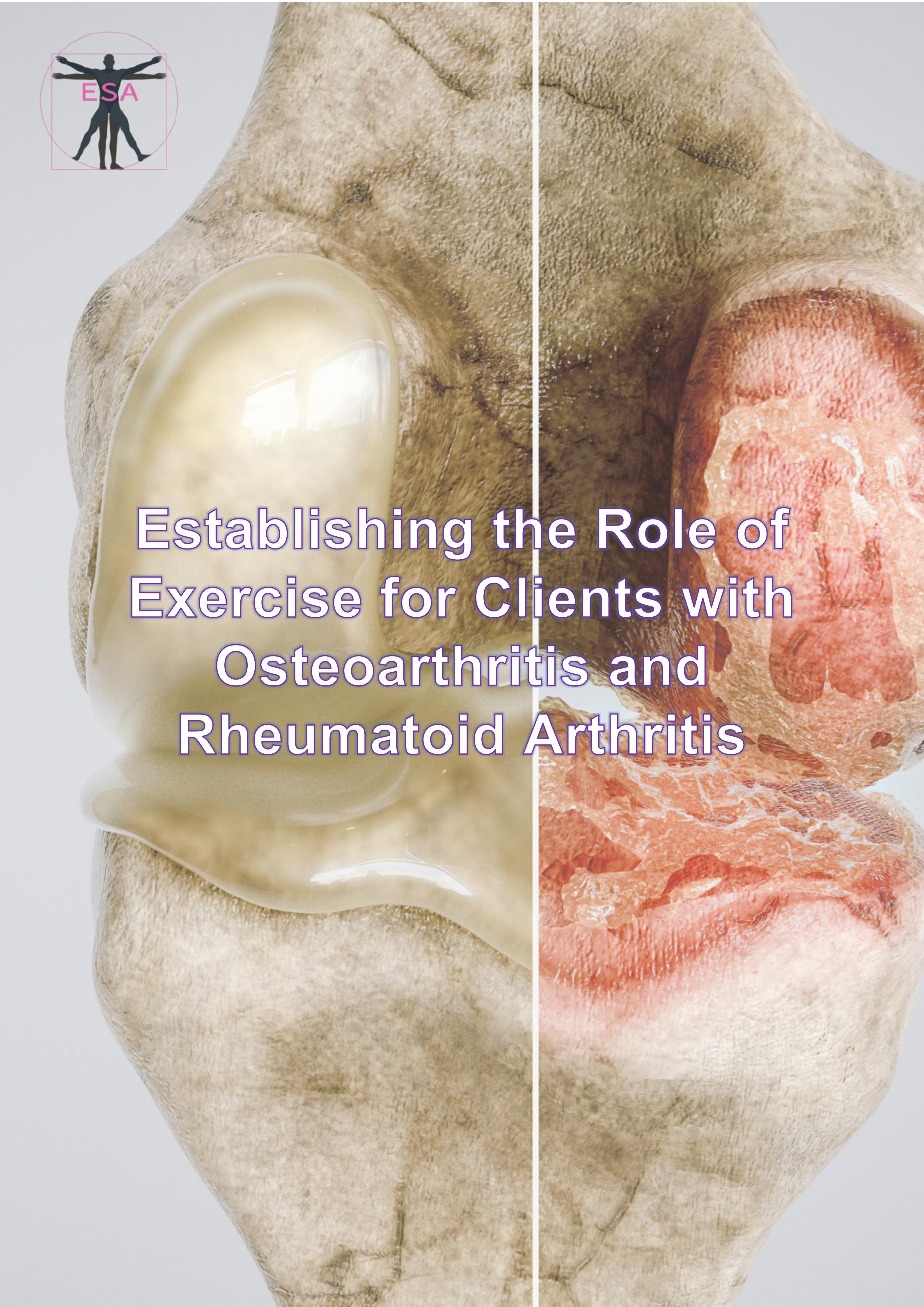

Establishing the Role of Exercise for Clients with Osteoarthritis and Rheumatoid Arthritis

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Introduction to Arthritis

Contrary to the common opinion that people with arthritis should elude vigorous physical activity (PA) for fear of aggravation and damage to the joints. Research has suggested and supported with clinical evidence that consistent client-centred exercise decreases disability and increases joint function in these clients. This may be accomplished without provoking symptoms while improving individuals' general health and quality of life (QoL) (American College of Rheumatology Subcommittee on Rheumatoid Arthritis Guidelines, 2002). This e-book largely considers the various forms of arthritis and focuses primarily on osteoarthritis (OA), rheumatoid arthritis (RA), and ankylosing spondylitis (AS) and the outcomes and benefits of performing physical activity and exercise for these disorders.

Clinical Definition

Arthritis is an umbrella term for disorders that involve inflammation of one or more joints. There are more than 100 distinctive types of arthritis with each categorised by different amounts of joint damage, limitation of movement, functional restriction, and discomfort.

In the US, chronic arthritis affects almost 23% of adults and is the leading cause of physical disability (Barbour *et al*., 2017). Annual therapeutic expenditures and earnings losses have been reported to cost the US economy over $300 billion. Worldwide, the economic burden of arthritis is estimated to cost between 1-to-2.5% of the gross national product of Western countries. The prevalence is reported to be greater for females (26%) than males (19%) and accelerates with age. For those individuals over 65 years, arthritis is the most dominant medical condition in both males and females, affecting 50% of this populace. Because of ageing and the increased frequency of obesity, arthritis is projected to increase in incidence globally and by 2040, 78 million Americans are forecast to have these disorders. Physical activity and exercise have, however, been acknowledged as one of the primary methods of decreasing the frequency of arthritis and offsetting the related disability and economic cost.

Regarding the various types of arthritis, OA occurs repeatedly, affecting 30.8 million Americans. Osteoarthritis-related operations are frequent, which contributes to OA being the fourth main cause of hospitalization in the US. Rheumatoid arthritis occurs in approximately 1.5 million Americans. Other forms of arthritis frequently reported include gout (8.3 million) and spondyloarthropathies (0.6-2.4 million) such as AS, psoriatic arthritis (PsA), reactive arthritis, and enteropathic arthritis. Arthritis is also linked with connective tissue maladies such as systemic lupus erythematosus (SLE), dermatomyositis, and systemic sclerosis (SSc; scleroderma). While arthritis is most frequent in the ageing populace, a projected 294,000 American children under 18 years (i.e., 1 in 227) have some form of the disorder.

Arthritis negatively affects both physiological and psychosocial performance and is the primary cause of disability in later years. For instance, work infirmity is stated in 31% of the US adults with medical-diagnosed arthritis; the results of arthritis on physical function are described later. Regularly overlooked, however, are the results of arthritis on societal functioning, which can be dramatic: 25% of individuals with arthritis never leave their home or only do so with assistance, 18% never partake in social activities, and people with arthritis account a drastically worse QoL than those who do not have arthritis. Moreover, arthritis relates to major depression (attributable risk of 18.1%), and 6.6% of people with arthritis account for severe psychological distress. These features, combined with pain, fatigue, and the raised energy cost of performing activities of daily living (ADLs) with increasing impairment, contribute to physical inactivity. In turn, this severe inactivity negatively affects health by increasing the risks of cardiovascular disease, dyslipidaemia, hypertension, diabetes, obesity, and osteoporosis.

Prevalence of Arthritis in the UK

According to NHS (2020), over 10 million people in the UK have arthritis or other similar conditions that affect joints. 9 million have the most common type of arthritis: osteoarthritis (OA). It can affect people of all ages, even children; around 8.75 million people in the UK having sought treatment (Versus Arthritis, 2020), with women more likely to be affected than men. The likelihood of OA increases with age between 45 and 75, with one third of this age range having sought treatment.

Rheumatoid arthritis (RA) is the second most common form of arthritis in the UK, affecting 400,000 people (NHS, 2020). RA occurs more frequently in women than men. It is most common between the ages of 40 and 70, but it can affect people of any age, and many cases are so mild as to be negligible or 'sub-clinical'. Of those diagnosed, 30% will recover, or the disease will 'burn out' in five years; 65% will continue having intermittent flare-ups, and 5% will become severely debilitated.

Versus Arthritis is a UK-based charity, which was formed in 2018 following a merger of Arthritis Care and Arthritis Research UK. Versus Arthritis and Imperial College London developed a Musculoskeletal Calculator, which is a prevalence modelling tool for OA of the hip and knee, to be used in local areas. It is estimated that 4.08 million people aged over 45 years have OA of the knee, and 2.90 million people aged over 45 years have OA of the hip in the UK (excluding Northern Ireland, where data are not available).

To illustrate the complexity of the data derived from the Musculoskeletal Calculator, there follows a list of data for the county of Lancashire, in the Northwest of England between 2011 and 2012 (Arthritis Research UK, 2014).

Knee Osteoarthritis

- It is estimated that 98,500 people aged 45 or over live with knee osteoarthritis.
- 18.5% of the total Lancashire population aged 45 years or over are estimated to have knee osteoarthritis, which is like the overall prevalence in England of 18.2%.

- 42,727 are male (male prevalence 16.8%) and 55,773 are female (female prevalence 20.0%).
- It is estimated that there are 33,778 people in Lancashire with severe knee osteoarthritis, which is 6.3% of the population aged 45 years or over.
- In 2011-12, there were 1,884 knee replacements (4 per 1000 people over 45 years) for people living in Lancashire, at a cost of £11,606,823.

Hip Osteoarthritis

- It is estimated that 59,007 people aged 45 or over live with hip osteoarthritis.
- 11.1% of the total Lancashire population aged 45 years or over are estimated to have hip osteoarthritis, which is like the overall prevalence in England of 10.9%.
- 20,657 are male (male prevalence 8.1%) and 38,350 are female (female prevalence 13.7%).
- It is estimated that there are 17,971 people in Lancashire with severe hip osteoarthritis, which is 3.4% of the population aged 45 years or over.
- In 2011-12, there were 1,667 hip replacements (3 per 1000 people over 45 years) for people living in Lancashire, at a cost of £9,587, 241.

Key Point: The relatively high prevalence of arthritis in the UK affords the opportunity for exercise referral schemes (ERS) to have a significant impact on our ageing population, to encourage, educate, and motivate clients to commence and adhere to regular exercise. Within the specific inclusion criteria for occupational standards in the UK (OA: mild to moderate severity; RA: medication controlled, not during flare-ups or active infection), the benefits of exercise are undeniable, but the risks of exercise must be understood and reduced, with the adoption of precautionary measures.

Pathophysiology

While the aetiologies and clinical indices of the numerous types of arthritis are largely distinctive, they share mutual features that impair the following:

- Exercise tolerance
- Muscle strength
- Muscular endurance
- Aerobic capacity
- Range of motion
- Biomechanical proficiency
- Proprioception

Subsequently, all forms of arthritis can theoretically be characterised by functional restriction and disability.

Osteoarthritis

Osteoarthritis (OA) involves the degradation of joints, which generally advances progressively and mainly affects the articular cartilage and subchondral bone. Primarily, the cartilage becomes pitted, rough, and brittle. In retort to this, and to decrease the load on the cartilage, the underlying bone thickens (**Figure 1**). Therefore, the synovial membrane swells and increases the production of synovial fluid, and the joint capsule and adjacent ligaments thicken and contract (Yahiaoui *et al*., 2012). These alterations lead to a restriction of the joint space, which in advanced OA can result in loss of cartilage, bone-on-bone friction, periarticular muscle loss, and ligaments becoming stressed and damaged. While generally referred to as wear-and-tear arthritis, this term is inaccurate because the pathology of OA involves a progression of continuous, atypical remodelling of joint tissues driven by inflammatory mediators (Yahiaoui *et al*., 2012). The resulting symptoms are incessant joint pain, rigidity, and deformity, with functional impairment. Individuals can present with crepitus, joint locking, effusion, and bone spurs (osteophytes).

