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### Session Objectives

- By the end of this presentation, you will be able to:
- Describe the Disease Staging of Osteoarthritis, Rheumatoid Arthritis
- Understand the Various Exercise Testing Modes.
- Apply various exercise prescriptions components for clients who live with Osteoarthritis and Rheumatoid Arthritis.
- Apply selective exercise intensity calculations [i.e., heart rate reserve, RPE and Mets].

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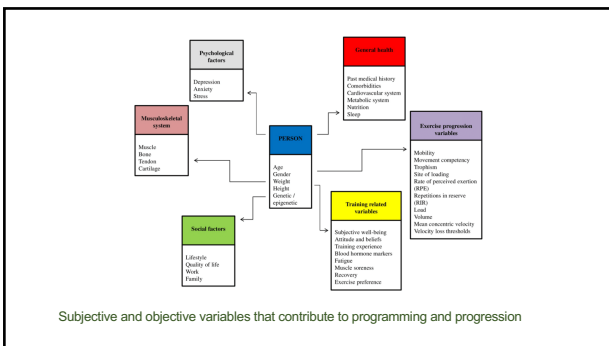
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## Disease Staging

Type of arthritis	Disease stage	Related impairments
Osteoarthritis	• Acute joint pain	• Often subtle
Rheumatoid arthritis	• Acute disease in multiple joints with pain, limited range of motion, and worsened functional impairment; often symmetrical joint involvement	• Joint stiffness, adverse body composition changes (rheumatoid cachexia, muscle loss and fat gain), muscle weakness, fatigue, and increased cardiovascular disease risk.

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## CR Exercise Testing

Mode	Protocol Specifics	Clinical Measures	Clinical Implications	Special Considerations
Use a treadmill for those with minimal to mild joint impairment.	Use protocols with small increment increases (i.e., modified Naughton or a ramp protocol) unless disease activity and severity are minimal.	Assess type of arthritis and degree of activity and impairment. Assess comorbidities and past surgical and medical history.	Standard peak $\dot{V}O_2$ prediction equations may overestimate functional capacity because they were developed on healthy (nonarthritic) populations.	With patient using handrails for support, use equation* to predict $\dot{V}O_{2max}$ .
Use cycle ergometry for those with mild to moderate lower extremity impairment.	Use protocols with small increment increases (i.e., 10-15 W $\cdot$ min <sup>-1</sup> ) or ramping protocols.	Assess the type of arthritis and degree of activity and impairment. Assess comorbidities and past surgical and medical history.		Additional investigations are needed to improve prediction of peak $\dot{V}O_2$ .
Use arm ergometry for those with severe lower extremity impairment.	Use arm ergometry-specific protocols with small increment increases or ramping protocols.	Assess type of arthritis and degree of activity and impairment. Assess comorbidities and past surgical and medical history.		Additional investigations are needed to improve the prediction of peak $\dot{V}O_2$ . Consider submaximal testing in those with severe impairment.

\*  $\dot{V}O_2$  (mL  $\cdot$  min<sup>-1</sup>  $\cdot$  kg<sup>-1</sup>) = 0.0098  $\times$  speed (m  $\cdot$  min<sup>-1</sup>) + 0.0147  $\times$  grade (%)  $\times$  speed (m  $\cdot$  min<sup>-1</sup>) + 7.533 mL  $\cdot$  min<sup>-1</sup>  $\cdot$  kg<sup>-1</sup>

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## Strength, Range of Motion, and Balance Testing

