative data for age and gender**

Swinging, stomping, pumping of the arms or feet, and swearing is not allowed

PUSH-UP TEST

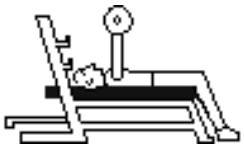
1. Explain the purpose of the test to the client.
2. Inform client of proper breathing technique (i.e., exhale when pushing away from the floor).
3. For male clients, use standard "up" position, with hands shoulder-width apart, back straight, head up, and the toes used as the pivotal point.
4. For female clients, use modified knee push-up position, with legs together, lower legs in contact with mat with ankles plantar flexed, back straight, hands shoulder-width apart, and head up. The subject must lower the body until the chin touches the mat. The abdomen should not touch the mat.
5. The subject's back must be straight at all times, and the subject must push up to a straight-arm position.
6. Demonstrate the test, and allow the client to practice if desired.
8. Remind the client that brief rest is allowed only in the up position.
9. Begin the test when the client is ready, and count the total number of push-ups that the client completes before reaching exhaustion.
10. The client's score is the total number of push-ups performed. Table29 in text Appendix A

Note: Females are allowed to do the modified push-up that will be included in the lab packet or you can perform the standard push-up



DYNAMIC MUSCLE ENDURANCE

- Performing as many repetitions as possible using a weight that is a set percentage of the body weight or 1-RM
- YMCA (Golding et al 2000) uses a bench press to assess dynamic muscular endurance of the upper body



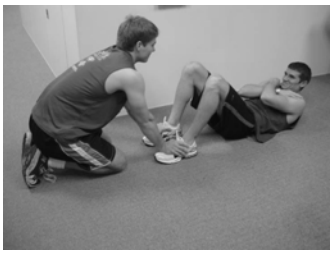
YMCA BENCH-PRESS FOR ENDURANCE

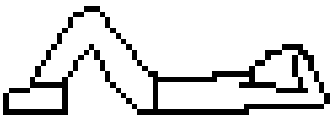
1. Use a 35-lb barbell for women and a 80-lb barbell for men
2. Set the metronome to 60rpm
3. The person lies on a bench, with feet flat on the floor
4. A spotter hands the weight to the person. The down position is the starting position (elbows flexed, hands shoulder-width apart, hands gripping the barbell, palms facing up
5. The person presses the barbell upward using free weights (with careful spotting) to fully extend the elbows. After each extension, the barbell is returned to the original position, the bar touching the chest. The rhythm must be kept with the metronome, each click representing a movement up or down (30 lifts per minute)
6. The score is the number of successive repetitions. The test ends when the person can no longer reach full extension or breaks cadence
7. Appendix A Table 37 will provide the norms by age and gender

Caution: Make sure you are spotting the individual lifting the weight, never leave someone unattended
Emphasize proper breathing technique
"out" on the lift
"in" on the lower

1-minute bent knee sit-ups

1. Start on the back with the knees bent, feet on the floor and heels 12-18 inches from the buttocks
2. Arms are crossed on the chest with hands on the opposite shoulders. Arms must be crossed and flat on the chest
3. Feet are held by a partner
4. Set the timer to 1 minute
5. During the sit-up, arm contact with the chest must be held. This is crucial! Also, buttocks must remain on the mat no more than 18 inches from the heels
6. 5. In the up position, the mid back makes contact with the floor.
7. The number of correctly executed sit-ups in 1 minute is the score. With proper technique!!!
8. Check your performance in Appendix A tables 5,6,15,20,24 for normative data





Partial Curl-up Test

1. Explain the purpose of the test to the client.
2. Inform the client of proper breathing technique (exhale when curling up from the floor).
3. Individual assumes a supine position on a mat with the knees bent 90°.
5. The arms are at the sides, with fingers touching a piece of masking tape. A second piece of masking tape is placed 8 cm (for those who are older than 45 yr) or 12 cm (for those who are younger than 45 yr) beyond the first.
6. A metronome is set to 40 beats · min^{-1} and the individual does slow, controlled curl-ups to lift the shoulder blades off the mat (trunk makes a 30° angle with the mat) in time with the metronome (20 curl-ups · min^{-1}). The low back should be flattened before curling up.

