Aspects of work and health in women with fibromyalgia

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"The real voyage of discovery consists not in seeking
new landscapes, but in having new eyes."

Marcel Proust

ABSTRACT

Fibromyalgia (FM) is characterized by persistent widespread pain, increased pain sensitivity and tenderness. FM is also associated with fatigue, psychological distress, impaired physical capacity, activity limitations, and impacts the ability to work. Work ability is complex and influenced by individual aspects, such as aspects of health, as well as work related aspects and environmental aspects.

The overall aim of this thesis was to gain deeper knowledge on aspects related to work and health in women with FM.

Methods: A cross-sectional study investigated differences in aspects of health between working and nonworking women with FM (study I). A qualitative focus group study explored the experiences of promoting factors for sustainable work in women with FM (study II). A controlled cross-sectional study compared perceived exertion at work in women with FM and in healthy women, and investigated explanatory factors for perceived exertion at work in women with FM (study III). A randomized controlled trial evaluated the effects of a person-centered progressive program of resistance exercise in women with FM (study IV).

Results: Working women with FM reported better health than nonworking women with FM in terms of pain, fatigue, stiffness, depression, disease specific health status and physical aspects of quality of life. Pain was found to be the only independent explanatory factor for work, meaning that reporting less pain increased the probability of being in work. The meaning of work and individual strategies, namely strategies for handling symptoms, the work day, and long term work life were found to be important individual promoters for sustainable work while a favorable work environment and social support outside work were found to be important environmental promoters for sustainable work. The promoting factors for sustainable work mainly involved the identification and use of internal and external resources to manage the risk of physical and mental overload. Perceived exertion at work was elevated in the women with FM compared to the healthy women. Perceived exertion at work in the women with FM was explained by their physical workload and physical activity level at work, as anticipated, but also by their hand-grip force, anxiety, and fear avoidance work beliefs. Person-centered progressive resistance exercise improved physical capacity, health status, current pain, pain management, and participation in activities of daily life. The low rates of reported adverse effects and very few

drop-outs due to increased pain indicate that this exercise program is feasible for women with FM.

In conclusion: Working women with FM reported better health than nonworking women with FM. Promoting factors for work involved the identification and use of internal and external resources to manage the risk of physical and mental overload, which was a careful balancing act performed by the women. Working women with FM perceived an elevated exertion at work, and for the women with a medium heavy physical workload, hand-grip force was an important explanatory factor for perceived exertion at work. Person-centered progressive resistance exercise can be recommended for improvement in muscle function, health status, current pain, pain management, and participation in activities of daily life.

Keywords: fibromyalgia, chronic pain, pain, tender points, work, work ability, health, women, physical, physical capacity, physical workload, resistance exercise, focus groups

SAMMANFATTNING PÅ SVENSKA

Aspekter av arbete och hälsa hos kvinnor med fibromyalgi

Fibromyalgi (FM) karaktäriseras av långvarig utbredd smärta och många upplever även trötthet, oro, nedstämdhet, har nedsatt fysisk kapacitet, aktivitetsbegränsningar och svårigheter att klara sitt förvärvsarbete. Andelen kvinnor med FM som är i arbete varierar mellan 34 och 77 procent, enligt internationella rapporter. Arbetsförmåga påverkas av individuella aspekter, såsom hälsoaspekter, så väl som av arbetsrelaterade aspekter och faktorer i omgivningen. Det övergripande syftet med denna avhandling var att nå ökad kunskap om aspekter relaterade till arbete och hälsa hos kvinnor med FM.

Avhandlingen består av fyra delarbeten. Den första studien var en tvärsnittsstudie vilken avsåg att undersöka skillnader i hälsorelaterade aspekter mellan arbetande och icke arbetande kvinnor med FM. Den andra studien var en kvalitativ intervjustudie med syfte att erhålla djupare kunskaper om upplevelser av främjande faktorer för att kunna fortsätta arbeta hos arbetande kvinnor med FM. Den tredje studien var en kontrollerad tvärsnittsstudie som avsåg att jämföra upplevd fysisk ansträngning i arbetet mellan kvinnor med FM och friska kvinnor samt att undersöka förklarande faktorer för den upplevda ansträngningen. Den fjärde studien var en randomiserad, kontrollerad behandlingsstudie vilken avsåg att utvärdera effekterna av ett personcentrerat styrketräningsprogram med successivt stegrad belastning.

Resultaten visade att arbetande kvinnor med FM rapporterade bättre hälsa än icke arbetande kvinnor med FM gällande smärta, trötthet, stelhet, nedstämdhet, hälsostatus, och fysiska aspekter av livskvalitet. Smärta visade sig vara den enda självständigt förklarande faktorn för arbete, vilket innebär att lägre smärta ökade sannolikheten för att vara i arbete (studie I). Den kvalitativa intervjustudien visade att arbetets betydelse och individuella strategier, det vill säga strategier för att hantera sina symtom, sin arbetsdag och sitt arbetsliv på lång sikt, var främjande faktorer för att kunna fortsätta arbeta, på individnivå. En fördelaktig arbetsmiljö och socialt stöd utanför arbetet var främjande omgivningsfaktorer för att kunna fortsätta arbeta. Gemensamt för de flesta främjande faktorer för arbete var att de innebar att identifiera och använda sig av såväl inre som yttre resurser för att hantera risken för fysisk och mental överbelastning, vilket var en svår balansgång för kvinnorna som till viss del påverkades av deras specifika

arbetssituation (studie II). Jämförelsen av den upplevda fysiska ansträngningen i arbetet visade en större upplevd ansträngning hos kvinnorna med FM jämfört med hos de friska kvinnorna. Den fysiska arbetsbelastningen och den fysiska aktivitetsnivån i arbetet visade starkast samband med den upplevda ansträngningen i arbetet hos kvinnorna med FM såväl som hos de friska kvinnorna. Vidare visade sig den fysiska aktivitetsnivån i arbetet bäst förklara den upplevda ansträngning i arbetet för hela gruppen kvinnor med FM samt för de kvinnor med FM som hade ett fysiskt lätt arbete. För gruppen kvinnor med FM som hade en medeltung fysisk arbetsbelastning visade sig däremot handstyrka och oro bäst förklara den upplevda ansträngningen i arbetet (studie III). Det personcentrerade styrketräningsprogrammet visade sig förbättra muskelfunktion, hälsostatus, smärtintensitet, smärthantering och deltagande i vardagsaktiviteter. Enstaka rapporter från deltagarna om negativa effekter och mycket få avhopp relaterat till ökad smärta under studiens gång tyder på att detta träningsprogram fungerar bra för kvinnor med FM (studie IV).

Sammanfattningsvis rapporterade arbetande kvinnor med FM bättre hälsa än icke arbetande kvinnor med FM. Vidare verkade arbetande kvinnor med FM ha utvecklat välfungerande strategier för att förbättra sin förmåga att arbeta. Såväl den fysiska som den psykosociala arbetsmiljön verkade vara viktig för kvinnor med FM för att kunna fortsätta arbeta, där ledningen, arbetskamraterna och organisationen till stor del skapade förutsättningarna för en hållbar arbetssituation. Arbetande kvinnor med FM upplevde en förhöjd ansträngningsgrad i arbetet jämfört med friska kvinnor. För kvinnor med FM med en medeltung fysisk arbetsbelastning var handstyrkan viktig för den upplevda ansträngningen. Personcentrerad, successivt stegrad styrketräning kan rekommenderas för att förbättra muskelstyrka, hälsostatus, smärtintensitet, smärthantering och delaktighet i vardagsaktiviteter hos kvinnor med FM. För att främja arbetsförmåga hos kvinnor med FM föreslås anpassning av arbetssituationen, t.ex. arbetsuppgifter och arbetstider, för att bättre överensstämma med individens förmåga samt stöd från hälso- och sjukvården såväl som från arbetsgivaren i utvecklandet av strategier för att hantera arbetets krav i relation till sin kapacitet. Dessutom rekommenderas styrketräning som ett behandlingsalternativ vid FM, speciellt för kvinnor med FM som har ett fysiskt belastande arbete.

LIST OF PAPERS

This thesis is based on the following studies, referred to in the text by their Roman numerals.

I. Palstam A, Bjersing J, Mannerkorpi K. **Which aspects of health differ between working and nonworking women with fibromyalgia? A cross-sectional study of work status and health**. BMC Public Health. 2012; 12: 1076.

II. Palstam A, Gard G, Mannerkorpi K. **Factors promoting sustainable work in women with fibromyalgia.** Disability and Rehabilitation. 2013; 35: 1622-9.

III. Palstam A, Larsson A, Bjersing J, Löfgren M, Ernberg M, Bileviciute-Ljungar I, Ghafouri B, Sjörs A, Larsson B, Gerdle B, Kosek E, Mannerkorpi K. **Perceived exertion at work in women with fibromyalgia – explanatory factors and comparison with healthy women.** Journal of Rehabilitation Medicine. 2014; 46:773-80.

IV. Larsson A*, Palstam A*, Löfgren M, Ernberg M, Bjersing B, Bileviciute-Ljungar I, Gerdle B, Kosek K, Mannerkorpi K. **Resistance exercise improves muscle function, health status and pain intensity in fibromyalgia – a randomized controlled trial.** *Submitted.*
* These authors contributed equally

CONTENTS

ABBREVIATIONS

ACR	American College of Rheumatology
EULAR	European League Against Rheumatism
FM	Fibromyalgia
IASP	International Association for the Study of Pain
ICD	International Classification of Diseases
ICF	International Classification of Function, Disability, and Health
OMERACT	Outcome Measures in Rheumatology Clinical Trials
RCT	Randomized Controlled Trial
VAS	Visual Analogue Scale
WCPT	World Confederation for Physical Therapy
WHO	World Health Organization

DEFINITIONS

Activity limitations	Difficulties an individual might have in executing activities *(WHO, 2001)*. In this thesis, the Fibromyalgia Impact Questionnaire subscale of physical function (FIQ physical function) is referred to as a measure of activity limitations in daily life *(Bennet, 2005)*.
Body functions	The physiological functions of body systems (including psychological functions) *(WHO, 2001)*.
Current pain	In this thesis, the VAS for current pain intensity is referred to as current pain.
Chronic pain	Pain persisting for more than the normal time it takes for an injury to heal, commonly defined as more than 3 months *(IASP, 1994)*.
Disability	The umbrella term for impairments, activity limitations, and participation restrictions *(WHO, 2001)*.
Exercise	A type of physical activity consisting of planned, structured, and repetitive bodily movement to improve or maintain components of physical fitness *(Caspersen et al., 1985)*.
Health	A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity *(WHO, 1948)*.
Health status	In this thesis, The Fibromyalgia Impact Questionnaire total score (FIQ total) is referred to as a measure of health status *(Bennet 2005)*.
Muscle strength	The amount of external force that a muscle can exert *(Caspersen et al., 1985)*.
Pain	An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage *(IASP, 1994)*. In the studies of this thesis, FIQ pain is referred to as a measure of pain *(Bennet, 2005)*.

