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# Exercise: An Important Component of Treatment in the Idiopathic Inflammatory Myopathies

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**Current Rheumatology Reports** 2005, 7:115-124

Current Science Inc. ISSN 1523-3774

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Resistive exercise is controversial for patients with idiopathic inflammatory myopathies. This paper provides an update on exercise and clinical assessment in these patients. The few published studies on this topic report unchanged disease activity from a variety of exercise regimens in patients in all stages of disease. Reduced disability was achieved in patients with polymyositis and dermatomyositis. In one study a slightly reduced impairment was reported in patients with inclusion body myositis, while in another study no objective reduction of disability could be detected. An increasing number of valid and reliable outcome measures are available for patients with polymyositis and dermatomyositis, but for patients with inclusion body myositis reliable and sensitive outcome measures are still needed.

## **Introduction**

Idiopathic inflammatory myopathies (IIM) are rare, chronic inflammatory muscle disorders categorized as polymyositis, dermatomyositis, and inclusion body myositis. The shared prominent clinical features in these conditions are slowly progressing muscle weakness, decreased muscle endurance, or muscle fatigue [1•]. Reduced aerobic fitness could also affect patients' activity performance and health-related quality of life [2]. High-doses of corticosteroids together with other immunosuppressive agents are generally the recommended medical treatment for patients with polymyositis or dermatomyositis [3,4]. Despite an initial favorable effect of pharmacologic treatment, most patients develop longstanding disability [5]. The reasons for the persisting disability despite aggressive immunosuppressive treatment are unknown. Potential causes of muscle

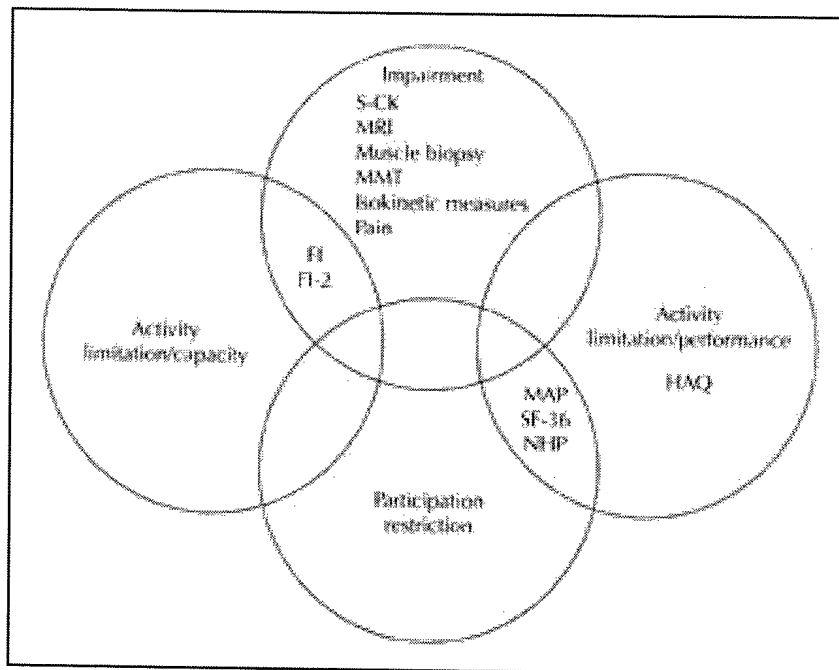
weakness include chronic muscle inflammation, use of corticosteroids, and physical inactivity. Expression of proinflammatory cytokines such as interleukin (IL)-1 on endothelial cells and expression of major histocompatibility complex (MHC) Class I on muscle fibers have been associated with muscle weakness in patients with active disease, but also in patients with chronic polymyositis or dermatomyositis without inflammatory infiltrates or raised serum levels of creatine kinase (s-CK) [6,7]. Muscle tissue hypoxia [8] and metabolic disturbances [9] have also been reported in these patients. In patients with inclusion body myositis, prominent muscle atrophy could be a major contributor to impairment. Abnormal accumulation of Alzheimer's related proteins or oxidative stress has also been suggested to play a role in muscle impairment in these patients [10•].