NOTICE THAT FEET ARE UNSUPPORTED FOR THIS TEST

7. Demonstrate the test, and allow the client to practice if desired.
8. The client performs as many curl-ups as possible without pausing, up to a maximum of 75. (An alternative is doing as many curl-ups as possible in 1 min.)
9. Terminate the test if the subject experiences discomfort or cannot keep up with the cadence
10. Norms appear in Appendix A Table 31

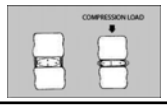
MUSCLE BALANCE RATIO

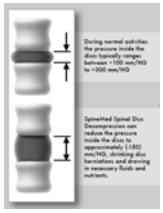
- The difference in strength between contralateral muscle groups should be no more than 10-15%
- The strength to body mass ratio of the upper body should be at least 40-60% of the lower body relative strength

YOU CAN OBTAIN A CRUDE INDEX OF MUSCLE BALANCE BY COMPARING 1-RM VALUES OF MUSCLE GROUPS

"Searching for the Perfect Sit-Up"

- Safest, most effective
- Safety factor – Does it protect the lumbar spine? Compressive forces on the lumbar spine while optimizing abdominal strength

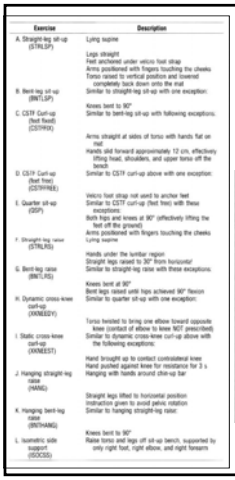


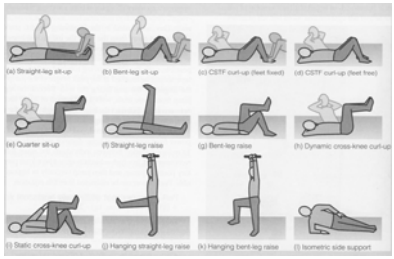


Compressive forces on the lumbar spine

High Challenge improved abdominal strength and endurance

SAFEST ABDOMINAL EXERCISE





Axler DT et al . MSSE 29:804-810, 1997

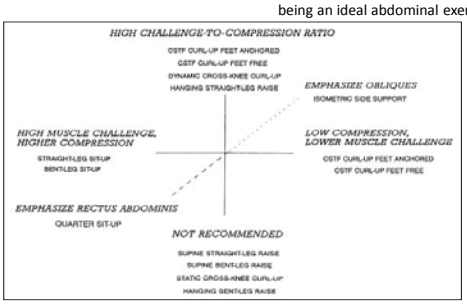
No single abdominal exercise recruits all the abdominal muscles (obliques and rectus abdominis have different functions)

Sit-ups performed with legs feet anchored, elevated or twists of the torso did not increase level of abdominal activity

•No differences in lumbar spine compression observed with sit-ups performed with the legs bent or straight

•No sit-up was identified as ideal (low compressive force and very effective)

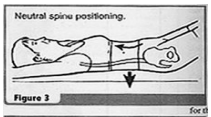
•The partial curl-ups did come close to being an ideal abdominal exercise

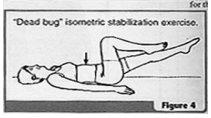


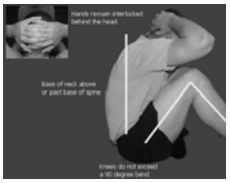
Axler DT et al . MSSE 29:804-810, 1997

Abdominal Exercises

"While there are lots of ways to injure a back, the sit-up is an easily preventable one. According to his research, a crunch or traditional sit-up generates at least 3,350 newtons (the equivalent of 340 kg) of compressive force on the spine. The U.S. National Institute for Occupational Safety and Health states that anything above 3,300 newtons is unsafe."







Squats Vs. Leg Presses

Squat – the spine is supporting the full weight.

Leg Press - the spine is under no compressive load

Squat - the stronger your legs are, the more weight you need to use and the more compressive force is placed on the spine

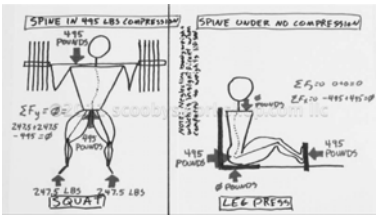
Leg press - Even the strongest Powerlifter has no compressive forces on the spine

Human spines are poorly designed for handling vertical compressive forces., better to handle horizontal compression.

WE FUNCTION BETTER AS QUADRAPEDS!

Good technique and strong core can lessen the spinal compression

Squats are not meant for everyone



IMPORTANCE OF INTRA-ABOMINAL PRESSURE

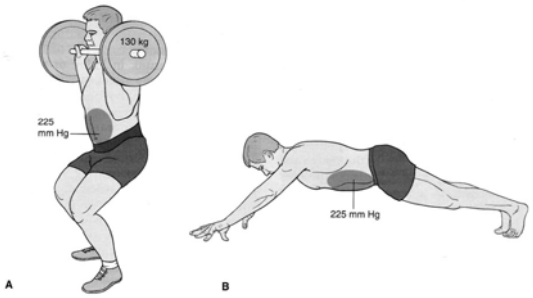


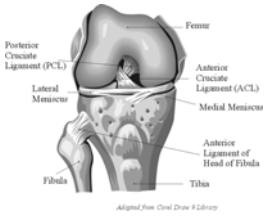
FIGURE 17.9 Role of intra-abdominal pressure in protecting the spine during lifting. In both **A.** heavy-resistance lifting and **B.** lifting of body weight, extreme intra-abdominal pressures are necessary to stabilize the spine.