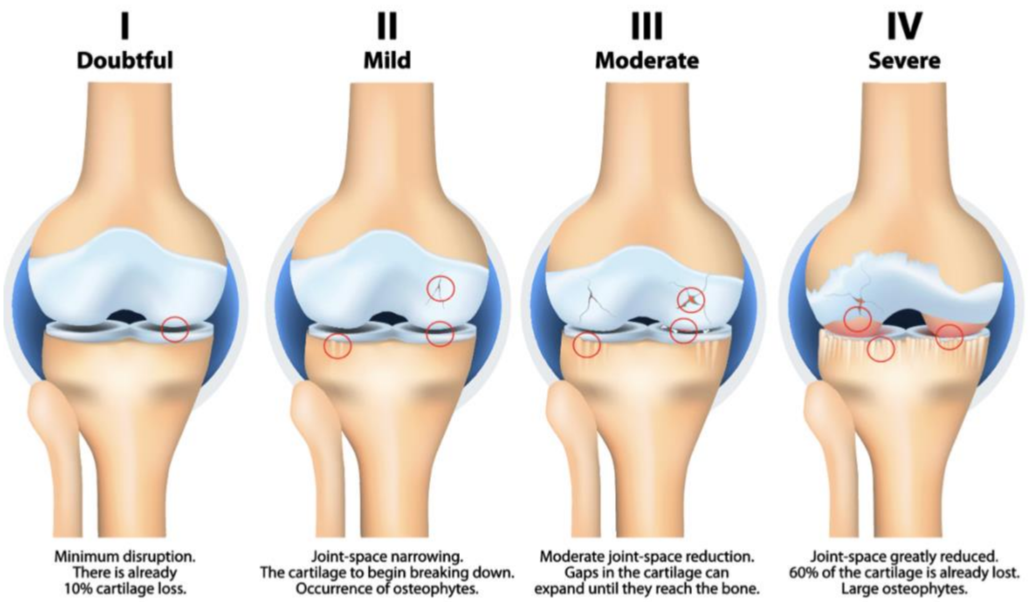

Figure 1. Stages of Osteoarthritis.

The joints most affected by OA are those of the hands, feet, and spine, as well as the large weight-bearing joints of the hips and knees (**Figure 1 and Figure 2**). As with the other types of arthritis, the aetiology of OA is not fully understood, although, there is evidence of genetic contribution (Anderson and Felson, 1988). OA is typically more prevalent in females (i.e., a ratio of 2-to-3:1, females to males), and its occurrence for both genders increases with age (OA seldom occurs in individuals younger than 40 years but is evident by radiography [X-rays] in >80% of those over 55 years). Moreover, obesity and joint damage or trauma are recognised to affect an individual to OA (Felson, 2009).

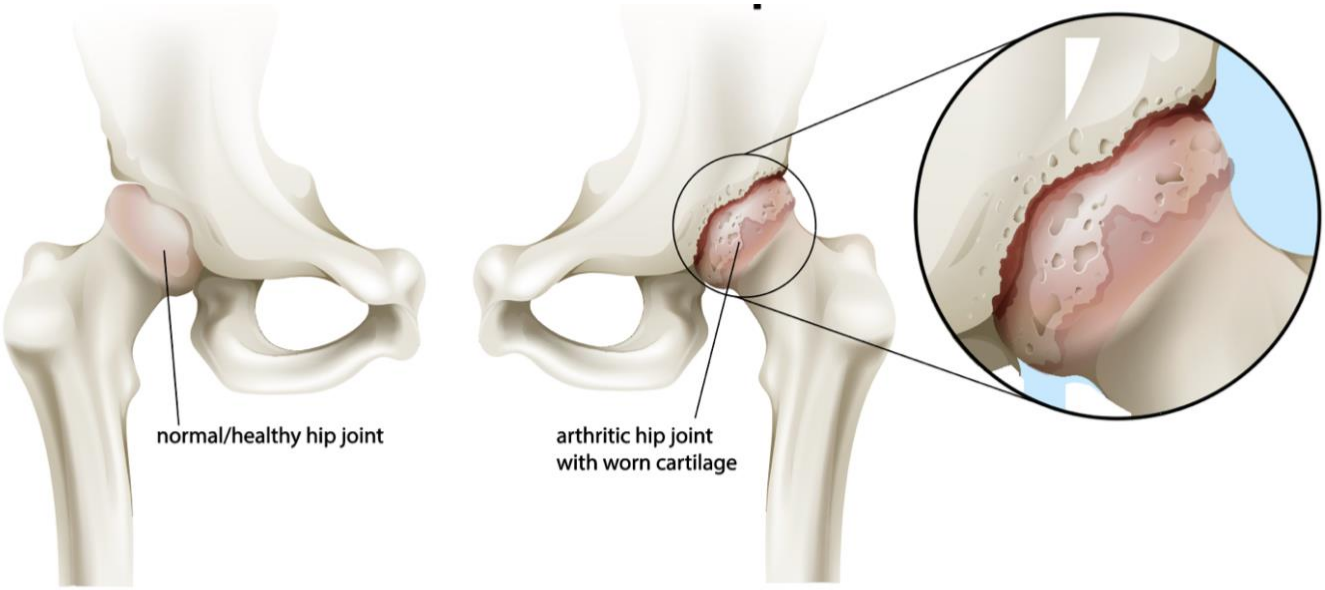

Figure 2. Arthritis of the Hip Joint.

Since our joints depend on active loading for the preservation of joint function and nutrition, chronic deficient loading is detrimental, as is chronic disproportionate loading, as demonstrated by the strong association between obesity and OA of the weight-bearing joints. Because of restricted movement local muscles deteriorate and ligaments become lax. Therefore, muscle weakness and joint instability are acknowledged outcomes of OA and, therefore, are involved in the development, progression, and severity of the disorder. This reduction of strength is a key contributor to the infirmity linked with OA and is the best-established association of lower limb functional constraints in individuals affected by knee OA. Osteoarthritis is also characterised by loss of joint ROM, which exacerbates the reduced function and disability produced by pain and muscle weakness.

Rheumatoid Arthritis

Rheumatoid arthritis (RA) is a chronic autoimmune syndrome, categorised by systemic inflammation and symmetrical polyarthritis. It affects several tissues and organs but primarily targets synovial joints. Rheumatoid arthritis is more frequent in females than males with a rate ratio of nearly 3:1, with a representative age of onset amongst 40- and 50-year-olds. The subsequent inflammatory response in joints (synovitis) is an outcome of synovial cell hyperplasia, disproportionate production of synovial fluid, and the development of pannus (an immune-mediated condition affecting the cornea or clear part of the eye). Eventually, synovitis results in loss of articular cartilage and marginal bone, with ensuing joint destruction and ankylosis. The joints most impacted by RA are the small joints of the hands and feet, followed by the larger joints of the wrists, elbows, shoulders, and knees respectively, though any joint with a synovial lining is vulnerable. Furthermore, RA also has extra-articular effects. Some are exclusive to RA, such as rheumatoid nodules, while nonspecific effects include muscle loss, increased adiposity (particularly truncal adiposity), fatigue, and increased risk of cardiovascular disease (CVD), metabolic syndrome, type 2 diabetes, and osteoporosis (Altman *et al.,* 1990; Canziares and Badley, 2012).

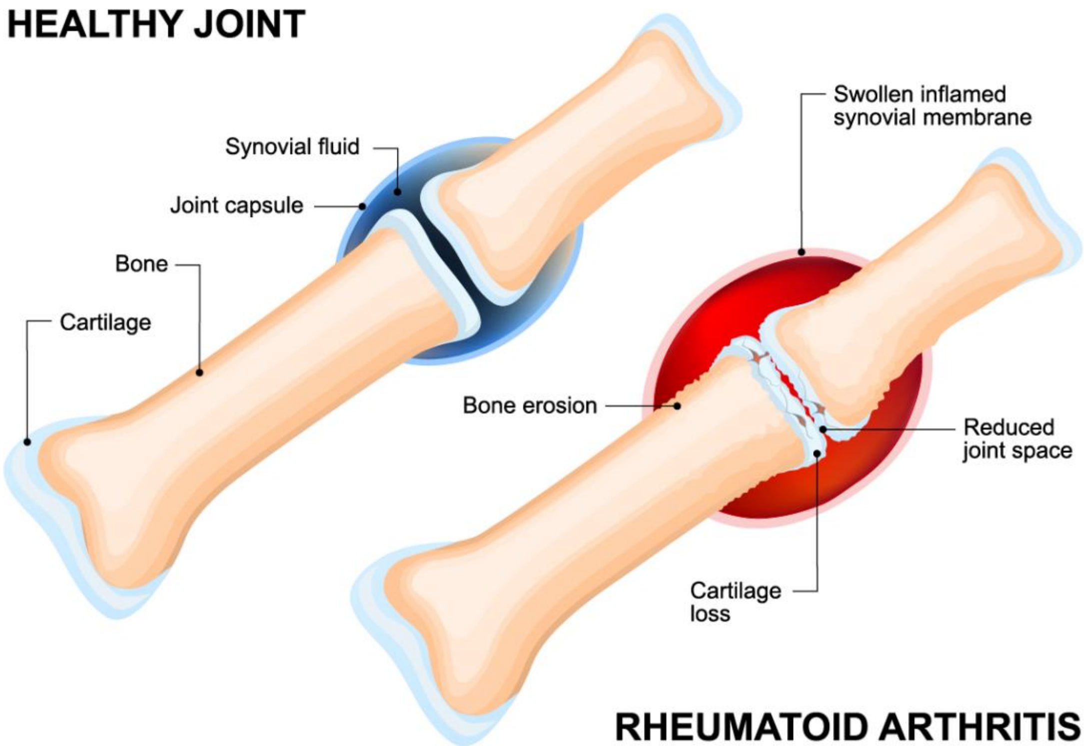

Figure 1. Healthy vs. rheumatoid arthritis.

Ankylosing Spondylitis

Like RA, ankylosing spondylitis (AS) is a chronic inflammatory arthritis and an autoimmune disease. However, in contrast to RA and OA, AS ensues more frequently in males (3:1 incidence rate), and the age of onset is typically between 20-40 years. The disorder mainly affects the spine and sacroiliac joint. Initially, the ligaments of the lower spine become exacerbated at the entheses. This development incites bone to grow within the ligaments. Progressively these bony growths form bony bridges between adjoining vertebrae, which ultimately can lead to the vertebrae fusing, with subsequent low back pain and immobility ensuing. Moreover, most AS clients suffer synovitis in the larger peripheral joints (primarily the hips and knees), and typical extra-articular features include fatigue, eye inflammation (uveitis or iritis), CVD, and inflammatory bowel disease (IBD). However, unlike people with other forms of arthritis, AS clients have for years been encouraged to be physically active, because back pain, which is often severe at rest, regularly improves with physical activity, and it was evident from initial treatment regimes that bed rest and immobilisation accelerated spinal fusion.