Perceived exertion	In this thesis, perceived exertion at work refers to a numeric rating scale that ranges from 0 to 14, where a higher score represents a higher degree of physical exertion at work *(Balogh et al., 2001)*. It is a modified form of the Borg scale for ratings of perceived exertion (RPE) *(Borg et al., 1970)*.
Person-centered	A person-centered approach is based on the assumption that a person is a physical, psychological, social and existential whole. It builds on a partnership between patient and care-provider including shared information, deliberation, and decision-making *(Ekman et al., 2011)*.
Physical activity	Any bodily movement produced by the contraction of skeletal muscles that results in a substantial increase over resting energy expenditure *(Caspersen et al., 1985)*.
Physical capacity	The capacity of an individual refers to the ability to execute a task or an action in a given domain at a given moment *(WHO, 2001)*. In this thesis, physical capacity was expressed by the following measures: 6MWT, hand-grip force, isometric elbow-flexion force, and isometric knee-extension force.
Repetition maximum	The heaviest resistance that can be used for one complete repetition of an exercise *(Fleck et al., 2014)*.
Resistance exercise	A type of exercise that requires the body's musculature to move (or attempt to move) against an opposing force, usually presented by some kind of equipment *(Fleck et al., 2014)*.
Self-efficacy	A person's beliefs in their capabilities to produce desired effects by their actions *(Bandura, 1994)*.
Work	In this thesis, work refers to employed work.
Work status	In this thesis, work status refers to percent of fulltime employed work. The data concerning work is self-reported by the participants. Nonworking refers to being on fulltime sick leave.

INTRODUCTION

Musculoskeletal disorders are one of the most common reasons for sick leave in Sweden (1, 2) and entails large costs for the individual as well as for society, predominately due to long-term sickness absence (3-5). Chronic musculoskeletal pain is reported by approximately 20% of the general population (6-8), and the corresponding number for chronic widespread pain is approximately 10% (6, 8). Chronic musculoskeletal pain has negative impact on quality of life and the ability to work (7, 9).

Women with fibromyalgia (FM) are challenged by chronic pain, fatigue, psychological distress (10), and impaired physical capacity (11-13). Their participation in activities of daily life (14, 15), including the ability to work (16, 17), is often reduced. Work ability is complex, and influenced by several individual aspects, such as aspects of health, as well as aspects related to work and the environment (18). The studies in this thesis investigate differences in aspects of health between working and nonworking women with FM, and describe promoting factors for work experienced by women with FM. Also, differences in perceived exertion at work between women with FM and healthy women are investigated, and explanatory factors for perceived exertion at work are studied. Effects of a person-centered progressive resistance exercise program on muscle function, health status, pain, and other aspects related to health and participation in daily life in women with FM are also studied.

Fibromyalgia

FM is characterized by persistent widespread pain, increased pain sensitivity and tenderness (10) and is associated with impaired physical capacity (11-13), activity limitations (14, 15), fatigue, and distress (10, 19). Fibromyalgia (FM) affects approximately 1-3 % of the general population and is more prevalent in older ages (20, 21) and is six times more common in women than in men (19). The prevalence of FM is quite similar in most parts of the world (19, 22-25). The prognosis of FM is not well studied, however, long-term follow-up of patients with FM indicate that fluctuations in symptoms are common over time but that complete remission is rare (26, 27).

Muscle pains have been described for centuries under various terminology (28). In the early 20th century the term *fibrositis* was first mentioned (29), and was described in 1977 in scientific literature as a generalized pain syndrome with

multiple tender points (30). The term fibromyalgia was coined in 1981 when the first controlled study of clinical characteristics was published and criteria for the classification of fibromyalgia were proposed (31). These criteria were used until the study of multicenter ACR criteria for classification of fibromyalgia was published in 1990 (10). This publication provided a uniform classification of FM for research and clinical practice all over the world (28).

Classification criteria

In 1990, the American College of Rheumatology (ACR) defined criteria for the classification of fibromyalgia (FM)(10) as described above. These criteria form the International Classification of Diseases (ICD-10) code for FM (M79.7) which is used in the Swedish Health Care System (32). The ACR 1990 criteria for FM were used as inclusion criteria for the study populations in this thesis.

The ACR 1990 criteria for FM include a history of widespread pain for at least three months, defined as pain in the left and right side of the body, above and below the waist, and the presence of axial skeletal pain (10), and pain on manual palpation in at least 11 of 18 predefined tender points (10), Figure 1.

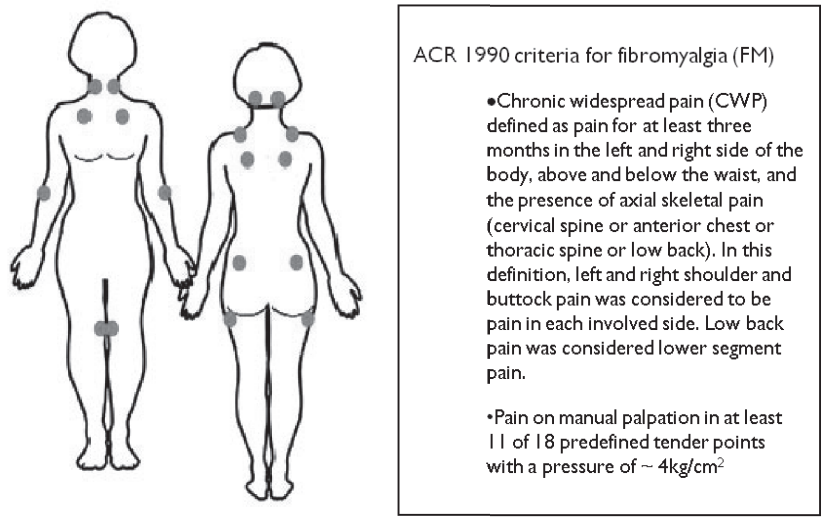

Figure 1. *Locations of the tender points included in the American College of Rheumatology 1990 criteria for fibromyalgia. © Karen Lee Richards. Reprint courtesy of Karen Lee Richards.*

The diagnostic criteria for FM are an ongoing topic for discussion. Since 2010, three alternative sets of criteria have been suggested with the stated purpose of facilitating use in primary care settings and for use in epidemiological research (33-35).

Etiology

Pain is defined by the International Association of the Study of Pain (IASP) as *an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage* (36), implying that pain is a subjective experience. Chronic pain is defined as pain persisting for more than the normal time it takes for an injury to heal, commonly defined as more than 3 months (36) and the experience of chronic pain is influenced by biological, psychological, and social aspects (37). The pathogenesis of FM is not entirely understood but FM is described as the upper end of a continuum of chronic pain and tenderness (38) and regional pain conditions are risk factors for developing FM (39). Environmental exposure to factors such as certain types of infections, trauma, stress (39), or a heavy physical workload (40) may play a role in the development and maintenance of pain in FM and a familial component has also been suggested (41). Approximately 10-30% of patients with rheumatic disorders also meet criteria for FM and it has been suggested that rheumatic disease may contribute in triggering the development of FM (42).

Tenderness in FM, also known as hyperalgesia and allodynia, is related to an increased responsiveness to peripheral stimuli, which can be either painful (noxious) or non-painful (non-noxious) (43). A combination of central sensitization and peripheral sensitization are suggested to explain pain and the hyper responsiveness to peripheral stimuli in FM (43, 44). Central sensitization refers to an amplification of pain due to abnormalities in the pain processing mechanisms of the central nervous system (44-47). Peripheral sensitization due to aberrations in nociceptor signalling has been shown to be essential for the maintenance of pain in FM (48).

Muscle function, physical capacity and activity limitations

The muscle function in FM has been shown to be altered displaying structural changes in muscle fibres (49), altered neuromuscular control mechanisms (50), impaired blood circulation (51), and disturbances in regulation of growth and energy metabolism (52). Exercise-induced pain is also common in FM (53) making it difficult for patients to engage in high intensity exercise (54). The physical capacity in women with FM, in terms of muscle strength (11-13, 55), endurance (13, 55), balance and agility (11), has been shown to be impaired. One contributing factor for reduced physical capacity in FM may be deconditioning due to pain and fatigue often leading to a decreased level of physical activity (56). Women with FM also report limitations in performing activities of daily life (15, 57) including the ability to work (9, 58-60).

Work ability

The concept of work ability has no absolute definition and many ways of interpretation (61). It is considered to be relational and is described as a balance between personal resources and work demands (18, 62). Work ability is multidimensional and includes physical, mental, and social dimensions (63). It is also influenced by environmental factors and changes over time (62, 64, 65). The multidimensional concept of work ability is illustrated by Ilmarinen in the Work Ability House model, Figure 2.