Test Type	Mode	Protocol Specifics	Clinical Implications
Lower extremity	Dynamometer	All testing in supine position except knee flexion and extension (knee seated)	Often up to 50% decreased in persons with arthritis
	30 s chair sit-to-stand test	The number of stands completed in 30 s, without using arms, from a chair with a seat height of 17.5"	
	BBB (B-repulsion measure)	The maximum resistance that can be moved through the full range in a controlled manner for 8 reps (BBB, e.g., kg press, knee extensions)	
Upper extremity and grip	Hydraulic dynamometer at the elbow	In the seated position with an unsupported arm flexed 90° at the elbow	Often up to 50% decreased in persons with arthritis
	Electronic dynamometer	Peak grip force Average sustained force	Usually up to 50% decreased in persons with hand arthritis
	90° arm curl test	Total number of arm curls in 30 s with 5 lb dumbbell for women and 8 lb dumbbell for men	
Range of motion	RFM	The maximum resistance that can be moved through the full range in a controlled manner for 8 reps (RFM, e.g., bench press)	Often up to 50% decreased in persons with arthritis
	Goniometer	App device taken with joint flexion	Usually up to 50% decreased in persons with arthritis
Balance	Figure-eight walking	Usual in those with limited or mild impairments Track width = 1.0 m Inner diameter = 1.5 m Outer diameter = 1.8 m	
	Sting balance scale	Usual in those with moderate to severe impairments Includes 14 single-limb postures with stable unsupported and progressing to standing on one leg	Often up to 50% decreased in persons with arthritis

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### Exercise Treatment and Management of Arthritis

The following are the objectives of the exercise treatment:

- Preserve or develop physical function
- Improve body composition
- Reduce the risk of comorbidities
- Lower inflammation and pain.
- Prevent contractures and abnormalities




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### ACSM (2020) Recommendations

	Aerobic	Resistance	Flexibility
Frequency	3-5 d-wk <sup>-1</sup>	2-3 d-wk <sup>-1</sup>	Daily
Intensity	Moderate (40%-59% VO <sub>2</sub> R or 40-59% HRR) to vigorous (60% VO <sub>2</sub> R or 60-89% HRR)	60%-80% 1-RM. Initial intensity should be lower (i.e., 20%-40% 1-RM) for those unaccustomed to resistance training.	Move through ROM feeling lightness-tension without pain. Progress ROM of each exercise only when there is little or no joint pain.
Time	Accumulate 150 min-wk <sup>-1</sup> of moderate intensity, or 75 min-wk <sup>-1</sup> of vigorous intensity, or an equivalent combination of the two, in bouts of ≥10 min.	Use healthy adult values and adjust accordingly (i.e., 8-12 repetitions for 1-3 sets); include all major muscle groups.	Up to 10 repetitions for dynamic movements; hold static stretched for 10-30 s and repeat two to four times.
Type	Activities with low joint stress, such as walking, cycling, swimming, or aquatic exercise	Machine, free weights, resistance bands, tubing. Body weight exercises are also appropriate for most individuals with arthritis.	A combination of active, static, and proprioceptive neuromuscular facilitation stretching of all major joints with a focus on affected joints and muscles crossing these joints.

1-RM, one repetition maximum; HRR, heart rate reserve; ROM, range of motion; VO<sub>2</sub>R, oxygen uptake reserve.

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### Overview Exercise Prescription (OA & RA)

- Exercising the joints is essential to maintain their function.
- Joints do not wear out with over-use from general exercise types and ADLs.
- **RA-specific:**
  - During an acute flare-up, the client must **REST** from active exercise, but maintain joint range of movement.
  - In remission, keep the muscles strong and to maintain a full range of joint movements.
  - Exercises and activities should all be low impact.
  - Appropriate footwear must be considered.
  - Previously damaged or involved joints should be protected.
  - Rest is important, especially when joints are inflamed.

pp. 77-78

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### Warm-up and Cool-down

- The warm-up should elevate muscular tissue temperature and improve tissue compliance.
- Flexibility training is best performed during the cool-down component.




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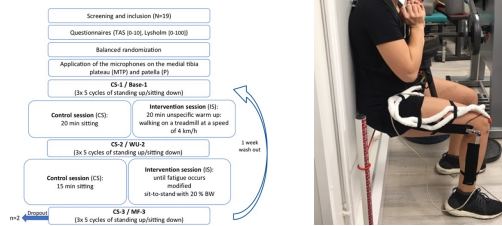
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### Tenberg et al., (2021)




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### Subject Group

Participants	N	age (years)	body mass (kg)	height (cm)	Tegner Activity Score
Male	7	26 ± 1.3 (23-30)	74.6 ± 13.4 (63-86.8)	180.76 ± 9.9 (174-190)	5.6 ± 1.7 (4-9)
Female	10	25.5 ± 1.7 (23-28)	57.6 ± 5.6 (45.2-68.4)	168.6 ± 6.6 (160-180)	5.8 ± 1.3 (4-8)
Total	17	25.7 ± 2 (23-30)	64.6 ± 11.6 (45.2-86.8)	173.9 ± 8.9 (160-190)	5.7 ± 1.6 (4-9)

Data are displayed as means and standard deviations, in addition to the ranges (in brackets).