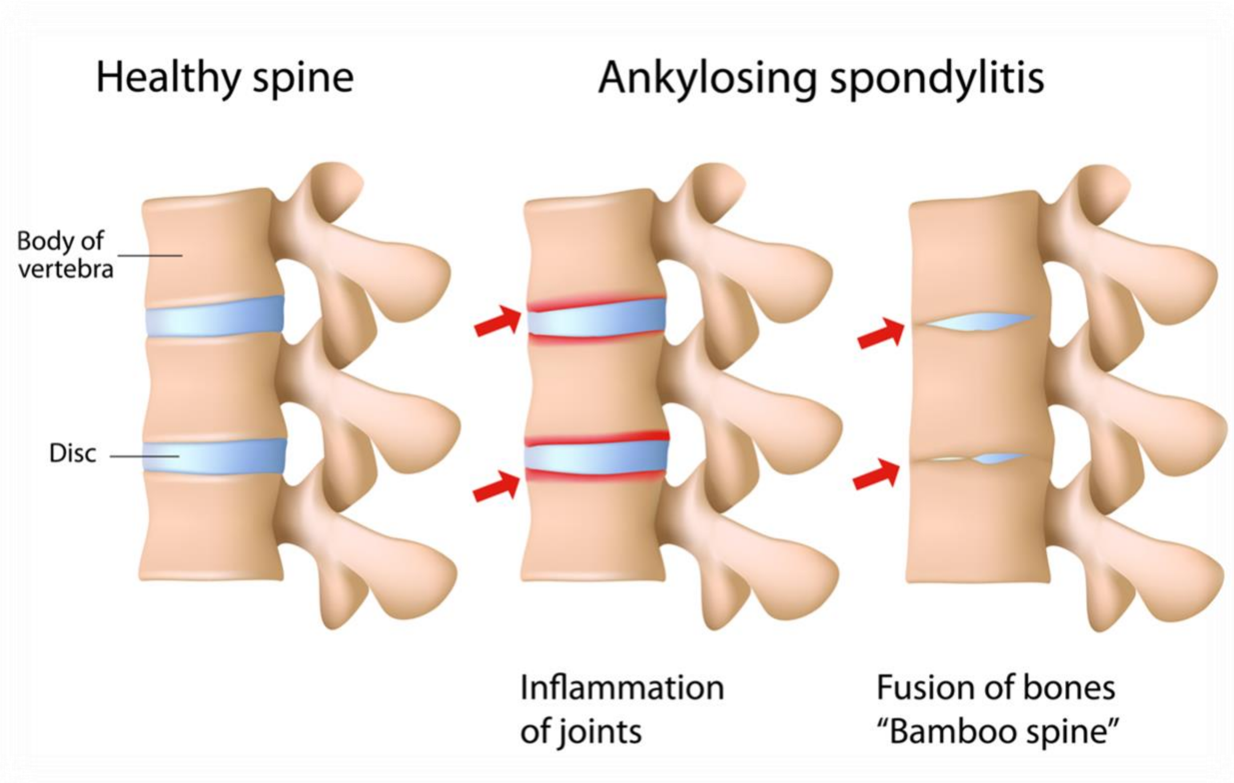

Figure 1. Healthy spine vs. ankylosing spondylitis.

Conventionally, arthritis disease stages have been categorised at three levels:

- **Acute:** reversible signs and symptoms in the joint related to synovitis
- **Chronic:** stable but irreversible structural damage brought on by the disease process
- **Chronic with acute exacerbation of joint symptoms:** increased pain and decreased ROM and physical function.

Each of the stages above has disease-specific appearances, treatment considerations, and goals.

Clinical Considerations

The various arthritides can be differentiated based on whether symptoms arise from the joint or from a periarticular location, the number of joints involved, their location, whether the distribution is symmetric or asymmetric, the chronicity of disease, and extra-articular features (Erlandson *et al*., 2020). Pharmacological treatment of OA, RA, AS and other forms of arthritis varies according to the condition, between individuals with the same condition, and even for the same individual over time. Despite these treatment nuances, exercise should be included in the routine management of these conditions.

Signs and Symptoms

In the appraisal of people with musculoskeletal complaints, the history and physical inspection are the most explanatory components. Limited movement of a joint and tenderness to palpation along the axis of joint movement is symptomatic of arthritis. This contrasts with tenderness around the joint, which is more indicative of periarticular soft tissue involvement. The signs and symptoms of arthritis are as follows:

- Pain
- Stiffness
- Joint effusion
- Synovitis
- Deformity
- Crepitus

Joint pain can arise from pathological changes in the joint capsule and periarticular ligaments, intraosseous hypertension, muscle weakness, subchondral microfractures, enthesopathy, and bursitis, and it may be aggravated by psychosocial influences such as depression. Soreness and pain should be documented if it does not stem from the articular cartilage directly since cartilage is aneural. In clients with inflammatory arthropathies, such as RA and AS, joint pain and stiffness fluctuate directly with disease activity such as the amount of inflammation. The prognosis of recent-onset arthritis is helped by a determination of whether the duration of symptoms has exceeded 4 to 6 weeks (Hubscher, 2014).

Table 1. Types of Arthritis, Stages, and Related Impairments.

Type of arthritis	Disease stage	Related impairments
Osteoarthritis	Acute joint pain	Often subtle
Chronic radiographic joint disease	Chronic with exacerbation	Increased joint pain and swelling, muscle weakness, and progressively declining functional impairment
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
Ankylosing spondylitis	Acute spinal pain and stiffness without significant decrease in mobility	Muscle loss, muscle weakness, and fatigue
Chronic spinal ankylosis predominant with decreased spinal and thoracic mobility	Chronic with exacerbation	Increased pain and stiffness of the back or peripheral joints

History and Physical Evaluation

The client's medical history is necessary for determining the duration, site, degree, and severity of musculoskeletal symptoms (Hubscher, 2014). Moreover, because of the innate component of OA, RA, and particularly AS, recognising the manifestation of these disorders in the family history significantly aids in diagnosis. Finding information on the existing degree of functioning and any previous or ongoing efforts at an exercise intervention, including any obstacles or enablers to exercise, is central when designing suitable exercise training interventions. The physical examination offers much of the information needed for creating an applicable diagnosis and for collating information about any irregularities of joint ROM, alignment, or function. Moreover, the physical examination may detect the presence of extra-articular features (e.g., rheumatoid nodules in RA, an eye disease in AS, and skin disease in psoriatic arthritis), which aids in forming an accurate diagnosis. The physical examination is also used to gauge joints for the four fundamental signs of inflammation: redness, swelling, pain, and heat.

Diagnostic Testing

The American College of Rheumatology (ACR) has developed diagnostic criteria for the classification of hip, knee, and hand OA and for RA (**Table 2, 3, 4**). Criteria for AS have been developed by the Assessment of SpondyloArthritis international Society (ASAS).

Currently, no conclusive diagnostic tests or markers of arthritis exist, and various specific serum and synovial fluid analyses are available that significantly aid in distinguishing the arthritic conditions. In combination with joint imaging, these assessments contribute to indicating the arthritis diagnosis. For RA, tests for the occurrence of anti-citrullinated protein antibodies (ACPA; also called anti-cyclic citrullinated protein antibodies [anti-CCP]) and rheumatoid factor (RF) have become routine features of the preliminary diagnosis. The ACPA test has high specificity (95%) and sensitivity (68%) for RA and the future development of RA. Although RF positivity occurs in about 80% of RA patients, as with ACPA/anti-CCP, a negative test for serum RF should not exclude RA as a possible diagnosis.

For AS, since the HLA-B27 genotype is present in nearly 90% of individuals, a positive test for this genotype aids the diagnosis. However, because only 5% of people with the HLA-B27 gene develop AS, a positive test for this marker in isolation is not sufficient to warrant a diagnosis of AS. Assessment of disease activity for arthritic conditions is aided (and often defined) by nonspecific measures of systemic inflammation, such as erythrocyte sedimentation rate (ESR) and serum levels of C-reactive protein (CRP). These inflammatory markers are high in active RA and are normal or only slightly higher when the disease is controlled. In contrast, while slight increases in ESR and CRP are often evident in active AS and severe OA, these markers can also be normal in these disorders despite significant inflammation.

When synovial fluid is removed (i.e., aspirated removed) to alleviate joint inflammation, synovial fluid analysis is also often beneficial for determining the type of arthritis. For instance, the leukocyte count usually increases in synovial fluid from a typical value of 500 cells·mm^{-3} to 2,000 cells·mm^{-3} in OA and 5,000 to 15,000 cells·mm^{-3} in RA and AS. Furthermore, macromolecules deriving from joint structures and measured in blood, synovial fluid, or urine reflect arthritic developments ensuing locally in the joint.

Joint imaging, such as radiographs (X-rays), ultrasound (US), and magnetic resonance imaging (MRI), is normally used to verify a certain arthritis diagnosis; for instance, involvement of the small joints of the hands and feet frequently suggests OA or RA, while specific skeletal variations in the lower back are indicative of AS (see **Figure 1**). The plain radiograph, which identifies bony alterations, is the conventional imaging modality. Though, since radiological changes are apparent only in established or progressive maladies, MRI and the US are the favoured imaging formats for suspected early-onset RA and AS. Radiologic features of OA include subchondral sclerosis osteophyte formation, bone cysts, and joint space narrowing. In RA, in addition to joint space restriction, radiographs may expose minor erosions and more distinct deformities. For early AS, there is a distinctive squaring of the corners of the vertebrae. Later in the disease process, there are suggestions of bone formation, ossification, or thin vertically oriented outgrowths that bridge the disc space and limit spinal motion.

Key points to note: the information obtained from the client's history, physical analysis, serum and synovial fluid tests, and joint imaging allows the medical professional to detect patterns that help in the diagnosis of a specific disorder.

Table 2. Distinctive Characteristics and ACR and ASAS Diagnostic Criteria for Osteoarthritis.

Classification	Measures
	Osteoarthritis
Distinctive characteristics	Joint pain Crepitus Gel occurrence
Appearance	• Affects the hands, hips, knees, and lumbar and cervical spine • Pain worsens throughout the day • Affects any traumatized joint
ACR Criteria	• Knee clinical • Knee pain and three of the following: • Age >50 years • Morning stiffness <30 min • Crepitus • Bony tenderness • Bony enlargement • No warmth
	Knee clinical and radiographic • Knee pain and one of the following: • Clinical criterion [a, b, or c] (see below) • Osteophytes on knee X-ray
	Knee clinical and laboratory • Knee pain and five of the following: • Clinical criteria [a] through [f] (see below) • ESR <44 mm · h^{-1} • RF <1:40 • Synovial fluid compatible with OA
	Hip combined clinical, laboratory, and radiographic • Hip pain and one of the following: • ESR <20 mm · h^{-1} • Osteophytes on hip X-ray • Joint space narrowing on hip X-ray
	Hand clinical • Hand pain or stiffness and three of the following: • Bony enlargement of two or more DIPs • Bony enlargement of two or more of 2nd and 3rd DIPs, 2nd and 3rd PIPs, 1st CMC • Fewer than three swollen MCPs • Deformity of at least one of 2nd and 3rd DIPs, 2nd and 3rd PIPs, 1st CMC

[a] Joint involvement refers to any swollen or tender joint on examination.
[b] Shoulders, elbows, hips, knees, and ankles.
[c] MCPs, PIPs, 2nd through 5th metatarsophalangeal joints, thumb interphalangeal joints, and wrists.
[d] As determined by local laboratory standards.

Abbreviation: ESR = erythrocyte sedimentation rate; RF = rheumatoid factor; DIPs = distal interphalangeal joints; PIPs = proximal interphalangeal joints; CMC = carpometacarpal joint; MCPs = metacarpophalangeal joints; ACPA = anti-citrullinated protein antibody; CRP = C-reactive protein; ESR = erythrocyte sedimentation rate.