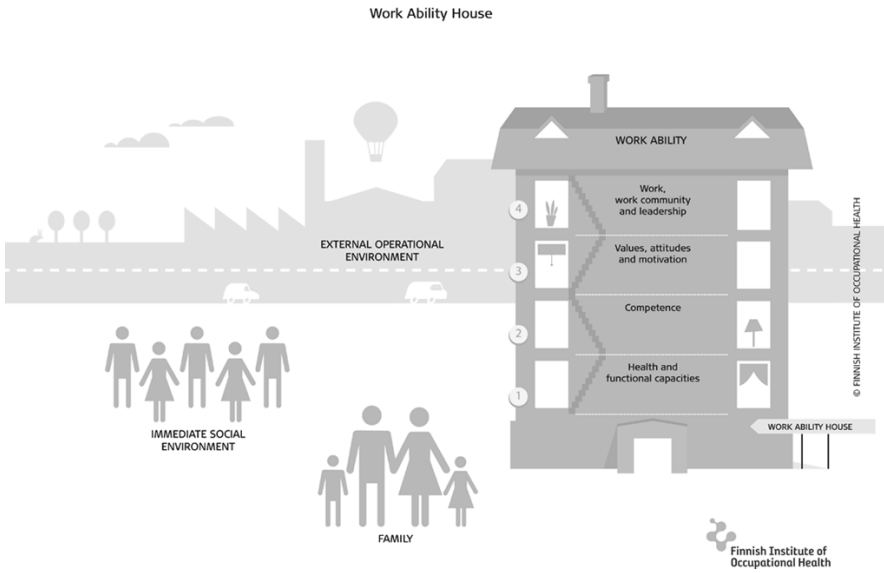

Figure 2. *Work ability house model. © Finnish Institute of Occupational Health. 2014.*

In Sweden, the legal concept of work ability is closely related to the Swedish sickness insurance with a distinct connection to disease, based on diagnosis according to ICD-10 (32), function, and activity (66). Disability benefits in Sweden are approved when a disease impairs a person's ability to work by at least 25% (67).

Work in persons with fibromyalgia

The degree of employment in FM varies geographically, with a range from 34% to 77% in different studies, the wide range relating to differences in the social benefit systems and labor markets of different countries as well as in varying definitions of work (16). Interview studies have indicated that work ability in women with fibromyalgia is complex, and influenced by symptoms such as pain, fatigue, stress, and impaired physical capacity (14, 17, 68, 69) as well as by

physical and psychosocial work related aspects and aspects related to the life situation and social support (14, 17, 68-70). The findings are supported by results of surveys conducted in large populations (16, 58, 71).

Health

The WHO definition of health is *a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*. This definition recognizes health as a multidimensional biological, psychological, and social experience (72).

The International Classification of Functioning, Disability and Health (ICF) provides a framework for classifying and measuring domains of health interacting in several ways, Figure 3. It is based on the WHO definition of health (73). The ICF organizes information as Function and disability and Contextual factors. Within Functioning and disability, *body functions and structures,* and *activity and participation* are included. *Body functions* are the physiological functions of body systems, and *body structures* are the anatomical parts. *Activity* and *participation* cover domains of functioning from both an individual and a societal perspective. The Contextual factors include *personal* and *environmental factors* (73). The ICF focuses on the impact of the individual functioning and acknowledges the importance of the context of the individual (73).

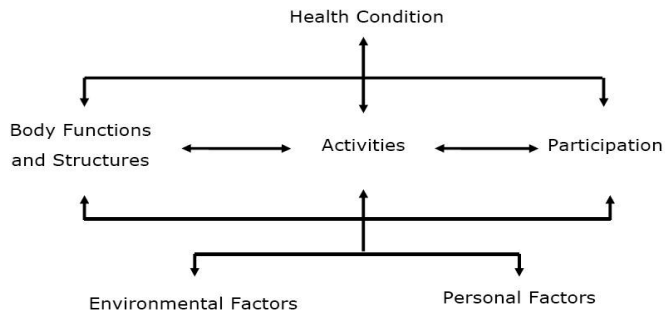

Figure 3. *Interaction between the components in the International Classification of Function, Disability, and Health (ICF). Geneva: WHO; 2001.*

Measuring health in persons with fibromyalgia

ICF Core Sets have been developed for a number of chronic health conditions, including chronic widespread pain and fibromyalgia (74, 75). These core sets include a selection of ICF categories out of the whole classification that reflect the health experience of persons with FM (75). Outcome measures that are

commonly used in patients with fibromyalgia have been analyzed according to their contents and compared with the ICF, linking items in outcome measures to specific ICF categories (76). This content comparison is the basis for the categorization of self-reported questionnaires according to the ICF that is presented in study I in this thesis. To build a common approach as to which outcomes to measure in clinical trials of the rheumatic diseases, the Outcome Measures in Rheumatology Clinical Trials (OMERACT) has, guided by the ICF, defined core sets for outcomes relevant for different rheumatic diseases comprising a minimum number of domains and instruments that describe outcomes in clinical trials and clinical practice (77). For FM, a multidimensional symptom core set has been proposed by the OMERACT for evaluation in clinical trials including pain, tenderness, fatigue, patient global, multidimensional function, and sleep disturbance (78).

Physical workload

Exposure to high physical workloads has been shown to be a risk factor for work disability in the general working population (79, 80) as well as in musculoskeletal pain conditions (81, 82). Further, a physical workload that exceeds the worker's physical capacity has been reported to be a risk factor for long-term sick leave in the general working population (83, 84) and a prognostic factor for longer sickness absence in musculoskeletal disorders (85). Also, there is evidence that physical exposure at work in terms of heavy workload and repetitive work could cause musculoskeletal pain in the neck, shoulders, and upper extremities (86).

Treatment

Similar to other chronic conditions, FM cannot be cured, but symptoms can be controlled. Evidence-based recommendations for the treatment of FM have been suggested by the European League Against Rheumatism (EULAR) based on systematic review and expert consensus (87). First, the recommendations conclude that a comprehensive assessment of pain, function, and psychosocial context should be conducted and that FM should be recognized as a heterogeneous and complex condition where there is abnormal pain processing and secondary features (87). The recommendations for treatment conclude that a multidisciplinary approach is required for effects on pain and function and include a combination of non-pharmacological and pharmacological treatment modalities tailored according to pain intensity, function, associated features such as depression, fatigue, and sleep disturbance in discussion with the patient (87). According to evidence-based guidelines for management of FM, treatment should include physical exercise and cognitive behavioral therapy in combination with pharmacological treatment (88, 89). In Swedish health care, a multidisciplinary approach to treatment is emphasized along the lines of the

EULAR recommendations, and non-pharmacological treatment including for example patient education and individually tailored physical activity is regarded as first choice for improving physical function and participation in activities of daily life (90).

Physiotherapy

Physiotherapy is characterized by the approach to the human being as a physical, psychological, social, and existential whole within the context of health, where movement is regarded as the basis for the human functioning (91). Movement is also regarded as a means with which a person can influence their own health and reach their goals in relation to their specific context (91).

The World Confederation for Physical Therapy (WCPT) policy statement describes physiotherapy as follows: Physical therapy provides services to individuals and populations to develop, maintain, and restore maximum movement and functional ability throughout the lifespan. Functional movement is central to what it means to be healthy (92).

Current recommendations for physiotherapeutic treatment for patients with FM in Sweden and internationally suggest physical exercise as first choice treatment for enhancing physical function and participation in activities of daily life (87, 90, 93-96). Other common physiotherapeutic interventions for patients with FM include patient education (97) and body awareness therapy (98).

Exercise has been defined as *a type of physical activity consisting of planned, structured, and repetitive bodily movement to improve or maintain components of physical fitness* (99, 100). Aerobic exercise is the exercise form that is most highly recommended by guidelines internationally and in Sweden, and the exercise is encouraged to be individually tailored (87, 88, 94, 96). Aerobic exercise, including for example walking, jogging, pool exercise, and cycling has been shown to improve global well-being, physical capacity (aerobic capacity and muscle strength) and, to some degree pain and number of tender points (101-103). Resistance exercise, also known as resistance- or strength training, has been described as *a type of exercise that requires the body's musculature to move (or attempt to move) against an opposing force, usually presented by some kind of equipment* (104). Individually tailored resistance exercise is recommended for persons with FM by guidelines internationally and in Sweden (87, 90, 94-96). However, a recent Cochrane review of resistance exercise in FM concludes low quality of the prevalent evidence of the benefits of resistance exercise for persons with FM due to few studies and calls for further research in the field (105). The scarcity of studies of resistance exercise in FM could possibly be related to known risks of exercise-induced pain in persons with FM (53). Further, high rates of drop-outs and low benefits has previously been reported in persons with FM engaging in exercise with higher intensity including components of resistance exercise (54). It has been suggested that exercise-induced pain can be avoided by progressive resistance exercise

with gradual introduction to heavier loads (106). Resistance exercise initiated on low loads (40% of one repetition maximum (RM)), and then gradually increased to 60% after 3-4 weeks and to 80% after 6-8 weeks, has been reported to be a mode of progression that is tolerated by women with FM, however in a small study sample (107, 108). Recommendations for resistance exercise in healthy novice adults with the aim of improving strength include: an exercise frequency of 2-3 days per week for at least 6 weeks, 20-60 minutes per session, including exercises with concentric, eccentric, and isometric muscle actions involving both single-joint and multiple-joint exercises, with emphasis on large muscle groups optimizing exercise intensity (109). The progression of resistance exercise for healthy novice individuals has been recommended to be dependent on and adjusted to each individual, their physical capacity and training status (109).

In study IV of this thesis, the person-centered approach focused on a partnership between participant and physiotherapist. The partnership meant shared decision-making based upon the individual's descriptions about wishes, needs and resources and is based on the assumption that a person is a physical, psychological, social and existential whole (110). For the women with FM engaging in person-centred resistance exercise in study IV of this thesis, the person-centred approach (110) to the exercise program, it's progression and the exercises included, based on self-efficacy principles (111), was thought to be of importance for the ability of the participants to manage exercise without inducing pain. The partnership between the physiotherapist and the participant that was established through dialogue was thought to promote the participant's ability to take charge of the exercise program and its' progress and to gain confidence for the management of exercise.

In study IV of this thesis, relaxation therapy was chosen as the active control intervention, comprising a program of mental exercises in which the participants were guided through their bodies by focusing their minds on the bodily experience of relaxation and letting the body part in focus rest on the ground. This was repeated for each specific body-part, aiming at feeling as relaxed as possible in the whole of the body at the end of the session (112). There is little research on relaxation therapy as sole treatment for FM, and evidence of effects are low (113). Relaxation in combination with patient education has been reported to improve pain, fatigue, global well-being, anxiety, and depression in patients with FM (114).