In healthy subjects, improved muscle function during strength training is because of neuromuscular adaptation, increased muscle fiber cross-sectional area, changes in fiber type composition, and metabolic changes [11•]. Healthy sedentary individuals usually respond to any kind of exercise and can attain approximately 40% increased muscle strength in 4 weeks, while longer training periods are needed to obtain the same effects in more trained individuals [11•]. Regular physical activity and exercise result in additional positive health outcomes such as reduced risk for cardiovascular disease and osteoporosis [12,13]. Today, there is substantial scientific evidence for safety and benefits of aerobic and strengthening exercises in patients with rheumatoid arthritis (RA). As patients with rheumatic disease are at increased risk for developing cardiovascular disease, regular physical activity is important in the management of these patients to reduce disability and enhance function [14••]. Exercise recommendations for patients with RA (Table 1) are very similar to recommendations from the American College of Sports Medicine concerning healthy individuals [15]. However, there is less evidence for the role of resistive exercise in patients with IIM. Although the studies are few and sample sizes are small, they all suggest a role for exercise in the rehabilitation of patients with inflammatory myopathies and will be discussed in this paper.

**Table 1. Evidence-based recommendations for aerobic and strengthening exercise in rheumatoid arthritis**

Aerobic exercise	Strengthening exercise
Mode—aerobic exercise, such as aquatics, walking, cycling, aerobic class participation	Mode—static or dynamic exercise against body weight or using resistance training equipment, pulley apparatus, dumbbells or elastic bands
Intensity—60% to 85% of maximum heart rate (moderate to hard)	Load—50% to 80% of a voluntary repetition maximum (moderate to hard)
Frequency—3 days a week	Frequency—2 to 3 days a week
Duration—30 to 60 minutes	Duration—not specified

(Adapted from Stenstrom et al. [14\*\*].)



**Figure 1.** Outcome measures used in patients with inflammatory myopathies listed according to the structure of The International Classification of Functioning, Disability, and Health. HAQ—Health Assessment Questionnaire; MAP—Myositis Activities Profile; MMT—manual muscle test; MRI—magnetic resonance imaging; NHP—Nottingham Health Profile; S-CK—serum levels of creatine kinase; SF-36—short form 36.

### International Classifications of Functioning, Disability, and Health

Several models for describing health and disability have been presented since Nagi [16] proposed the disablement model [17,18]. In 2001 the World Health Organization published the International Classifications of Functioning, Disability, and Health (ICF) providing a widely used unified and standardized language and framework for the description of health and health-related status [19]. The structure of these classifications offers the opportunity to measure health and health conditions on different levels. Functioning is the umbrella term encompassing all body functions and structures such as muscle function, aerobic capacity or pain, the activities we do in daily life (activity), and how we participate in society (participation). Disability on the other hand is the umbrella term for impacts of a health-related condition as impaired body functions and structures (impairment), limitations of activity (activity limitation), and restrictions of participation (participation restriction). Functioning and disability

can be divided into capacity (what you can perform in a clinical setting under standardized circumstances) and performance (what you can do in your daily life in different environments). These different levels interact with each other and also with environmental and personal factors. This structure provides a definition of health and enhances the possibility to grasp the total implications of a disease in an individual, and is used to describe clinical features, outcome measures, and exercise effects in patients with inflammatory myopathies (Fig. 1).

### Clinical Features in Idiopathic Inflammatory Myopathies

#### Impairment

The predominating clinical features in patients with polymyositis or dermatomyositis are mainly related to muscle problems but also involve the lung and heart. Reduced muscle strength, muscular endurance, and fatigue are the most common complaints [20]. One study reported

myalgia at rest in 58% of patients and exercise-induced muscle pain in 42% of a cohort of 107 patients in all stages of their disease [21]. Lung fibrosis is also a part of the clinical picture in 5% to 46% of patients [22] and reduced aerobic capacity has been reported [2]. Dermatomyositis also presents with a characteristic skin rash. Proximal muscle groups such as hip, shoulder girdle, and thighs, are involved most often but a few studies also provide data on distal muscle group involvement in a symmetrical fashion [21,23]. In most cases the muscle weakness, if untreated, progresses slowly over months and affects muscle strength and muscular endurance [24]. Patients with inclusion body myositis present with predominant muscle weakness of the quadriceps and distal muscle groups of the limbs together with a pronounced muscle atrophy [25•]. There are no studies describing aerobic capacity or impact of myalgia in this group of patients.