<https://doi.org/10.1371/journal.pone.0257622.t001>

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A		Measurement 1		Measurement 2		Measurement 3	
		Base control	Base intervention	Chair	Treadmill	Chair	Modified sit-to-stand
Medial tibia plateau	Extension	88 (78-99)	88 (80-96)	86 (69-93)	89 (84-98)	86 (70-97)	88 (82-97)
	Flexion	87 (75-99)	88 (80-95)	86 (64-98)	89 (84-98)	86 (72-96)	88 (81-94)
Patella	Extension	97 (83-104)	94 (71-103)	95 (80-104)	90 (75-103)	95 (80-104)	89 (67-103)
	Flexion	96 (80-103)	94 (71-102)	95 (80-102)	91 (74-103)	94 (76-102)	89 (72-102)
B							
Medial tibia plateau	Extension	205 (106-269)	214 (162-288)	202 (119-240)	210 (152-258)	205 (117-279)	210 (152-327)
	Flexion	197 (117-276)	225 (152-323)	201 (126-269)	211 (161-266)	204 (126-295)	211 (138-310)
Patella	Extension	178 (112-232)	177 (142-208)	172 (123-236)	192 (141-280)	170 (117-215)	189 (134-260)
	Flexion	178 (125-240)	193 (145-253)	186 (132-237)	198 (135-253)	182 (129-239)	197 (148-250)

Measurement 1: baseline, Measurement 2: after 20 min sitting on a chair (Chair) or 20 min of treadmill walking (treadmill), Measurement 3: after 20 min sitting on a chair (Chair) or the modified sit-to-stand movement until task failure (modified sit-to-stand).  
 No carry-over effect was found for any parameter of the warm-up or muscle fatiguing exercise ( $p > .05$ ).  
<https://doi.org/10.1371/journal.pone.0257852.t002>

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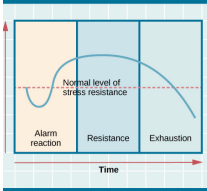

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### Exercise Intensity/Loading

- Adaptational Training Response

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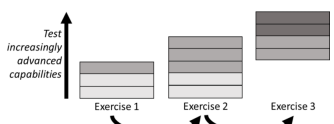

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### Exercise Intensity & Dosage

A concentrated increase in pain that lasts more than 2 hours after PA suggests the need to reduce the exercise intensity or volume for the next training bout [NOT DOMS]

pp. 86-87

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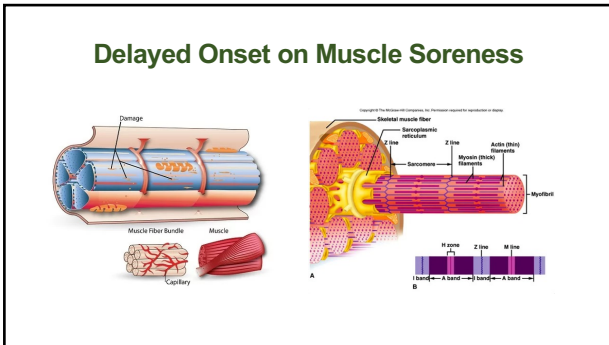
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### Exercise Progression

- The overriding aim for patients referred with arthritis is to adhere to regular physical activity and exercise to accrue as many benefits as possible.
- However, as patients get older, maintenance of health, fitness and functional ability becomes of greater importance.
- The exercise instructor should emphasise the maintenance of functional abilities to perform ADLs.