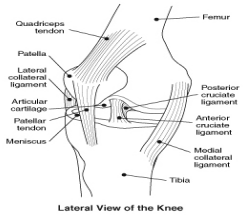
What is FLEXIBILITY?

- Derived from the Latin term “Flexibilis” to bend
- Def: Ability of a joint or series of joints to move through a full range of motion (ROM) without pain and injury
- Extensibility of all soft tissues that allow full range of motion
- Assessments of flexibility measure the ability of skeletal muscle and tendon to lengthen

JOINT CAPSULE and LIGAMENTS

- Flexibility depends on morphological Factors:
  - Joint geometry
  - Joint capsule
  - Ligaments
  - Tendons
  - Muscles spanning the joint





Lateral View of the Knee

Range of Motion

- Range of Motion is frequently used in place of FLEXIBILITY
- Having functional ROM at all joints ensures efficient body movement.
- Flexibility is considered a 'Joint-Specific'

ROM in the ELDERLY

- Many older drivers like this motorist may experience reduced range of motion, making it harder to rotate the head and neck and therefore more difficult to navigate skewed intersections

Benefits of Flexibility

- Increased movement range
- Reduction in rate of functional decline
- Postural symmetry and joint alignment
- Stress reduction, reduced tension, and tissue relaxation
- Reduced risk of injury
- Relief of muscle pain
- Improved quality of life

Factors Affecting Joint ROM

- Muscle tissue
- Connective tissue
- Neural receptors

Factors Affecting Flexibility

- **Body Type** – Muscular and obese may have lower ROM. Adjacent body segments contact each other sooner than smaller limb/trunk girths (example, large hamstrings limit the ability to fully bend the knees)
- **Age** – Inflexible older individuals increased muscle stiffness which decreases static flexibility. Counteract age-related process with flexibility training
- **Gender** – Females more flexible than males except for hip extension and spinal flexion and extension in the thoracolumbar region

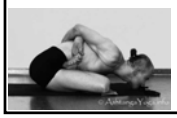
- **Diseases states** – Osteoporosis and arthritis have a negative impact on ROM
- **Physical Activity** – Habitual movement is more of a determinant of flexibility than age, gender, body type
  Disuse/immobilization causes shortening of muscles (e.g. contracture)

Can You Be Too Flexible?

JOINT LAXITY (Looseness/instability) hypermobility – Increase ROM of joints beyond normal, acceptable values

Increases one's risk of musculoskeletal injury

You must be able to accurately assess ROM and designate stretching
Programs that improve the client's flexibility without compromising JOINT STABILITY!



Types of FLEXIBILITY

- STATIC FLEXIBILITY – Linear or angular measurement of the actual limits in a joint or complex of joints. Measure of total ROM at the joint and is limited by the extensibility of the musculo-tendinous unit

  The hamstring has a large musculo-tendinous complex Partly explains why hamstring injuries are so common

Static Stretching

- Basic static – tissue is actively lengthened to a desired range and maintained at full length for optimally 30 seconds.
- Active assisted – force is added to the static stretch to increase movement range. External force may be mechanical, gravitational or human. Durations are 15-30 sec.

  Note: Static stretching reduces force output due to relaxation, negatively affecting strength and power movements performed following stretching.

Proprioceptive Neuromuscular Facilitation (PNF)

- Based on inhibition or reduced excitability of motor neurons in antagonist muscles and increase excitability in agonist muscles
- Joint sensory endings, muscle spindles (detect change and rate of change in length),Golgi Tendon Organs (proprioceptors sensing change in tension) are activated
- "Trick the tissue into greater ROM capabilities
- Contract relax applied over 3 short (6-10sec) periods per muscle group

2 Types PNF

Passive Stretch – Hold Relax "PUSH"

- Subject relaxes while trainer passively stretches muscle and hold 10 seconds
- Trainer instructs client to "PUSH" against resistance to produce isometric contraction of agonist 4-6 sec
- Limb is then re-stretched to a new position
- Passive stretch between isometric cont. 10 sec
- Repeat 3 times

Active Stretch – Contract Relax "PULL"

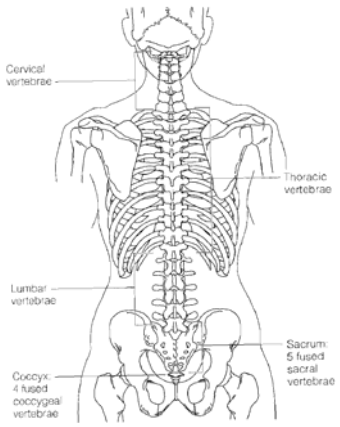
- Trainer passively stretches muscle hold for 6-10 sec
- After isometric period instruct client to "PULL"
- This pull phase lasts 4-6 seconds
- At the end of this contraction the client relaxes and the trainer passively stretches the muscle
- Repeat 2-4 up to 3 times

Dynamic Flexibility

- Measure of the rate of torque or resistance developed during stretching through the ROM
- Rate of increase in tension in relaxed muscle as it is stretched.
- Are they distinct entities or two aspects of the same flexibility component???