Table 3. Distinctive Characteristics and ACR and ASAS Diagnostic Criteria for Rheumatoid Arthritis.

Classification	Measures Assessment
Rheumatoid Arthritis	
Distinctive characteristics	• Hand pain • Swelling • Fatigue • Prolonged morning stiffness
Appearance	• Affects wrists, MCPs, and PIPs • Symmetric
ACR Criteria	A score of >6 out of 10 based on the following: • Joint involvement [a] Two to 10 large joints [b]: 1 One to three small joints [c] (with or without the involvement of large joints): 2 Four to 10 small joints (with or without the involvement of large joints): 3 More than 10 joints (at least one small joint): 5 • Serology Low-positive RF or low-positive ACPA: 2 High-positive RF or high-positive ACPA: 3 • Acute-phase reactants, abnormal [d] CRP or ESR: 1 • Duration of symptoms ≥6 weeks: 1

[a] Joint involvement refers to any swollen or tender joint on examination.
[b] Shoulders, elbows, hips, knees, and ankles.
[c] MCPs, PIPs, 2nd through 5th metatarsophalangeal joints, thumb interphalangeal joints, and wrists.
[d] As determined by local laboratory standards.

Abbreviation: ESR = erythrocyte sedimentation rate; RF = rheumatoid factor; DIPs = distal interphalangeal joints; PIPs = proximal interphalangeal joints; CMC = carpometacarpal joint; MCPs = metacarpophalangeal joints; ACPA = anti-citrullinated protein antibody; CRP = C-reactive protein; ESR = erythrocyte sedimentation rate.

Table 4. Distinctive Characteristics and ACR and ASAS Diagnostic Criteria for Ankylosing Spondylitis.

Classification	Measures Assessment
Ankylosing Spondylitis	
Distinctive characteristics	• Low back pain • Low back stiffness
Appearance	• **Early:** chronic low back pain (≥3 months duration) before age 45 • **Late:** vertebral fusion and sacroiliac joint fusion (via bone formation, ossification)
ASAS Criteria	**Clinical** ≥3 months of back pain before age 45 and either of the following: • Sacroiliitis on imaging (X-ray or MRI) + one or more clinical feature • HLA-B27-positive (laboratory test) plus two or more clinical features **Clinical features** • Inflammatory back pain • Arthritis • Dactylitis • Enthesitis • Good response to NSAIDs • Psoriasis • Inflammatory bowel disease • Uveitis • Positive family history • Elevated CRP
Abbreviation: CRP = C-reactive protein	

Exercise Testing

This section discusses the distinct exercise testing considerations for the arthritic populace. Modes and protocols may need adjusting depending on the level of disability or the functional limitations of an individual's arthritis.

People with RA have an elevated risk of CVD, which mainly accounts for greater rates of mortality. This increased CVD risk is mainly attributed to the inflammatory burden of RA and is nearly two-fold more than that of the general population, making RA equivalent to diabetes as a CVD risk factor. Due to this reported heightened risk, the European League Against Rheumatism (EULAR) task force (Aletaha *et al.,* 2010) has backed that risk scores determined by CVD calculators such as the Framingham and the Systemic Coronary Risk Evaluation (SCORE) methods should be multiplied by 1.5 when RA individuals fulfil two out of three of the following criteria: RA disease duration ≥10 years, the manifestation of extra-articular features, and RF or ACPA/anti-CCP positivity. Because AS is also linked with increased CVD incidence, EULAR suggests that this condition also be viewed as a CVD risk factor. Additionally, since individuals with arthritis are inclined to be more deconditioned than people without arthritis, the risk of CVD is heightened. In those individuals with an elevated CVD risk profile who wish to engage in exercise, a symptom-specific exercise test should be deliberated, both to screen for the existence of CVD and to aid in developing the exercise program. An exercise test is also frequently used for evaluating the individual's cardiovascular status and risk stratification when contemplating joint replacement surgery.

Though arthritis and musculoskeletal conditions are repeatedly documented as relative contraindications to graded exercise testing, 95% of those with severe end-stage hip or knee arthritis attributable to either OA or RA were found to be able to perform a symptom-limited exercise test using cycle ergometry means. Many of these individuals also attained a respiratory exchange ratio (RER = CO_2/O_2) greater than 1.0, determining a metabolically maximal test. Almost two-thirds of these subjects could complete tests by cycling with their legs, and the remaining subjects operated with their arms. However, during an exercise test, exercise professionals must be aware that joint symptoms and fatigue may negatively affect performance and prohibit maximal testing. Should a direct assessment of maximal aerobic capacity prove problematic, assessment of peak O_2 or estimating O_{2max} by submaximal tests provides a feasible substitute for developing applicable exercise prescriptions.

For all exercise testing, guidelines on typical contraindications for exercise testing should be adhered to. Exercise testing practises for individuals with arthritis are like procedures advocated for the elderly and deconditioned. These tests should have slight incremental changes in workload (e.g., increments of 10 to 15 $W \cdot min^{-1}$ on the cycle ergometer or the modified Naughton protocol with the use of a treadmill). Cycle ergometry is normally the favoured mode for testing because of the high frequency of lower extremity impairment in arthritis clients. Most individuals with arthritis can achieve maximal cardiorespiratory effort during cycle ergometry, which is not weight-bearing and is less dependent on balance. Conversely, equations for estimating O_2 by cycle ergometry have not been validated for arthritis clients. In the case of severe lower body joint pain and limitation, and in those with substantial deformities that contraindicate cycling, testing by arm ergometry may be required. Treadmill testing is commonly applied for individuals with marginal or no functional disability.

The following treadmill-specific equation was established to predict O_{2peak} in older adults with knee OA or CVD: O_2 ($mL \cdot kg^{-1} \cdot min^{-1}$) = $0.0698 \times$ speed ($m \cdot min^{-1}$) + $0.8147 \times$ grade (%) $\times$ speed ($m \cdot min^{-1}$) + 7.533 $mL \cdot kg^{-1} \cdot min^{-1}$. This formula, validated in both males and females, requires that subjects use front railings for support during the exercise test. This is the recommended procedure for testing an individual with a lower-body disability for whom standard non–hand support approaches of treadmill testing may be precarious.

Treatment

A wide-ranging client management strategy for arthritis should seek to counter sedentariness, re-establish a healthier body composition (i.e., increase muscle mass and reduce fat mass), improve physical function (i.e., decrease disability), and reduce comorbidity-related symptoms or risk. This method should include suitable medication to control disease activity and minimalize symptoms, as well as exercise.

Previously, the conventional standard of treatment for a symptomatic arthritic joint was rest (Bunning and Materson, 1991). Current guidelines highlight increasing physical activity, including exercise training, because of convincing evidence of the positive effects and safety of exercise for people with arthritis. As shown in **Figure 3**, exercise interventions can interact at each stage of arthritis pathology and can help mitigate the effects of the disease process on physical function and disability, as well as negative changes in body composition.

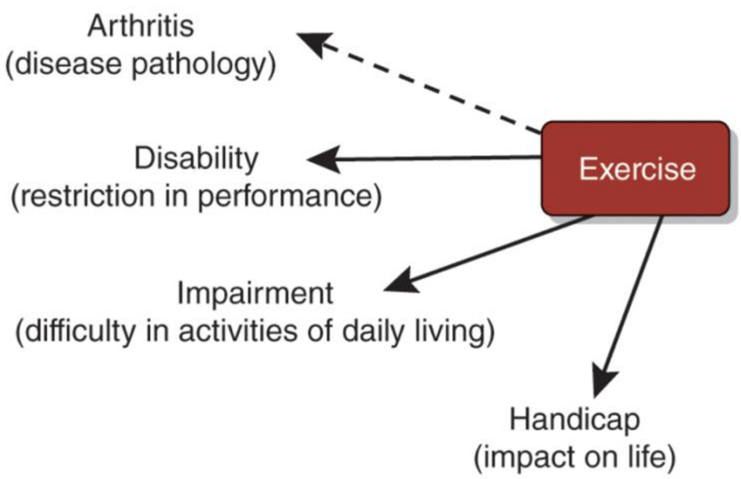

Figure 3. The World Health Organization (WHO) classification of impairments, disabilities, and handicaps (ICIDH) demonstrates the conceivable benefit of exercise as an interactive and mitigating factor in the arthritis disease process, and evidence shows the advantages of exercise on physical disability and impairment. While we need to more regarding the effects of exercise on condition-specific disease pathology, various studies show no deterioration of arthritis with exercise, and a significant amount displays favourable effects on clinical facets of the disease (e.g., reduced pain, joint stiffness, inflammation, bone loss).

The World Health Organisation (WHO) ICIDH-2 revision (2000), developing on the preceding classification of disease effects and their effects, establishes the need for a multi-perspective methodology, including the active nature of numerous elements (e.g., environmental, and individual factors) on activity and participation, among other things. The application of PA and exercise as part of an inclusive treatment strategy can be difficult. For example, Law and associates investigated subjects with RA perceptions of the effects of exercise on skeletal joint health, it was reported that subjects were conscious of the positives of PA and exercise for their disorder but felt that "health professionals lacked certainty and clarity regarding specific exercise recommendations and the occurrence of joint damage" (Law *et al*., 2010; p. 2444). The study also reported that GPs and allied health professionals infrequently advocated exercise to their arthritis patients, and when they do, they typically provide limited instruction.

Moreover, those GPs who do direct their arthritis patients to exercise frequently low-intensity rather than moderate- to high-intensity exercise, despite the recognised value and safety of moderate- to high-intensity exercise and the comparative ineffectiveness of low-intensity exercise (Munneke *et al*., 2003). This common failure by GPs to support and offer informed instruction on how best to exercise is a key factor in the physical inactivity that typifies a patient with arthritis. Individuals with symptomatic arthritis may not be driven to perform physical activity on their own since joint pain and fatigue are obstructions to engaging in exercise. These aspects contribute to adults and children with arthritis being largely less active than healthy people. This demonstrates the importance of the role of healthcare professionals in providing specific instructions on exercise and addressing patients' concerns about joint health and joint pain management.

For example, in 2008, 69% of RA individuals in the USA reported performing no routine physical activity, and only 17% stated that they achieved the recommended three or more sessions of physical activity per week. Additionally, it has been reported that in 2009, in the USA, a median of 32% of adults with any type of arthritis reported achieving no leisure-time PA compared with a median of 21% of adults without arthritis. The Osteoarthritis Initiative, which empirically evaluated PA using accelerometric, devices found that 50% of adults with knee OA were sedentary, with only 10% appropriately active to meet low or moderate aerobic PA recommendations. Moreover, a meta-analysis by (Wallis *et al*., 2013) reported that only 13% of people with knee OA attained the current weekly accumulation of 150 minutes of PA. Despite the recognised benefits of community-based arthritis exercise programs including the **Arthritis Foundation YMCA Aquatics Program** (AFYAP) and **People with Arthritis Can Exercise (PACE)**, below 1% of eligible individuals with arthritis enter these programs. Therefore, people with arthritis need education and support to increase and maintain PA as well as instruction on how to perform the appropriate modes of exercise.