p. 92

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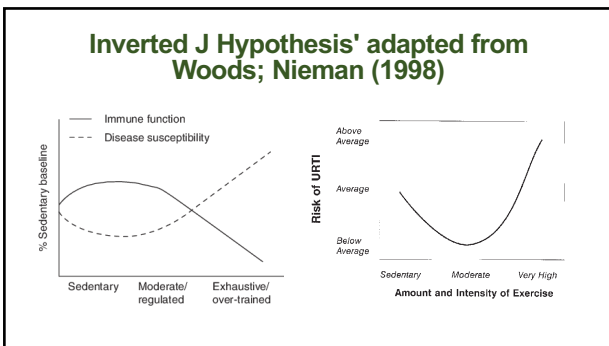
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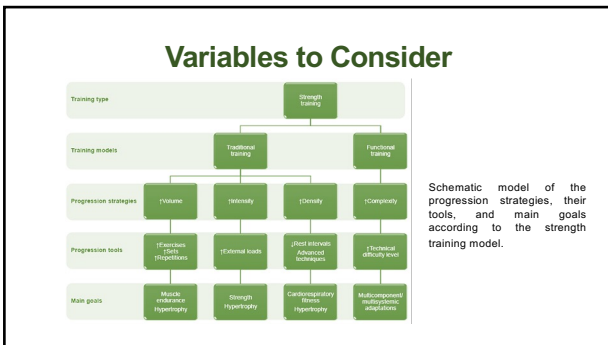
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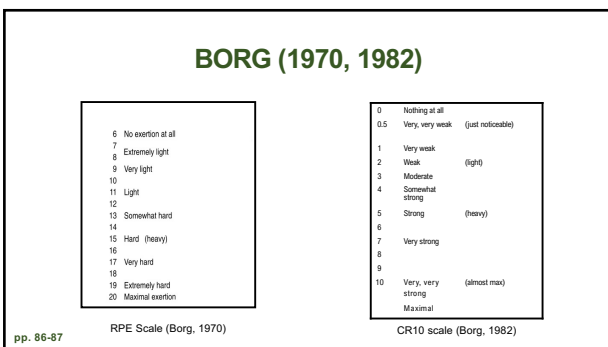
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### Heart Rate Reserve (HRR)

#### HRR = HR<sub>max</sub> - Resting Heart Rate (RHR)

Calculate a light/low intensity training zone for a 50-year-old client, with a RHR of 80bpm:

- HR<sub>max</sub> = 220 - (50) = 170bpm;
- HRR = 170-80 = 90bpm;
- Light (low) intensity = 20-39% of HRR...
- 90 x 20% = 18bpm
- 90 x 39% = 35bpm
- Finally, to calculate a corresponding target heart rate, you add on the RHR...
- 18 + 80 = 98bpm
- 35 + 80 = 115bpm

pp. 87-88

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### Metabolic Equivalents of Task (METs)

Metabolic Equivalents is another method of determining rate of energy expenditure.

- 1 MET = average oxygen consumption (VO<sub>2</sub>) at rest, where 1 MET = 3.5ml/kg/min;
- Therefore, the client from the example cited previously: (VO<sub>2max</sub> of **28ml/kg/min**) would have a 'MET capacity' (fitness level in maximal METs) of **8 METs**. The client has a low level of aerobic fitness.

p. 88-89

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### METs Continued...

- In order to use this information in a practical way, we would next select an appropriate exercise prescription (level of intensity) for this client and express it in a MET range, as follows:

For example, a **moderate** intensity training zone would correspond to **3.8-5.1 METs**.

pp. 89-90

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### Maximal Achieved MET's Levels

Maximal Acquired MET's Metrics	Low Intensity	Moderate Intensity	High Intensity
High Fitness 12 METs	3.2-5.3	5.4-7.5	7.6-10.2
Moderate fitness 10 METs	2.8-4.5	4.6-6.3	6.4-8.6
Low fitness 8 METs	2.4-3.7	3.8-5.1	5.2-6.9
Very low fitness 5 METs	1.8-2.5	2.6-3.3	3.4-4.3

pp. 89

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### METs Values of Common PA's Classified as Light, Moderate, or Vigorous Intensity