Pharmacological treatment

Pharmacotheraphy for improving symptom domains in FM has advanced in parallel with advances in the understanding of the pathophysiology of FM (115). Pharmacological therapies that act on reducing the activity of facilitating neuro-transmitters (gabapentinoids) or by increasing the activity of inhibitory neuro-transmitters (tricyclic antidepressants (TCAs) and serotonin and norepinephrine reuptake inhibitors (SNRI)) are generally considered to be effective (39, 87,

115). However, there are no pharmaceuticals in Europe that are registered for the indication FM (90, 116). Some pharmaceuticals have shown to have effects on FM symptoms in some cases and are therefore included as options for treatment in FM in Swedish health care including: TCAs (amitriptyline), SNRI (duloxetine), and anti-convulsives (pregabalin). Analgesics (paracetamol and non steroidal anti-inflammatory drugs (NSAIDs)) with the exception of Tramadol are not recommended because of lack of evidence of effects. However, restrictive use of pharmaceuticals is advised and recommendations are to use pharmaceuticals only in combination with multidisciplinary treatment (90, 117).

Gender

FM is six times more common in women than in men (19, 20). This is the main reason for only including women in the studies of this thesis. Further, aspects of health and work have been shown to differ between women and men with FM. Men with FM have reported better physical function than women with FM (118). Women with musculoskeletal pain appear to have an increased risk for work disability compared with men with musculoskeletal pain (119). Also, in the general population, predictors for sickness absence have been reported to differ between women and men (120) and the proportion of work-related disorders have been reported to be higher in women than in men (121). Considering these differences, it could be difficult to include both women and men with FM in the same studies without conducting separate analyses for the women and for the men. In research concerning work and health, the comparison of women and men is discouraged because of differences in work life, family life, and health, and the risk of creating generalizations of women and men rather than increasing the understanding (122). Aspects of work and health need to be further studied in both women and men with FM. However, it seems advisable to study women and men separately.

AIMS

The overall aim of this thesis was to gain deeper knowledge on aspects related to work and health in women with fibromyalgia (FM).

The specific aims of the studies included in this thesis were:

Study I

To investigate which aspects of health that differed between working women with FM and nonworking women with FM. We hypothesized that working women with FM would display better health than nonworking women with FM in terms of subjective ratings of health and performance-based tests of physical capacity.

Study II

To examine and describe factors promoting sustainable work in women with FM.

Study III

(*i*) To investigate whether perceived exertion at work was higher in women with FM than in healthy women matched by occupation and physical workload; and (*ii*) to study explanatory factors for perceived exertion at work. We hypothesized that perceived exertion at work would be higher in women with FM than in healthy women.

Study IV

To examine the effects of a person-centred progressive resistance exercise program on muscle function, health status, and current pain intensity in women with FM. Relaxation therapy was selected as an active control intervention.

METHODS

The thesis comprises four studies. Different methods for data collection and analysis were used based on the research questions of each study. The study designs together with methods of recruitment, study populations, number of participants, methods for data collection and analyses are briefly described in Table 1.

Table 1. *Research design overview*

	Study I	Study II	Study III	Study IV
Study design	Descriptive cross-sectional multicentre study	Qualitative exploratory focus-group study	Controlled cross-sectional multicentre study	Randomized controlled multi-centre study
Recruitment	Journal search and consecutive recruitment Primary health care	Previous studies in Primary health care	Newspaper advertisements	Newspaper advertisements
Study population	Working and non working women with fibromyalgia (FM)	Working women with FM	Working women with FM and working healthy women	Women with FM
Number of participants	N=129 Working (n=53) Not working (n=76)	N=27 Distributed in five focus group interviews	N=146 FM (n=73) Healthy (n=73)	N= 130 Resistance exercise (n=67) Relaxation therapy (n= 63)
Data collection	Clinical examination Standardized interview on demographics Self-reported questionnaires Tests of physical capacity	Short questionnaire on demographics Focus group interviews	Clinical examination Standardized interview on demographics Self-reported questionnaires Tests of physical capacity	Clinical examination Standardized interview on demographics Self-reported questionnaires Tests of physical capacity
Analysis	Non-parametric statistics	Qualitative latent content analysis	Non-parametric statistics Parametric statistics	Non-parametric statistics Parametric statistics

Study populations

Study I

A total of 129 women with FM were recruited from three primary health-care centers in West Sweden by systematic search of patient journals and by consecutive recruitment. The inclusion criteria were women who were 18–60 years of age with FM according to the ACR 1990 classification criteria for FM (10). Exclusion criteria were: other severe somatic or psychiatric disorders,

inability to understand or speak Swedish, physiotherapeutic treatment in progress (this was a sub study of an experimental study of exercise), or unemployment.

Study II

A total of 27 working women with FM were recruited from previous studies in primary health care in West Sweden. The inclusion criteria were women with FM according to the ACR 1990 classification criteria for FM (10), in the ages of 30–63 years, being gainfully employed part- or full-time and being able to participate in the planned interview occasions. The exclusion criteria were other severe somatic or psychiatric disorders and not working for the last three months, for any reason.

Study III

A total of 73 women with FM and 73 healthy women were recruited via advertisements in the local newspapers of three cities in Sweden (Gothenburg, Stockholm and Linköping) to this sub-study of a multi-centre experimental study (Study IV). Inclusion criteria for women with FM were: to be of working age, 20–65 years, to be working, and meeting the ACR 1990 classification criteria for FM (10). The healthy women, age range 21–63 years, were included in this study as matched controls. Exclusion criteria were: high blood pressure (> 160/90 mmHg), osteoarthritis in the hip or knee, other severe somatic or psychiatric disorders, other dominating causes of pain than FM, high consumption of alcohol (Audit > 6), participation in a rehabilitation program within the past year, regular resistance exercise or relaxation therapy more than twice a week, inability to understand or speak Swedish, and not being able to refrain from analgesics, nonsteroidal anti-inflammatory drugs (NSAIDs) or hypnotics for 48 h prior to examination.

Study IV

A total of 130 women with FM were recruited by newspaper advertisement in the local newspapers of three cities in Sweden (Gothenburg, Stockholm, and Linköping). Inclusion criteria were women aged 20-65 years, meeting the ACR 1990 classification criteria for FM (10). Exclusion criteria were the same as in study III. A flowchart of the study process is shown Figure 4.

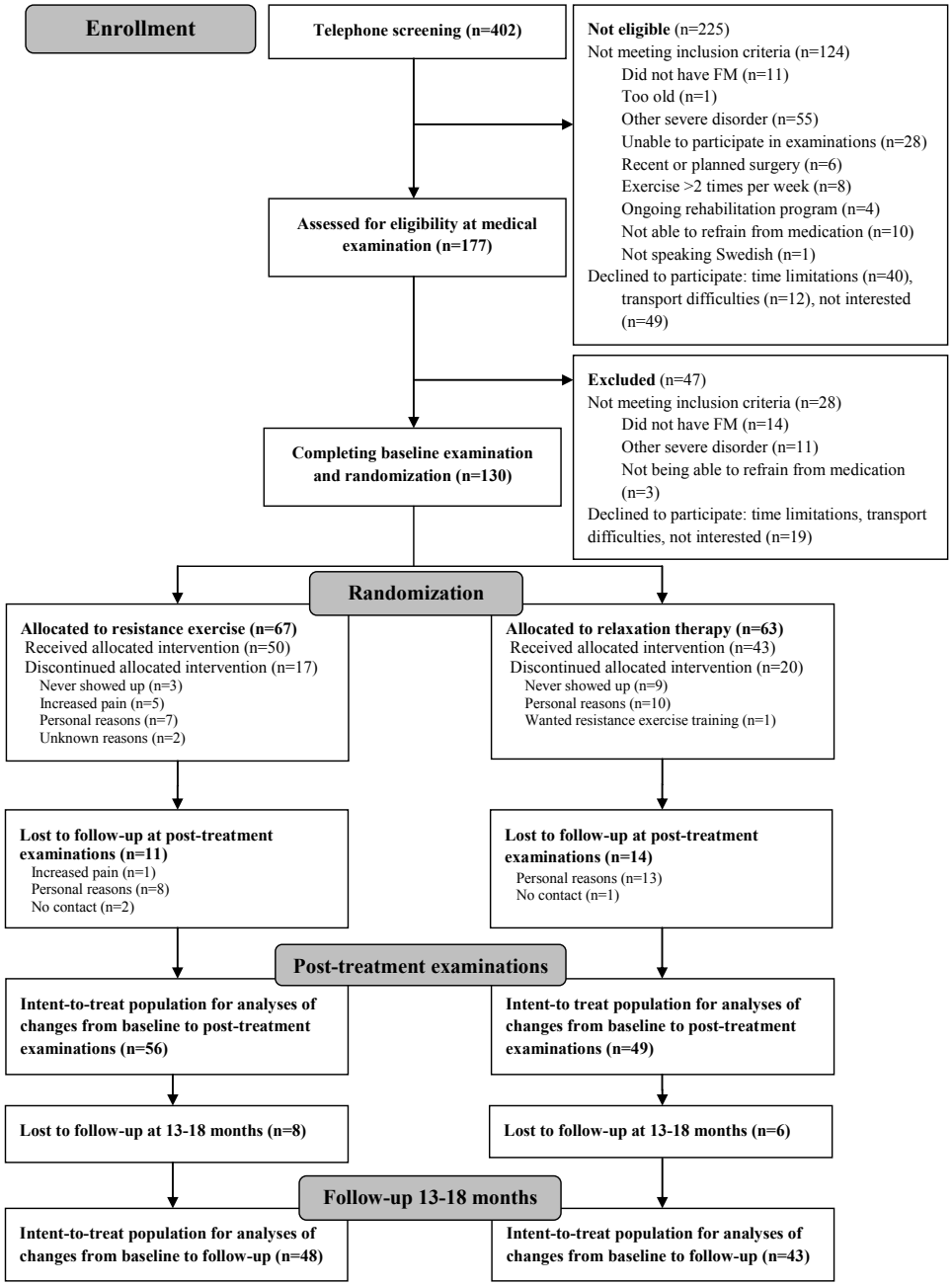

Figure 4. *Flowchart of the study process of Study IV.*

Ethics

Ethical approval for study I was granted by the Ethics Committee of the Sahlgrenska Academy, University of Gothenburg, Sweden (2003). Ethical approval for study II was granted by the Regional Ethical Review Board in Gothenburg, Sweden (2009). Ethical approval for study III and IV was granted by the Regional Ethical Review Board in Stockholm, Sweden (2010), with an additional application that was granted by the Regional Ethical Review Board in Stockholm, Sweden (2011). Written and oral informed consent was obtained from all participants.