### Activity limitation and participation restriction

Patients with polymyositis and dermatomyositis experience difficulties in many aspects of daily living, such as grasping or holding objects, maintaining a standing position, climbing stairs, running, washing hair, transporting everyday commodities, keeping in touch with friends and relatives, and coping with the work situation [26••]. Activity limitation gradually increases regardless of age and disease course in polymyositis and dermatomyositis and corticosteroid-related complications have a significant impact [27]. Impaired muscle function, a main feature of these diseases, could be argued to be the main factor leading to limited activity and participation. Very little is known about how myalgia, fatigue, or decreased cardiovascular fitness contributes to activity limitation and participation restriction in patients with polymyositis or dermatomyositis. Chung *et al.* [28] reported 42% to 84% more activity limitation/participation restriction in all domains (energy, pain, emotion, sleep, social, and physical) of the Nottingham Health Profile (NHP) compared with healthy individuals. The myositis patients scored between 6% and 57% significantly worse for activity limitation/participation restriction in the domains energy, social, and physical than patients with RA, osteoporosis, and osteoarthritis, but 26% to 39% less than patients with RA and osteoarthritis in the domain pain [28]. Sultan *et al.* [29] found similar results for patients with polymyositis and dermatomyositis, noting significantly poorer health, assessed with the SF-36, compared with healthy individuals. The impact on activity limitation/participation restriction in patients with inclusion body myositis is unknown.

## Outcome Measures

### Impairment—safety

Historically there has been a lack of valid, sensitive, and specific outcome measures for evaluation on all levels of

the ICF. The most common surrogate marker of muscle inflammation is s-CK levels. However, the use of s-CK alone as a measure of muscle inflammation has some limits with regards to sensitivity and specificity [30]. Other more specific methods include magnetic resonance imaging (MRI), which is costly, and muscle biopsy, an invasive method [31]. The International Myositis and Clinical Studies Group, proposed a core set including patient's and physician's global assessment of disease activity on a Likert or visual analogue scale, muscle strength measured by manual muscle test (MMT), physical function measured by the Health Assessment Questionnaire (HAQ), serum levels of muscle enzymes, and assessment of extramuscular involvement as the outcome measure for disease activity in polymyositis and dermatomyositis [32]. However, future studies need to assess the sensitivity of the International Myositis and Clinical Studies Group core set.

### Impairment—beneficial effects

Most exercise studies conducted in patients with inflammatory myopathies focus on impairment with MMT as the primary measure of impairment [33•]. However, the MMT measures muscle strength and not muscle endurance and the issue of inter-rater reliability when measuring patients with low degrees of impairment are limiting factors [34]. Computerized devices to assess isometric and isokinetic muscle strength testing have been used in clinical trials with adult inflammatory myopathies, but not validated in this group of patients [35–38]. These measures are costly and require trained personnel. As patients with polymyositis or dermatomyositis experience predominately reduced muscle endurance, this dimension of impairment is equally important to measure. In 1996, the first disease specific test of muscle impairment, the Functional Index (FI) in myositis, was developed and evaluated for some aspects of validity and also intra- and inter-rater reliability [23]. FI measures the number of repetitions in 11 muscle groups and thus to some extent measures muscle endurance. In addition the FI also measures the patient's ability to transfer from side to side when lying down and also up to a sitting position as well as peak expiratory flow. This index was used in clinical practice and in a few clinical trials in Europe [39,40•,41,42]. FI has excellent reliability, but was not evaluated for content and construct validity and was found to have ceiling effects when measuring patients with low to moderate impairment. Therefore the FI was modified into the FI-2, measuring muscle endurance, which is being tested for content and construct validity and reliability (Alexanderson *et al.*; Unpublished data). After one learning occasion FI-2 had a good to excellent inter-rater and intra-rater reliability.