Very Light/Light ( 3.0 METs)	Moderate (3.0-5.9 METs)	Vigorous ( 6.0 METs)
Walking slowly around home, store, or office = 2.0	<ul style="list-style-type: none"> <li>Walking 3.0 mph = 3.0</li> <li>Walking at very brisk pace (4 mph) = 5.0</li> </ul>	<ul style="list-style-type: none"> <li>Jogging at 5 mph = 8.0</li> <li>Jogging at 6 mph = 10.0</li> <li>Running at 7 mph = 11.5</li> </ul>
Standing performing light work, such as making bed, washing dishes, ironing, preparing food, or store clerk 2.0-2.5	<ul style="list-style-type: none"> <li>Cleaning, heavy — washing windows, car, clean garage = 3.0</li> <li>Sweeping floors or carpet, vacuuming, mopping = 3.0-3.5</li> <li>Mowing lawn — walk power mower = 5.5</li> </ul>	<ul style="list-style-type: none"> <li>Shoveling sand, coal, etc. = 7.0</li> <li>Carrying heavy loads, such as bricks = 7.5</li> <li>Heavy farming, such as baling hay = 8.0</li> <li>Shoveling, digging ditches 8.5</li> </ul>

MET values can vary substantially from individual to individual during swimming as a result of different strokes and skill levels

Table adapted from Ainsworth et al., (2000)

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### Calculate Intensity Task

- 15 minutes to complete the 3x clients

In groups you have 20 minutes to complete the Intensity Task

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### Cardiorespiratory Exercise

- Exercise treatment for arthritic disorders is to regulate the workload intensity, session volume and duration.
- Workload should be via the client's:
  - heart rate (i.e., %heart rate reserve, %HRR)
  - or rating of perceived exertion (RPE)

**RPE becomes the dominant method as a marker of exercise intensity**

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### Cardiorespiratory Exercise

- Use a mode that reduces the degree and rate of mechanical joint loading.
- These forms include walking, cycling, and swimming pool-centred exercise:
  - Free walking velocity generates less hip joint contractile pressure than isometric or standing dynamic hip exercises.
  - Nordic walking
- If ambulatory activities are uncomfortable:
  - a substitute cardiorespiratory exercise such as cycle ergometry, recumbent stair should be considered.

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### Water-based, or Aquatic Exercise

- Water-based increases physical function and ROM and reduces pain.
- Improved QoL has been extensively stated in OA clients.
- Water helps the individuals perform passive and active joint ROM exercises.
- Strengthening exercises can be accomplished due to water resists motion




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### Water-based, or Aquatic Exercise

- Clients with arthritis can endure longer-duration bouts in the water than land-based.
- Reported to increase exercise training adherence levels connected with this type of exercise.
- Reported that water-based exercise declines with water temperatures colder than 28.9 °C, and cardiovascular stress escalates with temperatures greater than 36.7 °C.

Considerations/ contraindications to hydrotherapy:

- Uncontrolled seizures,
- Bowel or bladder incontinence,
- pressure sores or contagious skin rashes,
- Cognitive impairments that would endanger the client's safety

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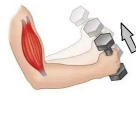
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### Resistance Exercise



**ISOTONIC**



**ISOMETRIC**

- At the start of resistance training, the loading should be about 60% 1RM (~15 reps maximum), with advancement transpiring progressively over 6 weeks.

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### Resistance Exercise and Intensity






**Strength**

- Strength-related characteristics of hypertrophy include an increase in muscle mass, which is due to an increase in the number of sarcomeres and myofibrils.
- Maximal differences in strength occur during the first 6-8 weeks of training.



**Hypertrophy**

- Hypertrophy is characterized by an increase in muscle mass, which is due to an increase in the number of sarcomeres and myofibrils.
- Maximal differences in strength occur during the first 6-8 weeks of training.



**Endurance**

- Endurance is characterized by an increase in the number of mitochondria and capillaries, which is due to an increase in the number of mitochondria and capillaries.
- Maximal differences in strength occur during the first 6-8 weeks of training.

Loading Recommendations for Muscle Strength, Hypertrophy, and Local Endurance: A Re-Examination of the Repetition Continuum (Schoenfeld et al., 2021)

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### Range of Motion Exercise

- Regular ROM exercise greatly facilitates maintenance of the degree of joint motion
- 5 to 10 min of active (i.e., executed without assistance) ROM exercise, performed on most or all days of the week, is recommended.
- ROM exercises should supplement aerobic and strength training

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### Exercise Prescription Review

Training Type	Frequency	Intensity	Time (Duration)	Type (Mode)	Progression
Cardio-respiratory	Begin at 2 or 3 d/wk and increase to 3-5 d/wk, more frequently for moderate-intensity activities; daily exercise is encouraged as tolerated	<ul style="list-style-type: none"> <li>40%-59% HRR or O<sub>2</sub> reserve</li> <li>RPE 12-16 (Borg 6-20 scale) or 3-6 (Borg 1-10 scale)</li> </ul>	20-60 min, equaling at least 150 min moderate intensity or 75 min vigorous; can combine intensities	Activities using large muscle groups with repetitive motion: walking, cycling, dancing, swimming or aquatics	Gradually increase duration and frequency of exercise, then increase intensity; if exercise naive or extremely deconditioned, begin at 40% HRR and progress up to 85% HRR.