Data collection

The measures used in the thesis are listed in Table 2 and presented in detail in the following section.

Demographic data

The information on socio-demographics, duration of symptoms, pharmacological treatment and work was gathered in a standardized interview in studies I, III, and IV. In study II the demographic information was gathered using a short questionnaire.

Family status was divided into two categories referring to whether the person lived together with another adult.

Ethnicity was divided into two categories referring to whether the person was born in Sweden or outside of Sweden.

Education was categorized according to $\leq$ 9 years, 10-12 years and > 12 years of education, respectively.

Mean income in area of residence was based on zip codes and the information was obtained by Statistics Sweden (123).

Work status was reported as percent of fulltime employment and exact work hours per week (100% or 40 hours per week respectively). Work status was presented in different ways in the studies of the thesis. In study I work status was dichotomized into working women, which included 25-100% of fulltime work, and nonworking women, which included 0% of fulltime work. In study II, work status was described as fulltime work when working 80-100% and part-time work when working 25-79%. In study III, the work status was presented in four categories: 20-49% of fulltime work, 50% of fulltime work, 51-79% of fulltime work, and 80-100% of fulltime work, and also in study IV, with the addition of the category of nonworking which included 0% of fulltime work.

Sick leave. In study I, sick-leave was presented as "receiving disability benefits" for the percentage not in employed work. In study III and IV sick leave was presented as percent of full-time sick-leave (25%, 50%, 75%, and 100%).

Table 2. *Measures used in studies I-IV categorized according to the ICF.*

Measures	Study I	Study II	Study III	Study IV
Body function				
Clinical examinations				
Pain threshold (kPa)	X			X
Tender point count (nr)	X		X	X
Tests of physical capacity				
6MWT (m)	X		X	X
Knee extension force (N)			X	X
Elbow flexion force (kg)			X	X
Hand grip force (N)	X		X	X
Self-reported questionnaires				
Pain impact on daily life (0-10)		X		
Current pain (VAS)				X
Pain localizations (nr)	X			
FIQ pain (0-100)	X		X	
FIQ fatigue (0-100)	X			
FIQ morning tired (0-100)	X			
FIQ stiffness (0-100)	X			
FIQ anxiety (0-100)	X		X	
FIQ depression (0-100)	X		X	
HADS (0-21)	X			
MFI-20 (4-20)	X			
PGIC (1-7)				X
Activity and participation				
LTPAI (h)	X		X	X
FIQ physical function (0-100)	X			
Perceived exertion at work (0-14)			X	
PHYI Physical activity level at work (7-21)			X	
FABQ work (0-42)			X	X
FABQ physical activity (0-24)				X
PDI (0-70)				X
CPAQ (0-120)				X
FIQ work (0-100)	X			
Work status	X	X	X	X
Personal factors				
Age (years)	X	X	X	X
Symptom duration (years)	X	X	X	X
Medication	X			X
Family status	X			X
Ethnicity	X			X
Educational status	X		X	X
FIQ feel good (0-100)	X			
Environmental factors				
Mean income in area of residence	X			
MOS-SSS (4-20)	X			
Multidimensional health scores				
FIQ total score (0-100)	X		X	X
SF36 PCS (0-100)	X			X
SF36MCS (0-100)	X			X

FIQ: Fibromyalgia Impact Questionnaire, HADS: Hospital Anxiety and Depression Scale, MIF-20: Multidimensional Fatigue Inventory, PGIC: Patient Global Impression of Change, LTPAI: Leisure Time Physical Activity Instrument, PHYI: Physical Activity Index, FABQ: Fear Avoidance Beliefs Questionnaire, PDI: Pain Disability Index, CPAQ: Chronic Pain Acceptance Questionnaire, MOS-SSS: Medical Outcome Study – Social Support Survey four item scale, SF36 PCS: Short Form 36 Physical Component Scale, SF36 MCS: Short Form 36 Mental Component Scale.

Physical workload. In study III, the study population was categorized using a standard classification system of physical workload based on occupation and work tasks (1–5): 1 = heavy work, 2 = heavy repetitive work, 3 = medium heavy work, 4 = light repetitive work, and 5 = light/administrative work (40, 124).

Pharmaceutical treatment. In study I, use of pharmaceuticals was divided into two groups: analgesics/NSAIDS and psychotropics (antidepressants and sedatives) and were registered as positive when use was regular or as needed. In study IV pharmaceuticals were divided into five groups: NSAID/paracetamol, opioids for mild to moderate pain, antidepressants, anticonvulsives, and sedatives. The use was registered as positive when use was regular or as needed.

Clinical examinations

Tender points were examined by manual palpation by trained examiners (Study I: physiotherapists, Study III and IV: physicians) to verify diagnosis according to the ACR 1990 criteria (10). The test-retest and inter-rater reliability has been found to be satisfactory (125, 126).

Pain threshold Muscle tenderness was examined by trained examiners (Study I, III and IV: physiotherapists) using a Somedic algometer (Somedic Production AB, Sollentuna, Sweden) (127). The pressure pain threshold examination with the Somedic algometer has shown satisfactory inter-rater and intra-rater reliability in healthy women (128).

Tests of physical capacity

Six-minute walk test (6MWT) is a performance based test that measures total walking distance (m) covered during a period of 6 minutes. The standardized instructions are to walk as fast as possible without running. The test has shown satisfactory intra-rater reliability in a Swedish FM population (129).

Isometric knee extension force was measured with Steve Strong (Stig Starke HBI, Göteborg, Sweden), a portable dynamometer. The participant was in a fixed seated position with back support, knee and hip in 90° of flexion and legs hanging freely. A non-elastic strap was placed around the ankle and attached to a pressure transducer with an amplifier. The subjects were instructed to pull the ankle strap with maximal force for 5 seconds. Three trials were performed for each test and there was a one minute rest between each trial. The best performance out of three trials was recorded. A mean value of the maximal force (N) in the right and left leg was calculated. The instrument has been used in previous studies of physical performance (130, 131) and has been reported to show satisfactory test-retest reliability for patients with a chronic condition (130).

Hand-grip force was measured using Grippit (AB Detektor, Göteborg, Sweden) which is an electronic instrument that measures hand grip force (N) (132). The mean force over a set period of time (ten seconds) was recorded. Two trials

were performed for each hand and there was a one minute rest between each trial. The best performance out of two trials was recorded. A mean value of the grip-force of the right and left hand was calculated. Grippit has shown satisfactory test-retest reliability for women with FM (132).

Isometric elbow flexion force was measured with Isobex (Medical Device Solutions AG, Oberburg, Switzerland), a portable dynamometer, in both arms, one by one. The participant was in a seated position without back support, legs stretched out in front. The upper arm was aligned with the trunk and the elbow in 90° of flexion. The maximum force (kg) during a period of 5 seconds was recorded (133). Three trials were performed for each test and there was a one minute rest between each trial. The best performance out of three trials was recorded. A mean value of the right and left arm was calculated. Isobex has shown satisfactory intra-rater and inter-rater reliability in assessing shoulder strength in healthy individuals (133).

Self-reported questionnaires

Fibromyalgia Impact Questionnaire (FIQ) is a disease specific measure of health status which comprises ten subscales of disabilities and symptoms ranging from 0 to 100. The total score is the mean of ten subscales. A higher score indicates a lower health status (134). The FIQ has been shown to have a credible construct validity, satisfactory test-retest reliability and good sensitivity in demonstrating therapeutic change (135). In study I and in the additional analysis of study IV, two subscales of the FIQ total score were omitted: Work missed, and Job ability. The reason for this was that the study population was dichotomized according to work status. Thus, an eight-item total score of the FIQ was applied in study I and in the additional between group analyses of study IV.

Short-Form 36 (SF-36) is a widely used generic questionnaire which assesses health related quality of life and comprises eight subscales ranging from 0 to 100. A higher score indicates better health related quality of life (136). The subscales build two composite scores, the Physical Component Scale (PCS) and the Mental Component Scale (MCS), which were used in this thesis. The SF-36 has been reported to be relevant in research of FM (137) and is validated for a Swedish population (138).

Current pain intensity was measured by Visual Analogue Scale (VAS). A 100 mm plastic VAS-scale with a moveable cursor along a line and anchors at the extremes only, was used. The participant was asked to assess her current pain ranging from "no pain at all" to "worst imaginable pain". The VAS has been reported to be a useful measure of pain intensity in most settings (139).

*Pain localization*s The localization and distribution of pain was reported in a sheet based on a drawing of the body with 18 predefined body regions (0–18) (8).

Multidimensional Fatigue Inventory (MFI-20) contains 20 statements that build five subscales (4-20) of different dimensions of fatigue. A higher score indicates a higher degree of fatigue (140, 141). The MFI-20 has been validated for a Swedish population with FM and has shown satisfactory test-retest reliability (141). This inventory is categorized as a measure of body function since 67% of its content concerns this ICF domain (76).

Hospital Anxiety and Depression Scale (HADS) contains 14 statements, ranging from 0 to 3, in which a higher score indicates a higher degree of distress. The scores build two subscales: HADS-A for anxiety (0–21) and HADS-D (0–21) for depression (142). The cut-off score of eight is suggested to indicate possible anxiety and depression (143). The instrument has shown satisfactory test-retest reliability and good sensitivity to therapeutic change (143). This scale is categorized as a measure of body function since 93% of its content concerns this ICF domain (76).

The Leisure Time Physical Activity Instrument (LTPAI) is a questionnaire that assesses the amount of time spent on physical activity during a typical week. The total score is the sum of hours of activities (144). The instrument has shown satisfactory test-retest reliability (144).