### Activity limitation/participation restriction

Strength and endurance in individual muscle groups may not be the most relevant or important outcome measures

from a patient perspective. Therefore outcome measures assessing activity limitation and participation restriction should be included in exercise studies (Fig. 1). The HAQ, developed for patients with RA, is the most commonly used instrument in clinical trials measuring activity limitation in patients with inflammatory myopathies. The HAQ is not validated for adult IIM patients and it is not sensitive to detect changes after a rehabilitation program in patients with RA [43]. Thus, the need exists for a disease-specific outcome measure assessing activity limitation in myositis patients. Recently, we developed a self-administered questionnaire, the Myositis Activities Profile (MAP) for adult patients with polymyositis or dermatomyositis [26••]. The MAP contains four subscales and four single items measuring activity limitation and to some extent also participation restriction, with excellent test/retest reliability. The MAP was also sensitive to detect changes after a short-term exercise period (Alexander *et al.*; Unpublished data). As the MAP was validated in a Swedish population, translation and validation to other cultures is necessary for use in other populations. The generic instruments SF-36 and NHP are multi-dimensional including some domains that correspond to activity/participation of the ICF while other domains do not. However, the SF-36 and the NHP will in this paper be defined as measures of activity limitation/participation restriction. These two measures have proved to be useful to describe disability [28•,29•] in adult polymyositis and dermatomyositis patients, the SF-36 also being sensitive to change, in patients with polymyositis or dermatomyositis [39,40•]. Progress towards a set of valid and reliable outcome measures has been achieved for patients with polymyositis or dermatomyositis. However, there is still a lack of sensitive, valid, and reliable outcome measures for patients with inclusion body myositis.

### Exercise in Patients with Idiopathic Inflammatory Myopathies

Until recently, active physical exercise was controversial in patients with inflammatory myopathies because of a fear of exercise leading to exacerbation of muscle inflammation. In the early 1990s these patients were recommended bed rest during active disease with range of motion exercises to prevent joint contractures [44]. Thus, efficacy and safety surveillance were important outcome measures in exercise studies in these patients. Furthermore, patients could respond differently to exercise depending on disease activity, disease damage, medication, and degree of disability. Caution with active exercise in the IIM has previously been based on the belief that high intensity exercise causes muscle inflammation with raised s-CK levels and inflammatory infiltrates in muscle [45,46]. In one recent randomized controlled study, the effects on histopathology and molecular expression in muscle tissue as well as on cellular components in peripheral blood

were investigated after strenuous eccentric cycling exercise in healthy individuals and compared with the effects of repeated muscle biopsies in healthy controls. Similar effects were reported on muscle tissue and in blood samples from groups of healthy individuals, suggesting that repeated muscle biopsies by itself may explain some of the previously reported signs of muscle inflammation; it is still uncertain how much muscle inflammation is caused by exercise itself [47•]. Furthermore, an acute raise of s-CK levels after physical exercise has been reported in numerous studies of healthy individuals [48•] usually returning to normal about 3 days post exercise [49]. During the past decade, 10 published studies have evaluated the safety and benefits of resistive exercise in patients with IIM, seven in polymyositis or dermatomyositis, and two in inclusion body myositis, and one study including all three (Table 2). Seven studies included patients with chronic disease, two included patients with active inflammatory disease, and one study included patients with chronic or active disease.