In addition to PA and exercise, various nonpharmacological interventions are used in the regular management and rehabilitation of individuals with chronic arthritis:

- Education
- Physical and occupational therapy
- Braces and bandages
- Canes and other walking aids
- Shoe modification and orthotics
- Ice and heat modalities
- Weight reduction
- Avoidance of repetitive-motion occupations
- Joint surgery (in select circumstances)

Joint replacement surgery is a means for patients with end-stage symptomatic OA who have increasingly deteriorating symptoms, leading to functional restrictions that affect ADLs and QoL. While arthroplasty (joint replacement surgery) is commonly implemented only when conservative methods have been unsuccessful, these methods are gradually increasing. For instance, by 2010, more than 7 million individuals in the USA were living with a total knee (4.7 million) or total hip (2.5 million) replacement, representative of 1.5% and 0.8% of the entire U.S. populace, respectively. The occurrence of arthroplasty surgery increases with age, with 10% and 5% of Americans aged 80 years or over having had total knee or total hip replacements, respectively. Although joint replacement surgery is very effective in resolving pain, the physical function of some patients may remain suboptimal 12 months after surgery. Incomplete rehabilitation is generally attributed to postsurgical rehabilitative exercise that was inadequate (in terms of both volume and intensity) in restoring muscle mass, strength, and aerobic capacity.

Pharmacological treatments for arthritis vary according to the form of arthritis and the type of symptoms exhibited. Regrettably, OA is an unalterable process, and the basis of treatment continues to be lifestyle changes (exercise and weight loss) and agents to reduce pain. Commonly applied and recommended oral medication include nonopioid analgesics such as acetaminophen and aspirin, tramadol (opioid-like), and nonsteroidal anti-inflammatory drugs (NSAIDs) such as ibuprofen and naproxen. The current ACR recommendations for the management of knee, hip, and hand OA are the use of oral supplementation with glucosamine and chondroitin sulfate (hand), the serotonin-norepinephrine reuptake inhibitor duloxetine (hand, knee, and hip), and topical capsaicin (knee) were all tentatively suggested for the use in different types of OA. Intra-articular corticosteroid injections are also frequently used and are advocated for pain management in hip and knee OA and can be considered in hand OA.

For individuals aged 75 years or older, topical rather than oral NSAIDs are suggested. This is because dosing an oral NSAID 1 hour before exercise may increase exercise compliance by decreasing pain and rigidity during PA. Intra-articular injection of corticosteroids is efficient for treating and addressing OA flares. However, upon receiving an injection, exercise should be avoided for 24 hours, as should load bearing when the injection is into the weight-bearing joints; it is commonly recommended that an individual receives no more than three intra-articular injections into the same joint during any 12-month cycle (not given < 3 months apart). In individuals with OA, being overweight relates to increased pain and disability and may exacerbate disease activity. Therefore, the inclusion of nutritional interventions in combination with exercise is ideal when weight loss is a treatment outcome.

In addition to the analgesics and anti-inflammatories stated above, a variety of disease-modifying antirheumatic drugs (DMARDs) are accessible for treating autoimmune inflammatory arthropathies, RA and AS. With DMARDs, the medical professional's objectives are to control syndrome activity by suppressing immune function and therefore impeding the inflammatory process. The preferred DMARDs for RA include methotrexate (MTX), leflunomide (LEF), sulfasalazine (SSZ), hydroxychloroquine (HCQ), the Janus kinase (JAK) inhibitor tofacitinib, and biologics including TNF-α inhibitors (etanercept, infliximab, adalimumab, certolizumab pegol, and golimumab), anti-T cell (anti-CD28) therapy (abatacept), anti-B cell therapy (rituximab), and anti-interleukin-6 receptor (anti-IL-6R) agents (tocilizumab). These medications are managed either singularly (DMARD monotherapy, usually MTX but may also be SSZ, HCQ, or LEF) or in combination: biologic + MTX; double DMARD therapy (e.g., MTX + SSZ, MTX + HCQ); or triple DMARD therapy (MTX + SSZ + HCQ), to attain low disease activity (preferably remission). This goal-oriented management method, which involves frequent examining of inflammation, with treatment adaptations required if the objective is not attained, is termed treat to target (T2T) or tight control of disease activity. Moreover, disease flares are repeatedly treated by high-dose intravenous or intra-articular corticosteroid injections.

For AS, generally, medications used are locally administered parenteral corticosteroids, DMARDs, and anti-TNF biologics—etanercept, infliximab, adalimumab, certolizumab pegol, and golimumab. Disease-specific clinical outcomes for AS can be evaluated by using the Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) (Garrett, et al., 1994), the Bath Ankylosing Spondylitis Function Index (BASFI) (van Riel, 1995), and the Bath Ankylosing Spondylitis Metrology Index (BASMI; an objective measure of axial mobility) (Jenkinson et al., 1994).

Because of its various benefits, exercise is suggested in the USA, and European treatment recommendations for OA, RA, and AS. These benefits include increased aerobic capacity, muscle strength, and flexibility; improved physical function, weight control, self-efficacy, and mood; enhanced QoL; reduced pain; and decreased CVD risk. Contrary to common belief, exercise does not increase the risk for OA, nor does it intensify joint damage in RA clients.

Exercise Prescription

The following are the objectives of the exercise, particularly for the treatment and management of arthritis:

- Preserve or develop physical function by conserving or improving muscle strength, cardiorespiratory fitness, and ROM.
- Improve body composition (i.e., restore muscle mass and reduce fat mass) and, when applicable, reduce body mass.
- Reduce the risk of comorbidities including CVD, type 2 diabetes, metabolic syndrome, and osteoporosis.
- Lower inflammation and pain.
- Prevent contractures and abnormalities.

Immobilization and inactivity increase the negative systemic and psychological indices that accompany arthritis. The consequences of inactivity include rapid reductions in strength (around 3%-8% per week) and aerobic capacity, muscle loss, decreased bone mass, and loss of cartilage matrix elements. Because cartilage is avascular, it requires regular repetitive loading of the joint for its nutrition and normal physiological function. Additionally, joints with effusions may develop synovial ischemia attributable to increased intra-articular pressure. For instance, ambulation and stationary cycling increase synovial blood flow in exacerbated knees. Furthermore, in both healthy and OA joints, the intra-articular oxygen partial pressure increases during joint movement, although the increase is weakened in arthritic joints.

An individual engaging in an exercise program, whether supervised or unsupervised, needs education, skill acquisition, and positive reinforcement. Clients may benefit from infrequent monitoring or direct supervision by a medical professional (if required). Supervised exercise training for clients with arthritis typically occurs in a group environment (vs. personal training), with several studies supporting this as a positive treatment modality. A supervised group setting may be valuable because it offers peer social support and aids in exercise training compliance. Access to an appropriate exercise specialist who has previously appraised the client may further help decrease anxiety. Moreover, the ES may have a critical role in supporting and enhancing client attendance at sessions in the initial treatment regime, because session adherence in the opening stages is the greatest predictor of attendance in the latter stages of the exercise intervention. These are central considerations because exercise training adherence is related to training response and improved physical function. Consistent monitoring by the ES also aids in ensuring the safety and suitable progress of the exercise intervention.

Complementing supervised classes with home-based exercise may positively enhance progress in pain and function. Furthermore, clients who engage in home-based exercise during the maintenance stage of the intervention typically adhere to the exercise program more than individuals who exercise only at a leisure facility. Therefore, the introduction of unsupervised and independent exercise sessions may be central to changing a person's behaviour so that routine exercise becomes a part of their daily lives.

Many exercise possibilities are accessible for unsupported programs. For example, walking is an effective cardiorespiratory exercise, though performing a variety of cardiorespiratory activities (e.g., cycling, swimming, and rowing) may help preserve interest and compliance and lessen the prospect of overuse injuries. An interactive tool featuring exercise programs suited to clients with arthritis is accessible through the Arthritis Foundation (www.arthritis.org). These physical activity and exercise opportunities include land-based cardiorespiratory and resistance training programs as well as water-based programs (e.g., water walking, and water aerobics) and ROM exercises. The ACSM has also produced informational documents and leaflets supporting the use of home exercise routines in clients with OA and RA via their Exercise Is Medicine campaign (www.exerciseismedicine.org).

Following the Arthritis Foundation's YMCA Aquatic Program (AFYAP), evidence has suggested positive changes in an individual's hip ROM, isometric strength, and flexibility when performed two or three times a week over 6 to 8 weeks. Further evidence was generated by Waller and colleagues (Waller *et al*., 2014) who performed a meta-analysis that included data from 1,092 subjects with lower limb OA. The authors determined that aquatic exercise attained small but significant improvements in pain and self-reported function like those improvements gained by land-based exercise or the use of NSAIDs. This stated benefit supports the work of Bartels and associates (Bartels et al., 2007). Likewise, Dunbar and colleagues (2014) noted that aquatic exercise performed 5 d/week for 4 weeks significantly diminished pain and improved QOL in AS subjects. However, like other researchers in this field, Bartels and colleagues did not observe significant benefits regarding muscle strength. This absence of effectiveness of aquatic exercise can be rationalised by the failure of this form of training to achieve the necessary intensity to increase strength, which in turn has led to the suggestion that aquatic exercise is complemented by more intense land-based strength training.

Non-facility-based physical activities and exercises that can be performed during the day include chin tucks, pectoral stretches performed in an entranceway, abdominal tightening/ bracing, examining posture in the mirror, and extending the walking time by taking the stairs or parking farther from a destination.

Table 5. Pharmacology Treatments for Osteoarthritis.

Medication class or name	Primary effects	Exercise effects	Special consideration
Analgesics (e.g., nonopioid analgesics such as acetaminophen, aspirin; tramadol)	Reduce pain Reduce fever (acetaminophen)	None reported	Aspirin may cause GI-related symptoms. Hypersensitivity to aspirin is reported in 1%-2% of the population (rash or hives, respiratory symptoms). Acetaminophen overdose can lead to liver damage. Tramadol is an opioid-like controlled substance with addictive potential; should be used with caution
Nonsteroidal anti-inflammatory drugs (NSAIDs) (e.g., diclofenac, ibuprofen, naproxen, and selective COX-2 inhibitors such as celecoxib	Reduce inflammation by inhibiting the enzyme cyclooxygenase, which in turn reduces prostaglandin synthesis Reduce pain	None reported	NSAIDs are associated with GI irritation, nausea, diarrhoea, and occasionally ulceration. Avoid use in patients with peptic ulcer disease and a history of bariatric surgery. NSAIDs should be used with caution in the elderly, and coincident use of proton pump inhibitors is advised. COX-2 inhibitors have a lower risk of GI complications. NSAIDs and COX-2 inhibitors may be associated with an increased risk of cardiovascular thrombotic events (MI, stroke).
Intra-articular corticosteroid injections	Reduce inflammation and consequently improve pain and mobility	Avoid exercise involving the affected joint for 24 hrs after injection	The recommendation is no more than 3 steroid injections per joint per year (i.e., given no less than 12 weeks apart).
Glucosamine	Was thought to provide pain relief and stimulate cartilage growth, but actual mechanism of action is unknown Not recommended for knee, hip, or hand OA	None reported	GI side effects are occasionally reported. Glucosamine may interact with warfarin (anticoagulant medication).
Topical capsaicin	Derived from chilli peppers; thought to attenuate cutaneous hypersensitivity by defunctionalisation of nociceptor fibres Conditionally recommended for knee OA	None reported	Use is associated with warmth, burning, or stinging sensation at application site. Not recommended for hand OA because of lack of direct evidence and risk of potential eye contamination with use

Table 6. Pharmacology Treatments for Rheumatoid Arthritis.