Medical Outcome Study - Social Support Survey four item scale (MOS-SSS) is a short version of the 18-item MOS-SSS consisting of a four-item social support scale (1–5). The total score ranges from four to 20. A higher score indicates a higher degree of social support (145).

Fear Avoidance Beliefs Questionnaire includes two sub-scales that assess how much fear and avoidance affect work beliefs (7 items range 0-42) and physical beliefs (4 items 0-24) in patients with chronic pain. A higher score represents more fear avoidance beliefs (146). The instrument has shown satisfactory test-retest reliability (146).

Physical Activity Index (PHYI) is a rating scale of physical activity level at work, which includes 7 items that reflect manual materials handling including lifting, and is a workload index, ranging from 7 to 21. The instrument has shown satisfactory test-retest reliability and validity in a Swedish study population (147).

Perceived exertion at work is a numeric rating scale that ranges from 0 to 14, where a higher score represents a higher degree of physical exertion at work (147). It is a modified form of the Borg scale for ratings of perceived exertion (RPE) (148).

Pain Disability Index (PDI) assesses the impact that pain has on the ability of a person to participate in essential life activities on a scale from 0 to 70. A higher score indicates greater disability (149, 150). The PDI has shown satisfactory test-retest reliability and is valid for patients with chronic pain (149-151).

Chronic Pain Acceptance Questionnaire (CPAQ) assesses the degree of pain related acceptance, the total score ranges from 0 to 120. It consists of 20 items ranging

from 0 "never true" to 6 "always true". A higher score indicates higher level of acceptance (152).

Patient Global Impression of Change (PGIC) is a seven point numeric scale ranging from "very much improved" to "very much worse" which measures global impression of change from the patient's perspective. The instrument has been shown to be useful for determining clinically significant change (153, 154).

Focus group interviews

A qualitative research design provides tools for researchers to better understand aspects that are not quantifiable but nevertheless influence elements of health for persons in their specific contexts (155, 156). Qualitative research is based on theories of human experience and interpretation (157). The researcher is regarded as an active part in constructing new knowledge as the pre-understanding of the researcher, including previous experience, hypotheses, and professional perspectives influence the research process, from creating the research questions to interpreting and analyzing the data (157). In study II, focus group interviews were used as a method for collecting data. Focus group methodology is based on the assumption that new knowledge is formed through interaction between participants sharing their experiences of a common phenomenon (158). Through discussions, a collective understanding of participants' views on a certain subject emerges (158). The reason for conducting focus group interviews rather than individual interviews in this thesis was that the interactions within the groups were thought to generate new knowledge through the discussions where participants shared individual experiences gaining new perspectives on a common phenomenon (158).

Procedures

Study I

Data was collected through clinical assessment, a standardized interview, performance-based tests and self-reported questionnaires, Table 2.

The study population was divided into two groups according to work status: working women (25-100%) and nonworking women (0%). The working women included 13 full-time workers (80-100%), 13 part-time workers working less than 50% (25-49%), 17 part-time workers working 50%, and 10 part-time workers working 50% or more (50-75%). Thirty-seven part-time working women received disability benefits while three did not. All nonworking women received disability benefits.

The working women with FM were compared with the nonworking women with FM on demographic data, performance-based tests of physical capacity, and self-reported questionnaires and all outcomes were categorized in the ICF

dimensions: personal- and environmental factors, body functions, activity and participation, and health status. Explanatory factors for work were analyzed.

Additional analysis (unpublished data)

The dichotomization of working and nonworking women was omitted and work status was instead analyzed based on work hours per week and correlation analyses of aspects of health with work status were performed.

The analysis of explanatory factors for work was conducted with a significance level of 0.05 instead of the initial 0.01 as criteria for entry into the model of analysis.

Study II

Interview data were gathered in five focus group interviews conducted at three sites in West Sweden during a period of four weeks in 2010. The number of participants in each focus group ranged from four to eight. The interviews were guided by a moderator (KM), a health-care professional working both as a clinician and with research. The moderator followed an interview guide with open-ended questions and encouraged discussions between the participants. The interview guide included the following questions: how do you experience your work, what factors influence your workload, what factors facilitate your work and what factors motivate you to work. The moderator summarized the discussions at the end of each interview and invited the participants to add, confirm and clarify any aspects discussed. The interviews lasted for two hours each. A co-moderator recorded the interviews and monitored the interview process. The interviews were then transcribed verbatim by the co-moderator.

Study III

Data was collected through clinical assessment, a standardized interview, performance-based tests and self-reported questionnaires in Gothenburg, Stockholm, and Linköping, Table 2.

The 73 women with FM were matched with 73 healthy women by occupation and physical workload (1–5) using the following standard classification system: 1 = heavy work, 2 = heavy repetitive work, 3 = medium heavy work, 4 = light repetitive work, and 5 = light/administrative work (40, 124). The matching resulted in 13 different occupational categories with similar work tasks and matching physical workload according to the 1–5 scale described above. The matching fitted for 71 out of the 73 women with FM. The 2 remaining women were matched by similar work tasks, and matching physical workload. None of the participants had a heavy (1) or a heavy repetitive (2) physical workload. Twenty-seven women (37%) in each group had a medium heavy physical workload (3), 2 women (3%) in each group had a light repetitive physical workload (4), and 44 women (60%) in each group had a light physical workload (5), Table 3.

Table 3. *Matching of the women with fibromyalgia (FM) and the healthy women by occupation and physical workload.*

Physical workload (1-5)	Women with FM (n= 73)	Healthy women (n= 73)	Occupations
Heavy (1)	0	0	(e.g. fireman, construction worker)
Heavy repetitive (2)	0	0	(e.g. laundry service, cleaner)
Medium heavy (3)	27 (37%)	27 (37%)	child care, assistant nurse, nurse, kitchen staff, laundry assistant, massage therapist
Light repetitive (4)	2 (3%)	2 (3%)	Laboratory assistant, factory worker (packing and handling of smaller products)
Light/administrative (5)	44 (60%)	44 (60%)	Administrator, administrative manager, head of unit, teacher, consultant

Data are presented as number n and percent (%)

The women with FM were compared with the healthy women on demographic data, performance-based tests of physical capacity, and self-reported questionnaires. Factors associated with perceived physical exertion at work were analyzed in both groups. Explanatory factors for perceived physical exertion at work were analyzed in the women with FM.

Study IV

The randomized controlled trial was carried out in Gothenburg, Stockholm, and Linköping. Data was collected through clinical assessment, a standardized interview, performance-based tests, and self-reported questionnaires, Table 2, at baseline and after 15 weeks intervention. The assessors were blinded to group allocation. Follow-up was conducted 13-18 months after the baseline and included the self-reported questionnaires only. The participants were randomized to a person-centred progressive resistance exercise program or to an active control intervention of relaxation therapy. Outcomes were analysed according to intention–to-treat design, implying that all participants were invited to post-treatment examination, whether they had participated in the intervention or not. Only measured values at baseline examinations, post-treatment examinations, and 13-18 month follow-up were included in analyses. The 13-18 month follow-up comprising the self-reported questionnaires was sent to the participants by mail. The participants who did not return the questionnaires in a reasonable time were reminded by telephone. After three reminders, the participants who had not returned the questionnaires were regarded as missing. Primary outcome was isometric knee-extension force (N) measured with Steve Strong®. Secondary outcomes were: health status assessed with FIQ total score (0-100), current pain intensity measured with VAS (0-100), 6MWT (m), isometric elbow-flexion force (kg), hand-grip force (N), health related quality of life, pain disability, pain acceptance, fear avoidance beliefs, and patient global impression of change.

Person-centred progressive resistance exercise was performed twice a week for 15 weeks and was supervised by experienced physiotherapists. It was conducted at physiotherapy premises and at a local gym in small groups to promote interaction between participants and to facilitate physiotherapeutic guidance. The intervention was preceded by an individual introductory meeting. The meeting was commenced with a dialogue between the participant and the physiotherapist regarding the participant's earlier experiences and thoughts of exercise. The introductory meeting also included exercise instructions, testing and adjustment of loads and modifications of specific exercises according to individual conditions and according to self-efficacy principles (111) of each participant's confidence in their ability to perform each exercise and to manage specific loads. The meeting resulted in a written protocol with descriptions of specific exercises and loads, which was used by each participant as an exercise program at each exercise session. Each session included a 10 minute warm up, a 50 minute standardized protocol including: leg-press, knee-extension, knee-flexion, heel-raise, biceps curl and hand grip strength, core stability and 10 minutes of stretching exercises. Exercises for power were added to the protocol five weeks, and eight weeks into the intervention with rapid heel-raises and explosive knee-extensions respectively, if tolerable. To promote the participants' sense of control, and to avoid possible negative effects related to exercise, a model of progression that had previously proved to be successful in persons with FM was used (107, 108). According to this model the exercise was initiated at low loads representing 40% of one repetition maximum (1 RM), with 15-20 repetitions in 1-2 sets. Possibilities for progressions of loads were evaluated every 3-4 weeks in dialogue between physiotherapist and participant. The regime was to increase loads to 60% of 1 RM, with 10-12 repetitions in 1-2 sets after 3-4 weeks, and to 80% of 1RM, performed with 5-8 repetitions in 1-2 sets after 6-8 weeks. In the case where the participant was not ready to increase exercise loads, she continued exercising on the same loads until she was ready to do so. This mode of exercise was anticipated to increase exercise self-efficacy, enhance the ability to chose proper level of exercise and better manage symptoms (pain).

Active control group. The relaxation therapy was performed twice a week for 15 weeks and was guided by experienced physiotherapists. It was conducted at physiotherapy premises and was preceded by an individual introductory meeting at the premise which included instructions and allowed for preparations and modifications of practical matter such as positioning and the use of mattresses and pillows to reach a good level of comfort. The relaxation therapy was performed as autogenic training (112, 113), which refers to a series of mental exercises including relaxation and autosuggestion. The physiotherapist guided the participants through their bodies, during approximately 25 minutes, by focusing their minds on the bodily experience of relaxation and letting the body part in focus rest on the ground. This was repeated for each specific body-part, aiming at feeling as relaxed as possible in the whole of the body at the end of

the session. After each session the participants were invited to share experiences and ask questions to each other and the physiotherapist and continued thereafter with the stretching exercises.