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### Exercise Prescription Review

Training Type	Frequency	Intensity	Time (Duration)	Type (Mode)	Progression
Resistance	2 or 3 d/wk, with at least 24 h between each session	<ul style="list-style-type: none"> <li>Begin at 50%-60% 1RM and progress to 60%-80% 1RM</li> </ul>	8-10 exercises, 8-12 reps, 2-4 sets	Isotonic, preferably performed on machines, but free weights can be used in select clients with proper safety precautions	Gradually increase the volume of training, then increase the intensity.

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### Exercise Prescription Review

Training Type	Frequency	Intensity	Time (Duration)	Type (Mode)	Progression
Range of motion	Daily	To no more than mild tightness or discomfort of stretched muscle group	Static and active stretches for 10-30 s for 3-5 reps; dynamic stretches for 10 reps	Static, active, and dynamic stretching; functional activities (e.g., sit-to-stand, stairs) [See next Slide]	Gradually increase ROM of stretching exercise; gradually increase volume and intensity of functional activities (e.g., sit-to-stand; reduce then eliminate use of arms).

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### Range of Motion Types

- Passive ROM involves no muscle work by the individual while an outside force (another person or a passive motion machine) moves the body part through a range of motion.
- Active range of motion is movement of a body part by the individual performing the exercise without outside forces.
- Active assisted ROM involves partial assistance with motion by an outside force, whereby a portion of the motion of the limb may be provided by a mechanical device, another limb, or another person.
- Dynamic stretching is a type of active ROM activity involving controlled movement of a body part with a gradual increase in the range and speed of the movement.

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### Summary Exercise Training: Important Considerations

Cardiorespiratory endurance	Skeletal muscle strength	Skeletal muscle endurance	Flexibility	Body composition
<b>OSTEOARTHRITIS</b>				
Aerobic exercise improves cardiorespiratory endurance, pain, depression, fatigue, function, health status, and gait and helps reduce fat mass.	Resistance training improves strength, muscular endurance, function, health status, pain, and stiffness and helps reduce fat and increase muscle mass.	Low-intensity resistance training improves strength, muscular endurance, function, health status, pain, and stiffness and helps reduce fat and maintain muscle mass.	Dynamic exercise improves joint mobility, pain, and function.  Aquatic exercise improves knee and hip range of motion, pain, and function	Combined diet and resistance and aerobic training produces weight loss and improves function, mobility, and pain to a greater extent than diet or exercise alone.

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### Summary Exercise Training: Important Considerations

Cardiorespiratory endurance	Skeletal muscle strength	Skeletal muscle endurance	Flexibility	Body composition
<b>RHEUMATOID ARTHRITIS</b>				
Aerobic exercise improves cardiorespiratory endurance, pain, function, and, with resistance training, mood; aerobic training improves fitness without worsening disease activity.	High-intensity resistance training improves strength, muscular endurance, function, and mobility; increases muscle mass; and reduces fat mass. Hand strengthening may improve dexterity and grip strength.	Low-intensity resistance training improves strength, muscular endurance, function, and mobility; maintains muscle mass; and reduces fat mass. Hand strengthening may improve dexterity and grip strength.	Joint mobility improves with dynamic exercise training	Combination of aerobic and resistance training (RT) or RT alone increases muscle mass and decreases fat mass without significant weight loss; also slows bone mineral density loss.

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**End Point**

- Properly performed exercise is safe and effective for individuals with OA, RA.
- Appropriate exercise can be expected to increase strength, aerobic capacity, and ROM; improve body composition; enhance physical function
- Precautions must be taken, to ensure that the prescribed exercise is appropriate (i.e., safe and tolerable).

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