Medication class or name	Primary effects	Exercise effects	Special consideration
NSAIDs	Reduce inflammation by inhibiting the enzyme cyclooxygenase, which in turn reduces prostaglandin synthesis Reduce pain	None reported	NSAIDs are associated with GI irritation, nausea, diarrhoea, and occasionally ulceration. Avoid use in patients with peptic ulcer disease and a history of bariatric surgery. NSAIDs should be used with caution in the elderly, and coincident use of proton pump inhibitors is advised. COX-2 inhibitors have a lower risk of GI complications. NSAIDs and COX-2 inhibitors may be associated with an increased risk of cardiovascular thrombotic events (MI, stroke).
Disease-modifying antirheumatic drugs (DMARDs) (e.g., methotrexate, azathioprine, leflunomide, sulfasalazine, hydroxychloroquine) and the biologics (e.g., etanercept, infliximab, adalimumab, golimumab, certolizumab pegol, abatacept, rituximab, and tocilizumab)	DMARDs are immunosuppressants and thus reduce inflammation; the biologics are specific cytokine or T cell or B cell modulators	None reported	Immunosuppressants reduce the body's response to infection. Each DMARD has recognized side effects and toxicities; careful monitoring is essential.
Systemic corticosteroids	Immunosuppression	None reported	In addition to reduced response to infection, chronic corticosteroid use is associated with osteoporosis and, in high doses, muscle loss.
Intra-articular corticosteroid injections	Reduce inflammation and consequently improve pain and mobility	Avoid exercise involving the affected joint for 24 hrs after injection	The recommendation is no more than 3 steroid injections per joint per year (i.e., given no less than 12 weeks apart).

Specific Exercise Prescription Considerations

When formulating an exercise treatment strategy, the EP should contemplate the success of several treatment modalities for joint impairments, as well as the client's affected joints, level of fitness, surgical history, comorbidities, medications, age, personal goals, and lifestyle. Inflammation and joint degeneration related to the disease process cause a sequence of declining functions and increasing impairment. It is not yet evident whether therapeutic exercise changes the pathological process of arthritides, although exercise (including long-term high-intensity training) does not exacerbate disease activity, and suggestions for reductions in pain, inflammation, and joint impairment are ample in the scientific literature.

Exercise and physical activity can produce muscle and joint pain, specifically during the commencement of exercise training; this is the main complaint and incapacitating factor related to arthritis. If pain happens, it can become problematic to arouse an individual to maintain adherence to an exercise program. An arthritic populace that is older, they are typically more inactive than the general population and may be using systemic corticosteroids, avoidance of injury, and pain is a central factor in facilitating exercise compliance and adherence. The EPs role is to make recommendations that reduce the aggravation of these symptoms. For instance, deconditioned clients should start exercise training programs at a low intensity and progress progressively to decrease the likelihood of muscle soreness. Moreover, the EP should investigate which joints are affected because this information will allow for the development of a more comprehensive assessment, bringing awareness to decreased ROM, instability, reduced muscle strength and flexibility, poor joint proprioception, and increased pain. This documentation may be developed with information from the client's GP, rheumatologist, orthopaedist, or physical therapist.

Reduced balance and increased fatigue are further factors that must be considered when creating an exercise program. To increase or retain client motivation to initiate or continue exercising, clients must be conscious that a decrease in arthritis pain and fatigue are expected benefits of routine exercise, and that improved strength and aerobic capacity will decrease the difficulty and subsequent fatigue related to performing ADLs. Client compliance with an exercise program can be difficult for individuals with arthritis. Efforts on the part of the EP to inhibit musculoskeletal injury associated with exercise and to appreciate the concerns of the individual with arthritis will enable overall satisfaction and exercise program compliance.

Disease Staging

A consideration in designing a suitable exercise program for individuals with arthritis is the disease stage. The focus of exercise treatment for chronic stages of arthritis should be to preserve or improve function while reducing or preventing symptom aggravation. Most patients referred for exercise therapy are experiencing arthritis in a chronic stage. **Table 1** lists the arthritis stages and their associated exercise-related considerations. This table provides guidance for the EP to follow when creating an exercise prescription for clients with arthritis who have disease-specific skeletal disorders.

Inhibiting Musculoskeletal Injury to Exercise

Since cardiorespiratory exercise involves high repetition of joint motion, there is an associated risk of overuse injuries. Thankfully, injuries attributable to administered exercise are uncommon. It is projected that 2.2 minor injuries happen per 1,000 hours of exercise and that significant injuries (i.e., those requiring a reduction or cessation of exercise for at least 1 week) occur at a rate of 0.48 per 1,000 hours of exercise. Clients with arthritis may reduce their overuse by performing interval or cross-training during endurance exercises. These include the following examples:

- Rotating the intensity of stationary cycling between 25% and 75% of the maximum work rate performed during a graded exercise test.
- Varying water walking with joint ROM exercises in a swimming pool environment.
- Walking and resistance load-bearing training.
- Walking and higher-intensity cardiorespiratory exercises including recumbent stair stepping or cycling.

The development of strong knee extensors with quadriceps-strengthening exercise reduces impulse loading of the lower limb during ambulation by slowing the deceleration phase that happens before the heel strike. Thus, sufficient quadriceps strength may aid in preventing knee injury and slowing the progression of knee OA. Another consideration is that clients may have laxity in the structures that support a joint due to the rheumatic process or the use of corticosteroids. Due to these conditions, the joint should be shielded during exercise or normal physical activities. For instance, clients should stretch carefully to avoid extending beyond the functional ROM; vigorous stretching or manipulative techniques are contraindicated. In various instances, providing external support to a joint may be required. To protect smaller joints during physical activities and exercises, larger muscles and joints should be used.

Fatigue

Fatigue is common with inflammatory rheumatic disease and can markedly affect the client's QoL. Morning rigidity lasting for 3 or 4 hours and fatigue starting in the afternoon and continuing until evening are typical symptoms of inflammatory arthropathies, leaving only limited time during midday when stiffness or fatigue is not problematic. Fatigue is a multifaceted occurrence associated with exertion, physical deconditioning, depression, sleeping patterns, or a mixture of these considerations. For example, a fatigued client is less able to exercise for a long duration and tends to be less enthused and may become exasperated. Though limited evidence has studied the outcomes of exercise training on fatigue levels in arthritis subjects, there are suggestions to support a benefit. This is coherent with expectations that increased aerobic capacity and strength assist the client with their performance of ADLs at a lower rate of their functional capacity, with reduced fatigue.

Previous Joint Replacement

Total joint replacement surgery is common in clients with advanced arthritis, especially in weight-bearing joints (i.e., knee and hip). People who undergo total knee or hip arthroplasty are typically deconditioned and overweight. Thus, exercise training is vital in improving their physical functioning and reducing the risk of comorbid conditions. Starting a suitable exercise rehabilitation program shortly after surgery has been suggested to improve strength and function, promote muscle hypertrophy, reduce pain and stiffness, and improve QoL. Post-surgical rehabilitation procedures should be followed under the management of the client’s orthopaedic surgeon.

Time of Day and Climatic Changes

Morning stiffness is an indication for many people with arthritis. The EP should recognise the impact of daily variability of symptoms, specifically the problems connected to early morning activities. For those clients with inflammatory arthritis categorised by protracted morning stiffness, exercise and physical activity should be administered in the late morning or early afternoon. Furthermore, a change in the ability to perform exercise during periods of extreme weather is often reported by clients with rheumatologic disorders. For example, persons with arthritis tend to report an escalation in pain and stiffness with changes in temperature, humidity, and barometric pressure.

Aquatic Treatment

Rheumatoid arthritis is frequently linked with Raynaud's phenomenon and Sjogren's syndrome. Raynaud's occurrence is a vasospastic disorder that is presented as blanching or cyanosis of the hands and feet, especially when exposed to cold weather or psychological stress. Though the disorder normally has a benign course, extreme incidents can result in scar indentation and potentially gangrene. Clients with Raynaud's syndrome should be aware that cold water can aggravate the symptoms. The selection of exercise and physical activity modalities should be founded on the symptoms attributable to arthritis and Raynaud's. Sjogren's syndrome is an autoimmune disorder categorised by dry mouth and eyes and is caused by lymphocyte infiltration of salivary and lacrimal glands. Clients with this disorder may find chlorinated water and the air surrounding swimming pools particularly irritating to the eyes and should always wear swimming goggles when in a swimming pool.

Footwear

The use of suitable footwear can decrease the risk of injury associated with poor lower limb biomechanics and repetitive impact. For example, lightweight running footwear that includes hindfoot control, a supportive midsole of shock-absorbing fabrics, a continuous sole, and forefoot flexibility can assist in shock reduction and improve biomechanics. People with OA, RA, and AS with mechanical malalignment or abnormalities of the lower limbs may profit from factory-made or custom-fit orthotics. Moreover, with lower limb arthritis, it is worthwhile to wear swimming pool footwear to aid mobility and guard the feet against harm during aquatic-based exercise.

Cardiovascular and Pulmonary Indices of Rheumatic Disease

Cardiovascular disease risk is increased in RA and AS and is projected to be 1.5- to 2-fold relative to that of the broader populace, making inflammatory arthritis equivalent to diabetes as a CVD risk factor. Pulmonary disease can also be associated with arthritic conditions. For instance, RA is believed to be linked with interstitial lung disease, and those individuals with AS frequently have obstructive lung disease due to compromised chest expansion and bilateral upper lobe pulmonary fibrosis. In most instances, cardiovascular and pulmonary indices of rheumatologic disorders are not associated with contraindications to exercise, though a vital capacity of 1 litre or less is viewed as a comparative contraindication to engagement in swimming pool therapy because of the compressive effects of hydrostatic pressure on the chest wall.

Ankylosing Spondylitis

The bony fusion that appears in the spine and sacroiliac joint with AS, unfortunately, cannot be avoided, however, dynamic treatment strategies can develop spinal mobility and physical function. Because people with AS tend to be younger and more physically active at diagnosis, exercise and physical activity can commonly be started at a higher relative intensity compared to RA and OA. When peripheral joints are involved, disease pathology is like that for RA, and therefore exercise recommendations specific to RA should be considered. An occurrence that may transpire is the last-joint syndrome, in which bridging ossification between vertebral bodies happens at every level except one. This solitary ambulatory segment is therefore exposed to considerable stress during exercise and can present with local pain and discitis. In this situation, bracing or surgical fusion may be required.

Corticosteroids

Systemic corticosteroids are frequently used in the treatment of RA. Although medical professionals attempt to curb the use of corticosteroids, prolonged use may be necessary. Chronic corticosteroid use is linked with a variety of negative outcomes, including muscle atrophy, myopathy, reduced bone density, increased adiposity and obesity, and the development of type 2 diabetes. These effects can place rheumatologic clients at greater risk of fractures and reduced muscle strength.

Body Composition

The EP recognises that obesity is a modifiable factor that is typical in most forms of arthritis. Obesity has also a strong risk factor for OA occurrence, progression, and disability due to the increase in mechanical loading and stress on weight-bearing joints. It has been suggested that a 5 kg weight reduction decreases the risk of developing knee OA within 10 years by as much as 50%. The Arthritis, Diet, and Activity Promotion Trial (ADAPT) reported significant improvements in physical function and pain for overweight or obese knee OA subjects when exercise and diet restriction were combined (Miller *et al*., 2003). ADAPT suggested that both diet and exercise in isolation improved pain sensitivity, but the effect was amplified when used in combination, leading the authors to suggest that dietary weight loss without exercise was ineffective for improving function, mobility, and pain sensitivity.