Additional analysis (unpublished data)

Correlation analyses between work status and aspects of health were performed on baseline values. The study population was dichotomized in working and nonworking women and between-group differences in aspects of health were analyzed. Unemployed and students were excluded.

Analysis

Statistical analyses

Data were computerized and analyzed using the Statistical Package Software for the Social Sciences (SPSS version 18.0-22.0, Chicago, IL, USA) in study I, III, and IV. Statistical Analysis Software (SAS 9.2, North Carolina, USA) was used in study I and III for conducting stepwise multiple logistic regression analysis and logistic regression analysis respectively. An overview of the statistical tests used in the thesis is shown in Table 4. The tests were two-sided in all studies and the significance level was set as 0.05 in study III and IV. In study I the significance level was set as 0.01 to minimize the risk of false significances due to the large number of statistical tests. Non-parametric statistics were predominately used in the studies of the thesis, because of ordinal, and non-normally distributed data. Descriptive statistics are presented as mean and standard deviation (SD), median and range (min; max) for continuous variables and as number (n) and percent (%) for categorical variables.

Between-group comparisons were conducted in study I, III and IV. The Mann Whitney U-test was used for continuous variables, Fisher's exact test for dichotomous variables, and Mantel- Haenszel chi-square test for ordinal categorical variables.

Within-group comparisons were conducted in study IV. The Wilcoxon signed rank test was used to analyze change over time for continuous variables.

Spearman's correlation analysis was used in study III to determine correlations with perceived exertion at work in women with FM and healthy women, respectively. Correlations with perceived exertion at work were further analyzed separately in groups based on physical workload in the women with FM. In study IV, correlations with patient global impression of change (PGIC) were analyzed with Spearman's correlation analysis. In study I and IV, additional analyses of correlations between aspects of health and work status have been added where Spearman's correlation analysis has been used. The following classification was used to interpret the correlation values, given that p-values were less than 0.05:

r_s 0–0.25 indicates little or no relationship, r_s 0.25–0.50 indicates a fair degree of relationship, r_s 0.50–0.75 a moderate to good relationship, while a correlation above r_s 0.75 indicates a very good to excellent relationship (159).

Table 4. *Statistical tests included in the thesis.*

Statistical test	Study I	Study II	Study III	Study IV
Descriptive statistics for continuous variables				
Mean (SD)	X		X	X
Median (min; max)	X	X	X	X
Descriptive statistics for categorical variables				
Number (n) and percent (%)	X	X	X	X
Comparison between two groups for continuous variables				
Mann Whitney U-test	X		X	X(*)
Comparison between two groups for dichotomous variables				
Fisher's exact test	X		X	X
Comparison between two groups for ordinal categorical variables				
Mantel-Haenszel chi-square test	X		X	X
Within-group comparison for change over time for continuous variables				
Wilcoxon signed rank test				X
Estimate of magnitude of change between two groups				
Effect size				X
Analyses of correlations				
Spearman's correlation analysis	X*		X	X(*)
Comparison between two groups adjusted for confounding variables				
Multiple logistic regression analysis			X	
Analysis of explanatory factors for dichotomous variable				
Stepwise multiple logistic regression analysis	X(*)			
Analysis of explanatory factors for continuous variable				
Stepwise multiple linear regression analysis			X	

*Additional analysis
(*) Used in original study and in additional analysis

Regression analyses were conducted in study I and III. *Stepwise multiple logistic regression analysis* was conducted in study I to evaluate explanatory factors for work, and also in the additional analysis of explanatory factors for work in study I. Variables displaying statistically significant differences ($p<0.01$) in between-group analyses of working women and nonworking women were entered into the stepwise multiple logistic regression analysis in study I. In the additional stepwise model p-value for entry into the model was set to <0.05. An odds-ratio (OR) with 95% CI was presented for descriptive purposes. The area under the Receiver Operating Characteristic (ROC) curve (AUC statistics) was calculated for a description of the goodness of the model (160). *Logistic regression analysis* was conducted in study III to adjust for the between-group analyses of outcomes for the background variables that differed significantly between the two groups. The logistic regression specified group as dependent variable, the outcome of interest as main independent variable, and background variables as covariates. *Stepwise multiple linear regression analysis* was used in study III to analyze explanatory factors for perceived exertion at work. Variables that correlated significantly with perceived exertion at work in the Spearman's correlation

analyses described above were included in the stepwise multiple regression model. The number of variables included in each model was limited to the number of women in each group, by one variable per every 10 women. P-values <0.05 were considered significant.

Effect size was calculated in study IV for variables showing a significant difference in change between the two groups to estimate the magnitude of change. Effect sizes for change over time between groups were calculated by dividing the mean difference for change between the post-treatment score and baseline score in the intervention group and in the control group by the pooled SD for difference. Effect sizes from 0.20 to < 0.50 were regarded as small, while effect sizes from 0.50 to < 0.80 were regarded as moderate (161).

Upper limit of expected number of false significances was calculated to control possible Type I errors in study I. It was calculated by the following formula: (number of tests – number of significant tests)$\times\alpha/(1-\alpha)$ where α is the significance level (162).

Sample size determination In study IV, 50 participants per group were determined to be a satisfactory sample size for performing statistical analysis of primary outcome. A total of 130 participants were recruited due to risks of possible drop-outs.

Qualitative content analysis

The transcribed interviews were analyzed by qualitative content analysis, according to Graneheim & Lundman (163). First, the interviews were read through several times separately by the three authors in order to obtain a sense of the whole. The unit of analysis consisted of whole interviews, and no parts were excluded from the analyses. Second, meaning units were derived from the text, abstracted and labeled with a code (163). The research question of factors promoting work guided the abstraction of meaning units. The codes were then sorted into categories and sub-categories. The analysis process moved continuously back and forth between the whole and parts of the text, Figure 5 (163). Discussions between the three authors resulted in a categorization of consensus with the aim of enhancing the credibility of the analysis. After finalizing the analysis, the participants were invited to a meeting to take part of the results of the analysis and to discuss the interpretations with the authors.

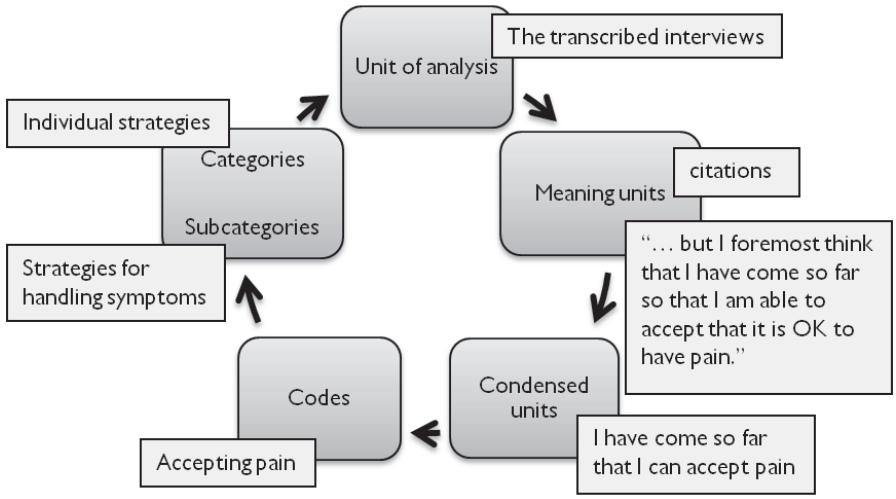

***Figure 5**. The process of the content analysis.*

RESULTS

The characteristics of the study populations included in study I-IV are presented in Table 5. Since Study IV has yet to be published the results of Study IV are presented briefly in the following results section.

Table 5. *Characteristics of the study populations in study I-IV.*

Variables	Study I		Study II	Study III		Study IV	
	Working women with FM	Nonworking women with FM		Women with FM	Healthy women	Resistance exercise	Relaxation therapy
Subjects, n	53	76	27	73	73	67	63
Age, years	45.4 (8.1)	46.0 (9.2)	52 (33;62)	50.4 (9.3)	50.7 (9.3)	50.8 (9.1)	52.1 (9.8)
Work status:							
-full time, n (%)	13 (25)	0 (0)	8 (30)	26 (36)	62 (85)	15 (22)	14 (22)
-part-time, n (%)	40 (75)	0 (0)	19 (70)	47 (64)	11 (15)	23 (34)	23 (37)
-not working, n (%)	0 (0)	76 (100)	0 (0)	0 (0)	0 (0)	29 (43)	26 (41)
Symptom duration, years	11.7 (5.8)	9.7 (7.9)		9.4 (7.8)	n.a.	11.1 (8.5)	9.4 (7.3)
Tender points, n	14.7 (2.5)	14.9 (2.4)		15.6 (2.0)	n.a.	15.8 (1.9)	15.5 (2.1)
Pain threshold, kPa	180.3 (64.6)	163.4 (66.4)		186.9 (72.5)		180.7 (71.2)	185.8 (85.9)
FIQ pain, (VAS 0-100)	62.5 (17.1)	77.0 (17.0)		58.1 (20.3)	4.2 (7.7)	62.7 (19.8)	63.9 (19.5)
Pain impact on daily life (0-10)			6 (0;10)				
FIQ total, (0-100)	58.7 (17.1)	69.3 (14.5)		55.9 (14.6)	7.0 (9.3)	60.5 (14.4)	61.1 (17.3)

FIQ, Fibromyalgia Impact Questionnaire
Data is presented as mean (SD), median (min;max) or number (n) and percent (%).

Which aspects of health differ between working and nonworking women with fibromyalgia? (Study I)

Working women with FM presented better health than nonworking women with FM in ratings of pain, fatigue, stiffness, and depression representing dimensions of body function (FIQ pain $p< 0.001$, FIQ fatigue $p=0.006$, MFI physical fatigue $p=0.001$, MFI reduced activity $p=0.001$ and MFI mental fatigue $p=0.006$, FIQ stiffness $p=0.009$, HADS-Depression $p=0.007$), presented in study I, Table 2. Fifty-two percent of the nonworking women and 29% of the working women scored above the cut-off score for possible depression (8). Ratings of overall health status were also significantly higher in the working

women than in the nonworking women (FIQ total, eight-item p=0.001) as well as physical health related quality of life (SF-36 PCS p<0.001), presented in study I, Table 2.