NO ONE KNOWS

The human spine is made up of 24 vertebrae divided into 5 distinct regions. Low-back pain is most commonly experienced at the L4-L5 lumbar segment.

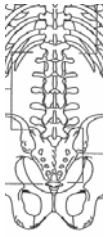


What is Low Back Pain?

- Low back pain is a common ailment—60-85% of all Americans will experience a bout of low back pain ranging from a dull, annoying ache to intense and prolonged pain.
- At any one time, about 15% of adults have low back pain, and is the 5th most common reason for all physician visits.
- Males and females appear to be affected equally; most cases of low back pain occur between the ages of 25 and 60 years (peak at age 40).
- The first attack often occurs early in life—up to one-third of adolescents report they have had at least one bout of low back pain.
- Fortunately, most low back pain is self-limiting. Without treatment, 60% of back pain sufferers go back to work within a week; nearly 90% return within 6 weeks. Pain is chronic in 5-10% of patients.

Major Risk Factors

- Heavy lifting with bending and twisting motions, pushing and pulling, slipping, tripping or falling.
- Long periods of sitting or driving, especially with vibrations.
- Obesity.
- Smoking.
- Poor posture.
- Mental stress and anxiety.
- Muscular weakness.
- Poor joint flexibility.

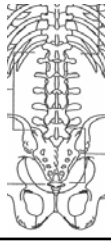


Risk Factors for Low Back Pain

- For workers under the age of 50 years, most low back pain cases are related to physical workload demands (heavy lifting, awkward posture, whole body vibration).
- For older workers, low back pain is more related to health behavior (smoking, overweight, and lack of exercise).

Prevention of Low Back Pain

- Exercise regularly to strengthen your back and abdominal muscles.
- Lose weight, if necessary, to lessen strain on your back.
- Avoid smoking (which increases degenerative changes in the spine).
- Lift by bending at your knees, rather than the waist, using leg muscles to do most of the work.
- Receive objects from others or platforms near to your body, and avoid twisting or bending at the waist while handling or transferring it.



Prevention of Low Back Pain

- Avoid sitting, standing, or working in any one position for too long.
- Maintain a correct posture (sit with your shoulders back and feet flat on the floor, or on a footstool or chair rung. Stand with head and chest high, neck straight, stomach and buttocks held in, and pelvis forward).
- Use a comfortable, supportive seat while driving.
- Use a firm mattress, and sleep on your side with knees drawn up or on your back with a pillow under bent knees.
- Try to reduce emotional stress that causes muscle tension.
- Be thoroughly warmed-up before engaging in vigorous exercise or sports.
- Undergo a gradual progression when attempting to improve strength or athletic ability.

Treatment of Low Back Pain

- Many nonsurgical treatments are available for patients with low back pain, but few have been proven effective.
- For subacute LBP (4-8 wks) intensive rehab with physical therapy is moderately effective.
- For chronic LBP (>8 wks), exercise therapy with supervised stretching and strengthening is effective.
- For most LBP cases <4 wks, low back pain should be treated as a benign, self-limiting condition that usually requires little medical intervention. Guidelines include:
  - Engage in low-stress activities such as walking, biking or swimming during the first 2 weeks after symptoms begin. Return to normal activities as soon as it is safe.
  - Bed rest usually isn't necessary and shouldn't last longer than 2-4 d. More than 4 d rest can weaken muscles.

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Treatment of Low Back Pain

- Nonprescription pain relievers such as aspirin and ibuprofen work as well as prescription painkillers and muscle relaxants and cause fewer side effects.
- Among treatments not recommended, due to lack of evidence that they work, are traction, acupuncture, ultrasound, and transcutaneous electrical nerve stimulation.
- Spinal manipulation by a chiropractor or other therapist can be helpful when symptoms begin, but patients should be re-evaluated if they haven't improved after four weeks of treatment.

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- Lift in a slow, even motion
- Bend your knees and keep the back straight when lifting
- Lift with the legs not the back
- Do not twist the body. If you must turn, move the feet not the torso
- Bring the load close to the body
- Keep the back straight when lowering the load

Safe Lifting Techniques