Rheumatoid arthritis is typified by rheumatoid cachexia, a disorder that features decreased muscle mass and increased adiposity levels. Studies have reported that significant muscle loss is apparent in almost two-thirds of RA individuals. Obesity among RA clients is more prevalent with an occurrence rate of approximately 80%, with fat accumulation around the midsection (i.e., central obesity). Both muscle loss and increased adiposity are present in clients with well-controlled diseases, including those individuals in remission. Due to the corresponding loss of muscle and increase in fat mass, body weight often remains constant, rendering body mass index (BMI) an ambiguous indicator of obesity in this populace. In findings including high-intensity progressive resistance training (PRT), the turnaround of rheumatoid cachexia (i.e., increased muscle mass and decreased fat mass) has been attained without impairing disease activity. Moreover, a study by Engelhart and colleagues (1996) reported that obese subjects with RA that completed a program of moderate physical training, reduced dietary energy intake, and a high-protein, the low-energy supplement was successful in attaining significant weight loss without loss of lean tissue. Cachexia has also been suggested to be a feature of AS. This muscle atrophy relates to reduced muscular strength and physical function. Therefore, exercise interventions designed at promoting muscle hypertrophy, such as progressive resistance training, may be useful for people with this disorder.

It should be acknowledged that, to date, none of the DMARDs or biologics used in the treatment of inflammatory arthritides is anabolic, and some agents may increase adiposity (i.e., high dosing of corticosteroids and the anti-TNFs). Therefore, it is not unforeseen that pharmaceutical treatment of this disease activity fails to re-establish an improved body composition phenotype in either RA or AS clients. Subsequently, an exercise intervention that can improve body composition is needed if the purpose is to be improved and comorbidity risk mitigated; exercise training, especially high-intensity exercise training, is suggested to be the most applicable intervention for achieving these objectives.

General Exercise Prescription Recommendations

Warm-up and Cool-down

The order and sequence of exercises for clients with arthritis are comparable to the general populace, starting with a warm-up and finishing with a cool-down. The warm-up should be performed to elevate muscular tissue temperature, and consequently tissue compliance, throughout the client's body. As decreased rigidity and greater ROM develop, clients should be educated to judge whether increasing the range through which they are exercising is safe and appropriate for them. Strengthening and cardiorespiratory conditioning activities should be performed after the warm-up and should be followed by a cool-down phase. Flexibility training is best performed during the cool-down component because muscles and connective tissue are more malleable when body temperature is raised.

Exercise Intensity

Exercise intensity (or loading), duration, or frequency (or a combination of these variables) should be developed when the exercise is not as challenging as it was previously (due to the adaptational training response) and when symptoms do not increase for two or three successive bouts. Conservative increments in these dose variables are suggested. Typically, after 1 week of coherent exercise training without the aggravation of symptoms, the exercise training demands should be increased toward the maximum advocated. To ensure that progression in aerobic, resistance or combined training programs is safe, firstly the EP should ensure there is an increase in the training volume dose (i.e., total duration of exercise or physical activity, the number of exercises performed, or the time spent exercising with the use of shorter rest periods) and then progressively increasing the intensity or loading (e.g., increasing the per cent heart rate reserve for aerobic exercise, or the per cent one-repetition maximum for progressive resistance training). An increase in the client's symptoms may necessitate a lowering of the intensity or volume of exercise, especially for the affected joint. When the client has adapted to this exercise (i.e., muscle soreness is not merely due to the unacquainted physical activity), the two-hour pain ruling is a useful adage for controlling and regulating the client's exercise intensity. A concentrated increase in pain that lasts more than 2 hours after a physical activity suggests the need to reduce the exercise intensity or volume for the next training bout. Collating the client's physical metrics consecutively to accurately evaluate the response to exercise therapy is advantageous.

Tables 7 and 8 catalogues an assortment of physical function methods and assessments that can be applied to appraise muscular strength, aerobic capacity, physical function, ROM, coordination and balance, and body composition in arthritis clients. Additionally, respective standardised and endorsed instruments (questionnaires) are accessible for measuring arthritis pain, stiffness, subjective function, and response to therapy for OA, RA, and AS.

Cardiorespiratory Exercise

An important consideration of cardiorespiratory (aerobic) exercise treatment for arthritic disorders is to regulate the workload intensity, session volume and duration. Cardiorespiratory exercise workload should be directed by the client's heart rate (i.e., per cent heart rate reserve, %HRR) or rating of perceived exertion (RPE); RPE becomes the dominant method as a marker of exercise intensity when maximal HR is pharmaceutically controlled by β-blocker or calcium channel blocker agents. Because most individuals with arthritis can attain normal exercise training heart rate ranges, typical HRR recommendations and standards can frequently be applied. A cardiorespiratory exercise intensity of 12 to 16 on the 6- to 20-point Borg RPE scale or 3 to 6 on the 10-point Borg RPE scale is advocated.

Aerobic exercise training is normally attained using a mode that reduces the degree and rate of mechanical joint loading. These forms include walking, cycling, and swimming pool-centred exercise. For example, free walking velocity generates less hip joint contractile pressure than isometric or standing dynamic hip exercises. Nordic walking (which uses walking poles) provides several benefits over normal walking. It expends more calories, aids in vertical body positioning, and reduces joint impact when descending. If ambulatory activities are uncomfortable, if the pain lasts more than 2 hours after walking, or if the client has distorted lower body biomechanics, a substitute cardiorespiratory exercise such as cycle ergometry, recumbent stair stepping, upper body ergometry, or deep-water walking should be considered. Cycle ergometry should be performed with the seat height and crank length attuned to limit knee flexion and curtail pedal load, which in turn reduces knee joint stress.

Water-based, or aquatic, exercise relatively increases physical function and ROM and reduces pain, but it has been suggested to not affect strength in OA or RA subjects or on balance and fall risk in people with knee OA. Improved QoL has been extensively stated in OA clients after aquatic exercise training. Equally, improvements in pain and QoL have been reported with aquatic exercise in AS subjects. The buoyant feature of water aids individuals to perform passive and active joint ROM exercises. Strengthening exercises can be accomplished in the water because water resists motion (i.e., the faster a limb or body moves in water, the greater the resistance and therefore the workload). Though, as previously stated, the failure to accomplish an appropriate working intensity may explain the lack of effect on strength commonly witnessed after aquatic training.

Many individuals with arthritis can endure longer-duration bouts in the water than land-based, and this may account for the elevated exercise training adherence levels connected with this type of exercise. Concerning the swimming pool settings, compliance with aquatic exercise declines with water temperatures colder than 84 °F (28.9 °C), and cardiovascular stress escalates with temperatures greater than 98 °F (36.7 °C). Contraindications to hydrotherapy include a record of uncontrolled seizures, bowel or bladder incontinence, pressure sores or contagious skin rashes, and cognitive impairments that would endanger the client's safety. Furthermore, if excessive help is required with dressing, or if changing clothes causes fatigue or joint pain, then hydrotherapy should not be applied. In conclusion, the proposal of Bartels and associates (2007) in their review is applicable: *"One may consider using aquatic exercise as the first part of a longer exercise programme"* for arthritis.

Resistance Exercise

Isotonic exercise is favoured over isometric exercise for dynamic strength training as it more closely resembles everyday activities and therefore helps improve daily functioning. However, low-intensity isometric exercise may be suitable for muscle strengthening during the acute arthritic stage since it produces low articular pressures. In this occurrence, instructions should be given to complete a submaximal isometric contraction for 6 seconds while exhaling. Additionally, isometric exercise should focus on one muscle group at a time.

For resistance training, workload intensity is determined by the percentage of the client's one-repetition maximum (1RM) that a load (weight) resembles. While increases in strength and muscle mass can be accomplished in previously untrained individuals with loads of 50% 1RM, greater effects are reported with somewhat heavier loads, with 80% 1RM suggested to be within the optimal range. At the start of resistance training, the loading should be about 60% 1RM (~15 reps maximum), with advancement to 80% 1RM (~8 reps maximum) transpiring progressively over 6 weeks. Low muscle and high-fat mass are strongly linked with reduced function and increased comorbidity and mortality risk. Thus, resistance training should highlight increases in strength and body composition because increased strength has been indicated to produce the beneficial effects of exercise training on pain and physical function.

Table 7. Cardiorespiratory Exercise Testing in Individuals with Arthritis.

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 VO_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 VO_{2max}
Use cycle ergometry for those with mild to moderate lower extremity impairment.	Use protocols with small increment increases (i.e., 10-15 W · min^{-1}) 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 VO_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 VO_2. Consider submaximal testing in those with severe impairment.

* VO_2 (mL · min−1 · kg^{-1}) = 0.0698 × speed (m · min^{-}1) + 0.8147 × grade (%) × speed (m · min^{-1}) + 7.533 mL · min^{-1} · kg^{-1}

Table 8. Strength, Range of Motion, and Balance Testing in Individuals with Arthritis.

Test Type	Mode	Protocol Specifics	Clinical Implications
Lower extremity	Dynamometer	All testing in supine position except knee flexion and extension (while 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 in.	
	8RM (8-repetition maximum)	The maximum resistance that can be moved through the full range in a controlled manner for 8 reps (8RM, e.g., leg press, knee extension)	
Upper extremity and grip	Hydraulic dynamometer	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 90%) decreased in persons with hand arthritis
	30 s arm curl test	Total number of arm curls in 30 s with 5 lb dumbbell for women and 8 lb dumbbell for men	
	8RM	The maximum resistance that can be moved through the full range in a controlled manner for 8 reps (8RM, e.g., bench press)	Often (up to 50%) decreased in persons with arthritis
Range of motion	Goniometer	Align device fulcrum with joint fulcrum	Usually (up to 90%) decreased in persons with arthritis
Balance	Figure-eight walking	Useful in those with limited or mild impairments Track width = 150 mm Inner diameter = 1.5 m Outer diameter = 1.8 m	
	Berg balance scale	Useful in those with moderate to severe impairments Includes 14 single tasks beginning with sitting unsupported and progressing to standing on one leg	Often (up to 50%) decreased in persons with arthritis

Range of Motion Exercise

Consistent ROM exercise assists in the maintenance of the degree of joint motion required for ADL performance. Therefore, 5 to 10 minutes of active ROM exercise, performed on most or all days of the week, is suggested. Though, these isolation exercises predictably lack the intensity needed to produce functional improvements in most clients with arthritis. Hence, ROM exercises should supplement aerobic and strength training. Significant improvements in ROM are doubtful in those with severe joint destruction (e.g., limited or no joint space) and very restricted joint mobility; therefore, forceful stretching is not endorsed.

Exercise Training

Exercise training for cardiorespiratory, strength and ROM improvement is essential for individuals living with arthritis because academic evidence and clinical practice demonstrate considerable and clinically significant improvements with each of these types of exercise training. This segment discusses the evidence available from the exercise training literature that pertains to OA, RA, and AS.

Osteoarthritis

Systematic reviews and meta-analyses of exercise (aerobic or strength training or both) for OA have determined that exercise training is safe and has positive effects on pain and disability. Due to this coherent body of scientific evidence, it is not unforeseen that the up-to-date recommendations for hand, hip, and knee OA, the ACR stated strong endorsement for the inclusion of aerobic, resistance, and aquatic exercise training.

For example, Cochrane reviews of randomized controlled trials (RCTs) on land-based exercise report improvements in pain and physical function for knee and hip OA. Likewise, evidence on aquatic exercise for knee and hip OA determines that this type of exercise training has small to moderate benefits for function and QoL and a slight beneficial effect on pain. A large RCT by Ettinger and associates of exercise for knee OA compared education against exercise interventions (home-based aerobic and resistance exercise with partial supervision) for 15 months after a preliminary 3-month period of supervised exercise. In this study, aerobic or resistance exercise program participation revealed: “improvements in measures of disability, physical performance and pain” (Ettinger *et al*., 1997, p. 25). Moreover, further evidence suggested that aerobic walking and quadriceps-strengthening programs provide similar positive effects on pain and disability in OA subjects.