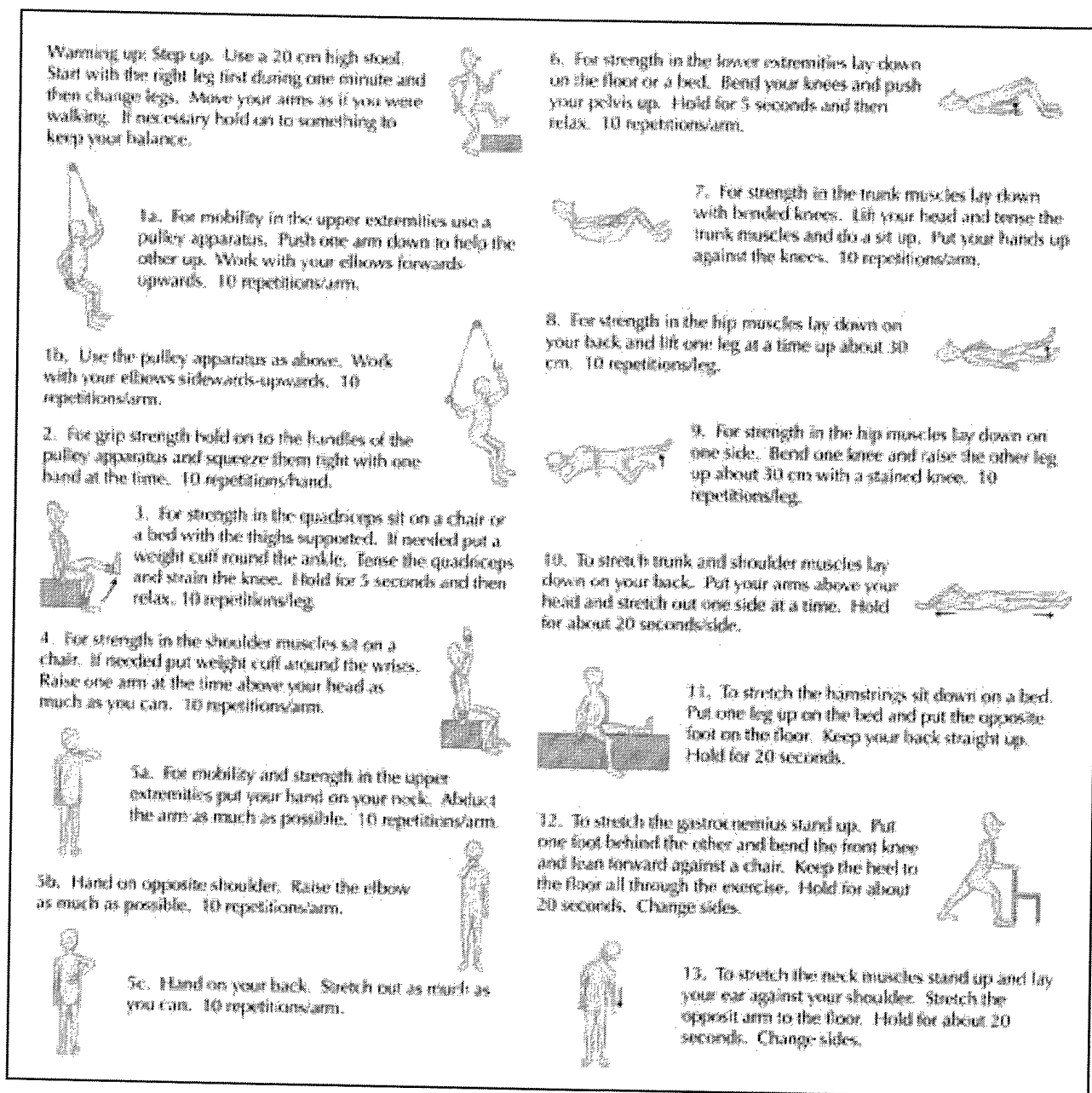
### Exercise in Polymyositis and Dermatomyositis Muscular training

The first reports on exercise in polymyositis or dermatomyositis were published in 1993. These two reports included a total of six patients where the effects of short-term exercise periods were tested. Hicks *et al.* [35] reported improved muscle strength in one patient with polymyositis after a 6-week isometric strength-training program in a Cybex device. This patient performed isometric exercise on 60% of isometric maximum in the right upper arm and quadriceps three times a week using the left arm and leg as controls. The other case report from 1993 included five patients with active polymyositis or dermatomyositis participating in an alternating 2-week program with periods of sub-maximal muscular training followed-up by periods of passive range of motion exercise. Safety and benefits were analyzed individually for each patient. Increases in peak isometric strength and reduction of activity limitation during periods of active exercise varied between 22% and 40% and between 4% and 42%, respectively [36]. Escalante *et al.* [36] also reported a mean 7.7% increase of s-CK levels as an acute response after 30 minutes of exercise, falling to pre-exercise values after about 5 hours. However, both studies reported unchanged s-CK levels after completed exercise periods. As there is a discrepancy between CK-levels and degree of inflammatory infiltrates and muscle impairment [30,41] Alexander *et al.* [39] used a more careful approach to evaluate muscle inflammation. The researchers combined analysis from muscle biopsies taken from the vastus lateralis, MRI scans of the thighs, and s-CK levels to evaluate muscle inflammation after a 12-week home exercise program. In this open study, 10 patients with stable, chronic polymyositis or dermatomyositis with low inflammatory disease activ-

**Table 2. Published studies evaluating safety and benefits of different exercise regimens in patients with idiopathic inflammatory myopathies**

Study	Study design	Patients, n	Diagnosis	Disease activity	Training duration	Load/intensity, % of max	Results safety	Outcome benefits	Results benefits
<b>Muscular Training</b>									
Hicks <i>et al.</i> [35]	Case report; controlled	1	PM	Chronic	6 weeks	60	0	Isometric peak torque	+
Escalante <i>et al.</i> [36]	Open study	5	PM/DM	Active	8 weeks	NR	0	Isometric peak torque	
Spector <i>et al.</i> [52]	Open study	5	IBM	Chronic	12 weeks	5 VRM	0	Isometric peak torque 3 VRM	0
Alexanderson <i>et al.</i> [39]	Open study	10	PM/DM	Chronic	12 weeks	NR	0	Muscle endurance (FI)	+
Alexanderson <i>et al.</i> [40]	Open study	11	PM/DM	Active	12 weeks	NR	0	SF-36 Muscle endurance (FI)	+
Heikkilä <i>et al.</i> [42]	Open study	22	PM/DM/IBM	Chronic	3 weeks	NR	0	Muscle endurance (FI)	+
Varju <i>et al.</i> [37]	Open study	19	PM/DM	Chronic/ active	3 weeks	NR	0	Isometric peak torque	+
Arnardottir <i>et al.</i> [53]	Open study	7	IBM	Chronic	12 weeks	NR	0	HAQ Isokinetic peak torque Muscle endurance	+
<b>Aerobic Exercise</b>									
Wiesinger <i>et al.</i> [51]	Randomized controlled	14	PM/DM	Chronic	6 weeks	70	0	VO2 max	+
Wiesinger <i>et al.</i> [38]	Controlled	13	PM/DM	Chronic	6 weeks	70	0	Isometric peak torque HAQ VO2 max Isometric peak torque HAQ	+

0—unchanged; +—beneficial effect.  
 DM—dermatomyositis; FI—functional index; IBM—inclusion body myositis; HAQ—Health Assessment Questionnaire; PM—polymyositis; SF-36—short form 36; VRM—voluntary repetition maximum.



**Figure 2.** The resistive home exercise program used in patients with idiopathic inflammatory myopathies. The patients performed 10 repetitions in one set per muscle group. (Adapted from Alexanderson *et al.* [39, 40•] and Arnardottir *et al.* [53•].)

ity performed a resistive 20-minute home exercise program in addition to 15-minute walks 5 days a week during 12 weeks (Fig. 2). They had a median age of 53 years (range 27–60) and median disease duration of 4 years (range 2–10). All had unchanged disease activity and medication for at least 3 months prior to exercise. There were no signs of increased muscle inflammation according to analysis of muscle biopsies, MRI, or s-CK levels. The group improved significantly by a median of 15% to 17% reduced impairment, assessed by the FI, and median 23% reduced activity limitation/participation restriction (SF-36; Table 2) [39]. This home exercise program was also evaluated