Besides decreasing pain and disability, exercise programs to strengthen knee extensors and hip and ankle flexors in OA clients have decreased rigidity, increased QoL and independence, and improved strength, ROM, balance, and gait. An RCT, performed by Knoop and associates (2015) credited these positive effects to increases in leg strength. This inference was also made by Runhaar *et al*., (2015), who reviewed the mechanisms underlying improved pain and function after exercise in OA. These outcomes highlight the significance of including strength development as an outcome objective of the exercise intervention. Regarding aerobic exercise, the outcome that the level of severity of knee OA is negatively allied with the level of cardiorespiratory fitness supports the notion that regular aerobic exercise should be performed by people with OA. For aerobic training, comparatively low-level exercise intensity (at 40% of heart rate reserve) may be as effective as high-intensity cycling (at 70% of heart rate reserve) in improving function, gait, and aerobic capacity and reducing pain in OA clients.

Alterations in the client's body composition and weight loss have been shown to reduce knee joint forces in OA, and evidence has intimated that the incorporation of exercise and diet produces greater improvements in pain, physical function, and mobility compared with either exercise or dietary interventions in isolation (Messer *et al*., 2000). Though exercise-induced weight loss is generally linked with aerobic training, resistance training may be more effective. As with aerobic training, resistance training increases daily energy expenditure and is an applicable adjunct to restricted energy intake for weight reduction in young adults; its effectiveness in middle-aged and senior individuals is debated. This is since sedentary ageing individuals, specifically, those with chronic disorders, are typically so physically deconditioned that they are unable to perform the physical activity of the necessary duration and intensity to significantly increase energy expenditure. In comparison, after 12 weeks of progressive resistance training (PRT), the resting metabolic rate (RMR) was increased by 15% in ageing males and females due to increased lean body mass (Campbell et al., 1994). Given that RMR accounts for 60% to 75% of daily energy expenditure, an increase of 15% is exceedingly pertinent to weight loss.

Messier and associates (2005) examined the relationship between alterations in body weight and change in knee-joint loads during ambulation in overweight and obese sedentary senior adults with symptomatic knee OA after an 18-month clinical trial of dietary intake and exercise. Subjects were allocated to one of four groups (healthy lifestyle [control]; exercise only; dietary weight loss only; and dietary weight loss and exercise). The outcomes showed that “each pound of weight loss will result in a 4-fold reduction in the load exerted on the knee per step during daily activities” (p. 2026). A review on land-based exercise for knee OA determined that supervised individual exercise programs produced greater improvements in function and pain than either group classes or home-based programs. The MOVE consensus (Roddy *et al*., 2005) determined that since group exercise and home-based exercise were similarly positive, client preference should be considered in the design of an exercise program. The MOVE group also reported that exercise adherence was an essential predictor of exercise benefit, and that adherence is helped by the maintenance of an exercise diary, telephone and mail communication, support from family and friends, and working with exercise professionals. Alternate approaches to exercise including yoga and tai chi also seem to improve pain, flexibility, and function in clients with OA.

Rheumatoid Arthritis

With RA, reducing disability, body composition changes, and risks of CVD and osteoporosis should be the main considerations in the design of applicable exercise treatments. Resistance training and aerobic conditioning are both advocated in an exercise prescription for individuals with RA and have been suggested to increase muscle strength, aerobic capacity, functional capacity, and QoL. Moreover, these modes reduce pain, fatigue, and CVD risk without having unfavourable effects on disease activity or joint damage (in some cases, decreasing disease activity).

It has been reported that physical activity and exercise are safe for RA clients, even long-term high-intensity (≥2 years) exercise interventions. Previously, a universally held belief was that high-intensity exercise would hasten joint destruction in individuals with arthritis. Primarily, details from the Rheumatoid Arthritis Patients in Training (RAPIT) study, which included 150 subjects that performed high-intensity aerobic and strength training twice weekly for 2 years, raised concerns that this exercise program was accelerating joint damage progression in large joints with extensive pre-existing damage (de Jong et al., 2003; Munneke *et al*., 2003). However, when supplementary data were composed, the authors determined that long-term intense weight-bearing exercise was safe for all joints, including large joints that were previously significantly damaged. This outcome corresponds with the findings of other studies (Hakkinen, Hakkinen, and Hannonen,1994; Hakkinen *et al*., 2001; Nordemar *et al*., 1981) and with the inference of a meta-analysis on RCTs of aerobic exercise interventions in RA (Baillet *et al*., 2010).

Whole-body dynamic exercise has been suggested to be superior to static or isometric exercise because the former produces greater body composition, muscular strength, aerobic capacity, and function and is more pertinent to ADL performance. Moreover, higher-intensity exercise constantly yields significantly better gains than low-intensity ROM exercises. For instance, Lemmey and colleagues (2009) performed an RCT in which RA subjects were randomised to perform 24 weeks of either high-intensity progressive resistance training (PRT; two sessions per week, eight exercises, three sets of eight repetitions at 80% 1RM) or low-intensity ROM exercises. Subjects in the PRT group displayed significant mean gains in muscle mass (1.5 kg), substantial reductions in total fat mass (2.3 kg) and trunk fat mass (2.5 kg), and improvements in strength (119%) and objective tests of physical function designed to reflect the ability to perform ADLs (17%-30%). This contrasted with the subjects that were randomised to ROM exercise in which they demonstrated no changes in body composition or physical function despite compliance with training. Another outcome from this intervention was that after 24 weeks of high-intensity PRT, RA subjects who had formerly been moderately disabled achieved levels of physical function that were equivalent to or better than those of age- and sex-matched healthy controls.

Non-traditional exercise modalities including dance and tai chi may also have beneficial effects on depression, anxiety, fatigue, tension, and lower body ROM in RA clients. While previous investigations of home-based exercise programs failed to determine improvements in physical function, Hakkinen and associates (1994, 2001) reported significant improvements in strength, physical function, and disease activity. The authors additionally reported that there were trends toward decreased pain and increased bone mineral density (BMD) in RA subjects performing high-intensity home-based strength training equated with subjects performing home-based ROM. These outcomes show that exercising at home can benefit RA individuals if the exercise intervention is correctly devised.

Most studies assessing the effectiveness of exercise interventions for RA subjects have applied intensity values of 50% to 85% of maximum heart rate for aerobic exercise training; for resistance training, intensities initiated at 50% to 60% of 1RM and progressed to 80%. The established attainment and safety of these interventions provide the foundation for the suggestion of moderate- to high-intensity physical activity for exercise prescription in RA. However, it has also been suggested that even very light and light workload intensities have been shown to present positive effects on disability and CVD risk in those with RA (Khoja *et al*., 2016). Therefore, individuals who are hesitant to commence moderately high-intensity exercise can be assured that benefits can still be achieved from very light to light physical activity, as is the case for the general populace.

As with any population, exercise training effects are preserved only if exercise continues, and these benefits diminish quickly after the cessation of exercise. Independent exercise training after a supervised physical activity program maintains these beneficial outcomes. In terms of exercise training responses for those with RA, alterations in body composition, strength, and aerobic capacity are comparable in magnitude to those commonly reported for healthy middle-aged or senior individuals. This comparison in response to exercise is consistent with reports that muscle features are unaltered by RA, even when evident muscle atrophy has followed.

Ankylosing Spondylitis

Exercise is strongly recommended by the ACR in their recommendations for the treatment of AS, having formerly been among the 10 important recommendations for the administration of AS developed by the ASsessment in AS (ASAS) International Working Group and the European League Against Rheumatism (EULAR) (Zochling *et al*., 2009). The scientific review suggested that various types of exercise-based intervention could affect disease outcomes in AS. Coherent with these standards are recommendations made by Millner *et al*., (2015) for individual exercise prescriptions for AS subjects, which include stretching, strengthening, cardiopulmonary, and functional fitness components.

A review by Cramp et al., (2013) reported that exercise training improves spinal mobility and physical function in those with AS, although this inference was founded on low-quality evidence. However, various studies investigating exercise effects on AS have emerged, and subsequent systematic reviews and meta-analyses provide credible evidence that exercise training considerably improves disease activity, physical function, and spinal mobility as well as chest expansion, cardiorespiratory function, pain, QoL, and depression in those with AS. These reviews also suggest that unsupervised home-based exercise interventions can be proposed to achieve these benefits, although superior results are commonly observed in supervised group exercise programs.

Walking for 50 minutes, three times per week for 12 weeks, considerably increases aerobic fitness as well as clinical outcomes (Jennings *et al*., 2015). Additionally, Nordic walking at moderate to high intensity (up to 85% maximum HR) for 30 minutes, twice a week for 12 weeks, combined with ROM exercise achieves greater improvements in aerobic capacity and peripheral pain than ROM exercise in isolation; moderate- to high-intensity (50%-80% O_{2peak} and 60%-80% 1RM) home-based combined aerobic, strengthening, and ROM training performed twice weekly for 3 months produces superior gains in aerobic capacity and function than ROM training alone; and combined aquatic exercise five times a week for 5 weeks presents greater benefits in pain management and general health than home-based ROM.

Particularly, high-intensity (up to 95% maximal HR) aerobic interval training combined with strength training, performed three times per week for 12 weeks, is safe and effective for decreasing disease activity and CVD risk (including arterial stiffness). Moreover, improvements are reported in aerobic fitness, physical function, and body composition in AS subjects with moderately to highly active disease. For example, Stavropoulos-Kalinoglou *et al*., (2013) observed these same benefits in subjects with RA in a comparable combined aerobic and strength training program. A further benefit of exercise training for those with AS is that when it is concurrent with anti-TNF therapy, there seems to be a synergistic effect, with enhanced effectiveness in improving disease activity, function, spinal mobility, pain, and fatigue compared with biologic therapy in isolation (Lubrano *et al*., 2015).

Given the objectives of maintaining posture and functional ability in this disease, where disability is largely related to spinal indices, most interventions use flexibility and strengthening interventions. Attaining functional ROM of the hip joints should be highlighted because an absence of such capability can be particularly disabling. Moreover, muscle strengthening in this populace can permit the maintenance of correct posture during spinal extension. Daily exercise is considered essential to the maintenance of spinal mobility; however, long-term outcomes have not been studied. Rheumatoid cachexia also ensues in AS, and the resultant muscle loss is linked with impaired strength and physical function. Thus, the high-intensity PRT promoted for RA clients to improve muscle mass and function is also fitting for individuals with AS.

The mode and order of exercise are essential considerations for individuals with AS. The exercise program should commence as soon as possible after a diagnosis of the disorder, starting with exercises to improve spinal and peripheral joint motion before moving to combined aerobic and strengthening interventions. High-impact physical activities should be excluded because they are demanding and stressful to the spinal and sacroiliac joints. Swimmers with restricted spinal and neck motion can use a face mask, snorkel, and fins to reduce trunk and neck rotation. Physical activities that encourage extension are favoured over actions that require flexion, and contact sports are contraindicated for those with cervical spine or peripheral joint involvement.

Summary

The existing information suggests that correctly performed exercise is safe and effective for clients with OA, RA, and AS. In a comparatively short period, client-centred exercise can be expected to increase strength, aerobic capacity, and ROM; improve body composition; augment physical function, therefore decreasing, or occasionally even eliminating, disability; decrease pain and rigidity; and improve mood and mental health wellness. However, safeguards must be taken, to ensure that the suggested exercise is suitable (i.e., safe, and tolerable), taking into consideration any causal arthritic disorders.

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