in 11 patients with recent onset active polymyositis and dermatomyositis [40•]. Their median age was 47 years (range 23–80) and their median duration since diagnosis was 2 months (range 1–3). Ten patients had signs of active muscle inflammation in muscle biopsies, MRI, or had elevated s-CK levels before starting the exercise program. After 12 weeks of exercise there were no signs of increased inflammation and the group improved significantly with a median of 12% to 16% reduced impairment and a median of 25% to 45% reduced activity limitation/participation restriction (Table 2) [40•]. Heikkilä *et al.* [42] investigated safety and benefits from a 3-week exercise period during

a patient education course. Twenty-two patients, 15 with polymyositis, four with dermatomyositis, and three with inclusion body myositis were included. Their mean age was 54.5 years (range 28–81) and their mean disease duration was 6.4 years (range 1–27). In a self-administrated questionnaire, the patients reported to have participated in a variety of exercise programs. Three patients performed training of functional tasks such as climbing stairs, transfers from lying down, to sitting and standing three times a week, while two patients performed strengthening exercises of the extremities 10 to 60 minutes twice a week. Five patients performed physical therapist-supervised strengthening exercises at a gym for 20 to 60 minutes two to six times a week. Ten patients performed group exercise in a pool or at a gym, three patients underwent pain relieving treatment, and seven patients performed outdoor walking every day. The group improved significantly with a mean 4.1% reduced impairment assessed by the FI, while s-CK levels and pain remained unchanged [42]. Another open study evaluated a 3-week sub-maximal muscular endurance program together with spa treatments in nine patients with chronic poly/dermatomyositis and 10 patients with active poly/dermatomyositis [37]. Spa treatment included warm mud, gentle massage, and relaxing terminal warm baths before exercising. The physical therapist-supervised training included assisted range of motion exercises followed-up by isotonic muscle training of the trunk, neck, dorsal muscles, and of the extremities at 65% to 70% of their maximal number of repetitions. Each muscle group was exercised in two sets with a 3-minute rest in-between. Both patient groups improved significantly in isometric muscle strength assessed by a Cybex device with a mean of 37% and 46% in the active and chronic group respectively. Improvement in fatigue and aerobic fitness was also reported while s-CK levels remained unchanged in both groups [37]. We performed an intensive 7-week muscular training program in patients with chronic, stable polymyositis or dermatomyositis. The program included resistive exercise in five muscle groups on 10 voluntary repetition maximum (VRM) performed in three sets. This resulted in significantly reduced impairment including improved muscle strength (10–15 VRM) and endurance (FI-2), without signs of increased muscle inflammation measured by physician's global assessment of disease activity, muscle biopsies, or s-CK levels (Alexanderson *et al.*; Unpublished data). A double-blind, randomized, controlled trial reported a favorable effect of creatine supplements in combination with the resistive home exercise program compared with exercise alone in patients with chronic polymyositis and dermatomyositis [50].

#### Aerobic exercise

Wiesinger *et al.* [51] performed the only controlled trial investigating the effects of exercise in patients with chronic polymyositis or dermatomyositis. Seven patients performed a 60-minute mixed program including a 3 to 5

minute warm-up followed-up by aerobic cycling and step-up exercise at 70% of maximal heart rate. Each training session ended with 5 minutes of cool-down and stretch. The patients exercised twice weekly during the first 2 weeks and then three times a week during the remaining 4 weeks. The control group, including seven patients, remained sedentary throughout the 6-week trial. All patients underwent maximal exercise testing using a symptom-limited, incremental cycle ergometer protocol that was well tolerated. The exercise group improved significantly with reduced impairment and activity limitation compared with the control group while s-CK levels remained unchanged in both groups [51]. Four patients each from the training group and the control group in the previously described study were then included to perform a similar program during 6 months. Five nontraining patients regularly visiting the clinic were included as a comparison group. Patients exercised twice a week during the first 2 weeks, three times a week during the following 4 weeks and once a week during the remaining 18 weeks. All patients were also encouraged to perform stationary cycling three times a week at home during this period. Significant improvements were achieved with reduced impairment, including a mean of 26% improved isometric muscle strength and 28% improved maximal oxygen uptake. A significant 10% reduction of activity limitation was also reported. The comparison group did not improve in any of these variables and s-CK levels remained unchanged in all patients [38].

#### Exercise in Inclusion Body Myositis Muscular training

Two open studies investigating exercise effects in inclusion body myositis alone included altogether 12 patients. Spector *et al.* [52] evaluated a 12-week muscular training program in four muscle groups, knee extensors and flexors, right side elbow flexors, and wrist flexors. Five patients with a mean age of 66 years (range 50–74) and with a steady progressive decline over a mean of 6.2 years (range 4–9) were included. Three sets with a 90-second rest in-between were performed on 5 VRM in each muscle group. The group improved significantly with means of 25% to 120% increased muscle strength assessed by 3 VRM, but no statistically significant improvement was achieved in isometric muscle strength or activity limitation. There were no signs of increased muscle inflammation as assessed by analyses of open muscle biopsies or by s-CK levels. Whole muscle cross-sectional area also remained unchanged by MRI [52]. The above described 12-week home exercise program, that was developed for patients with polymyositis or dermatomyositis, was also employed in an open trial including seven patients with inclusion body myositis with a mean age of 60.4 years (range 45–78) and a mean duration since diagnosis of 3 years (range 2–6) [53•]. These patients performed the home exercise program and

additional 20-minute walks or stationary cycling 5 days a week during 12 weeks. No significant improvement in impairment or activity limitation was achieved, however, several patients, as also reported by Spector *et al.* [52] reported subjectively reduced activity limitation. No signs of increased muscle inflammation could be detected by muscle biopsies or s-CK levels [53•].

### Possible Mechanisms Behind Exercise Improvements

Very little is known about the possible mechanisms behind exercise improvements in patients with IIM as few studies have addressed this question in such patients. Improved neuromuscular adaptation is the earliest response to exercise [11•]. As most studies are looking at short-term exercise effects over 3 to 6 weeks, it is most likely that neuromuscular adaptation played an important role in early benefits in IIM. In the exercise study of patients with inclusion body myositis where the clinical effects were limited, there was no change in muscle size as estimated by repeated MRI investigations [52]. In our own study of patients with chronic polymyositis and dermatomyositis [39], we determined an increased percentage of the slow twitch, oxygen dependent type I fibers in muscle biopsies after 12 weeks of home exercise together with a significant increase of mean fiber area and improved muscle endurance [54]. Further investigations are needed to explore other mechanisms for exercise improvements, such as whether exercise might contribute to reduced hypoxia or to increase capillary density and fiber type composition and fiber area. Reduced levels of adenotriphosphate and phosphocreatine in muscle together with a reduced utilization of adenotriphosphate and phosphocreatine during exercise and recovery [9] could support the use of creatine supplementation in addition to exercise.

### Conclusions

Although published studies evaluating exercise therapy in patients with inflammatory myopathies are few and include small sample sizes they still support the notion that exercise can be employed without risking an increase in muscle inflammation. Furthermore, reductions of impairment and of activity limitation and participation restriction can be achieved with exercise in patients with polymyositis and dermatomyositis. Data on exercise benefits in patients with inclusion body myositis are contradictory; however, intensive muscular training might reduce impairment in these patients. There is not enough evidence to give general recommendations on intensity/load or frequency for exercise in IIM. However, we recommend that supervised continuous aquatic or land-based exercise adapted to disease activity and disability should be included in the rehabilitation of patients with chronic

as well as active IIM. Furthermore, the general recommendation of 30 minutes accumulated physical activity on most days of the week [55] should also be employed in patients with IIM. Further research is needed in the form of multicenter randomized controlled trials to establish the efficacy of different exercise regimens, particularly in patients with recent onset polymyositis or dermatomyositis and those with inclusion body myositis. It is important to perform regular follow-up and to use valid and reliable assessments encompassing all levels of the ICF from a patient perspective in future clinical trials and in clinical practice. For patients with inclusion body myositis there is still a major need for valid and sensitive outcome measures.

### Acknowledgments

Grant support was received from the Swedish Rheumatism Association, Vardal Foundation, The Swedish Research Council no 2001-74-X14045. To Björn Lundberg for drawing the illustrations to the exercise program.

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