FIQ pain was an independent explanatory factor for work in stepwise multiple logistic regression analysis (OR 0.95, CI 0.93- 0.98), p < 0.001, (AUC 0.75, CI 0.66-0.83).

Type I error The between-group analyses comprised a total of 33 statistical analyses, with 11 significant values at significance level 0.01, and the upper level of number of false significances was 0.2, which indicates that 0–1 of the significances found might be false.

Additional results (unpublished data)

Pain, physical fatigue, reduced activity, physical function, feel good, health status (FIQ total), and physical health-related quality of life (SF36 PCS) showed fair correlations (159) with work status, Table 6. 6MWT, symptom duration, pain localizations, pain threshold, fatigue, stiffness, anxiety, depression, general fatigue, and mental fatigue showed weak correlations (159) with work status, Table 6.

Table 6. *Analysis of correlations between work status and aspects of health in the study population of Study I.*

Aspects of health (ICF)	Work status
	r_s (p-value)
Body function, tests of physical capacity	
6MWT (m)	0.20 (**0.026**)
Body function, ratings	
Symptom duration (years)	0.20 (**0.023**)
Pain localizations (number)	-0.24 (**0.005**)
Pain threshold (kPa)	0.21 (**0.018**)
FIQ pain (0-100)	-0.44 (**<0.001**)
FIQ fatigue (0-100)	-0.20 (**0.021**)
FIQ stiffness (0-100)	-0.22 (**0.012**)
HADS anxiety (0-21)	-0.19 (**0.031**)
HADS depression (0-21)	-0.22 (**0.012**)
MFI-20 General fatigue (4-20)	-0.19 (**0.033**)
MFI-20 Physical fatigue (4-20)	-0.31 (**<0.001**)
MFI-20 Reduced activity (4-20)	-0.29 (**0.001**)
MFI-20 Mental fatigue (4-20)	-0.22 (**0.014**)
Activity and participation	
FIQ physical function (0-100)	-0.26 (**0.004**)
Personal factors	
FIQ feel good (0-100)	-0.26 (**0.004**)
Health status	
FIQ total (0-100)	-0.33 (**<0.001**)
SF36 PCS (0-100)	0.38 (**<0.001**)

6MWT: 6 minute walk test, FIQ: Fibromyalgia Impact Questionnaire, HADS: Hospital Anxiety and Depression Scale, MFI-20: Multidimensional Fatigue Inventory, SF36 PCS: Short Form 36 Physical Component Scale.
r_s= Spearmans rho
significant p-values are shown in bold text

The stepwise multiple regression analysis conducted at the 0.05 significance level resulted in three independent explanatory factors for work: FIQ pain (OR 0.97, CI 0.94-0.99), p= 0.0065, Mental fatigue (OR 0.88, CI 0.78-0.98), p=0.023, and SF36 physical component scale (OR 1.08, CI 1.02-1.15), p=0.0096, (AUC 0.79 CI 0.70-0.87).

Factors promoting sustainable work in women with fibromyalgia (Study II)

Forty-one percent of the participants worked with management/administration, 37% with care of children or elderly people, 11% at a laboratory or industry and 11% in sales or with gardening. The majority of the participants worked part-time (70%), while the remaining (30%) worked full-time.

Four categories were identified describing factors promoting sustainable work: the meaning of work, and individual strategies were individual promoters for sustainable work while a favorable work environment, and social support outside work were environmental promoters for sustainable work. Each category included subcategories, covering a number of aspects. An overview of the categories, sub-categories, and aspects identified is presented in Table 7.

The participants expressed that continued work despite FM was important to them. They described different meanings of work and how these motivated them to continue work. The descriptions were divided into two sub-categories: individual meaning and social meaning.

The participants had developed a number of strategies for sustainable work. They had been increasingly aware of their capacity and limitations and had built personal skills as they had learned well-functioning strategies to plan and adjust their work life and their personal life to be able to remain working. It seemed as though they had gone to great lengths in planning and adjusting both their work life and their personal life to be able to remain in work. Their descriptions were divided into three sub-categories: strategies for handling symptoms, strategies for handling the work day and strategies for handling long-term work life.

The work environment was pointed out as a complex and important factor that influenced sustainable work for the participants. Aspects of the physical work environment were in many cases critical for managing physical workload. The psychosocial work environment was described as having a great impact on sustainable work, where a supportive management was crucial in that it had a great influence on conditions for work. Two sub-categories were developed in the analysis: physical and psychosocial work environment.

To receive understanding, acceptance and help from society, family and friends was experienced as important to manage work by the participants. Two sub-categories were developed in analysis; societal and private social supports.

The perceived risks of physical and mental overload from work challenged the work ability of the participants. Thus, promoting factors mainly involved the identification and the use of internal and external resources to manage the risk of physical and mental overload, regardless of whether it concerned developing individual strategies, having a favorable work environment or receiving social support outside work. The participants seemed to hold a careful balancing act where well-functioning strategies were experienced as necessary for managing work, in the short- and long term, without risking overload.

Table 7. *Factors promoting sustainable work in women with FM.*

Categories	Sub-categories	Aspects
The meaning of work	Individual meaning of work	Satisfaction in work Meaningfulness Confirmation Identity Distraction Income Structure in daily life
	Social meaning of work	To be part of a social context Participation in society Normality
Individual strategies	Strategies for handling symptoms	Mental strategies Adjustment Alleviating symptoms
	Strategies for handling the work day	To avoid heavy work tasks To set limits To take pauses
	Strategies for handling long term work life	To change career To control work schedules To plan and prioritize To develop personal qualities To improve health by physical activity
A favorable work environment	Physical work environment	Opportunities for flexibility Ergonomic aids Non-strenuous work tasks
	Psychosocial work environment	Well structured work organization Social support from colleagues Social support from management
Social support outside work	Societal social support	From healthcare From the Swedish Social Insurance Agency
	Private social support	From family From friends

Perceived exertion at work in women with fibromyalgia – explanatory factors and comparison with healthy women (Study III)

Perceived physical exertion at work – comparison with healthy women

Perceived physical exertion at work (0-14) was significantly higher in the women with FM as compared with the healthy women. There was no significant difference in physical activity level at work (PHYI) between the women with FM and the healthy women.

Physical capacity, represented by hand-grip force, upper-arm strength, knee-extension force, and walking distance, was significantly lower in the women with FM than in the healthy women. Symptoms were significantly more severe, and health status (FIQ total) was significantly more impaired in the women with FM compared with the healthy women. The significant differences persisted when adjusted for background variables that differed significantly between the groups (LTPAI, education, and work hours per week), Table 8.

Table 8. *Comparison of women with FM and healthy women on health-related aspects*

Measures	Women with FM (n=73) Mean (SD)	Healthy women (n=73) Mean (SD)	Adjusted p-value
Perceived exertion at work (0-14)	5.77 (3.27)	4.11 (2.71)	**0.0069**
Physical activity level at work (PHYI) (7-21)	9.68 (2.70)	9.34 (2.99)	0.16
Hand-grip force (Grippit) (N)	158.69 (64.27)	239.49 (49.52)	**<.0001**
Upper-arm strength (Isobex) (kg)	12.35 (5.02)	19.99 (5.16)	**<.0001**
Isometric knee-extension force (Steve Strong) (N)	324.45 (103.91)	423.18 (79.88)	**0.0001**
Walking distance (6MWT) (meters)	562.15 (67.66)	660.48 (65.58)	**<.0001**
Health status (FIQ total) (0-100)	55.94 (14.56)	6.99 (9.34)	**<.0001**
Pain (FIQ pain) (0-100)	58.07 (20.29)	4.20 (7.66)	**<.0001**
Depression (FIQ depression) (0-100)	43.73 (30.39)	6.96 (14.15)	**<.0001**
Anxiety (FIQ anxiety) (0-100)	54.49 (29.51)	9.27 (18.31)	**<.0001**
Fear avoidance work beliefs ($FABQ_{work}$) (0-42)	12.23 (10.08)	n.a	n.a

FIQ: Fibromyalgia Impact Questionnaire
n.a: not applicable
significant p-values are shown in bold text

Perceived physical exertion at work – correlations and explanatory factors

An overview of factors correlating with perceived physical exertion at work (0-14) in the FM population is displayed in Table 9.

Table 9. *Factors associated with perceived physical exertion at work (0-14) in women with FM.*

Measures	Total FM group (n= 73) r_s (p-value)	FM in medium heavy work (n= 27) r_s (p-value)	FM in light work (n= 44) r_s (p-value)
Physical activity level at work (PHYI)	0.68 (**<0.001**)	0.44 (**0.022**)	0.53 (**<0.001**)
Physical workload (categories 1-5)	-0.54 (**< 0.001**)	n.a.	n.a.
Hand-grip force (Grippit)	0.15 (0.21)	-0.48 (**0.012**)	0.23 (0.14)
Health status (FIQ total)	0.22 (0.066)	0.41 (**0.033**)	0.00 (1.00)
Pain (FIQ pain)	0.15 (0.20)	0.44 (**0.020**)	-0.12 (0.44)
Anxiety (FIQ anxiety)	0.26 (**0.027**)	0.46 (**0.017**)	0.14 (0.37)
Fear avoidance work beliefs ($FABQ_{work}$)	0.53 (**<0.001**)	0.43 (**0.024**)	0.31(**0.038**)
Work status	-0.02 (0.88)	0.42 (**0.031**)	-0.02 (0.91)

r_s= Spearmans rho
significant p-values are shown in bold text
n.a. = not applicable

*Total group of women with FM (*n = *73).* Physical activity level at work, physical workload, and fear avoidance work beliefs showed moderate to good correlations with perceived exertion at work while anxiety showed a fair correlation with perceived exertion at work, Table 9. Physical activity level at work and fear avoidance work beliefs were the only statistically significant variables to independently explain perceived exertion at work in the whole group of working women with FM, explaining 50%. The values are presented in Figure 6.

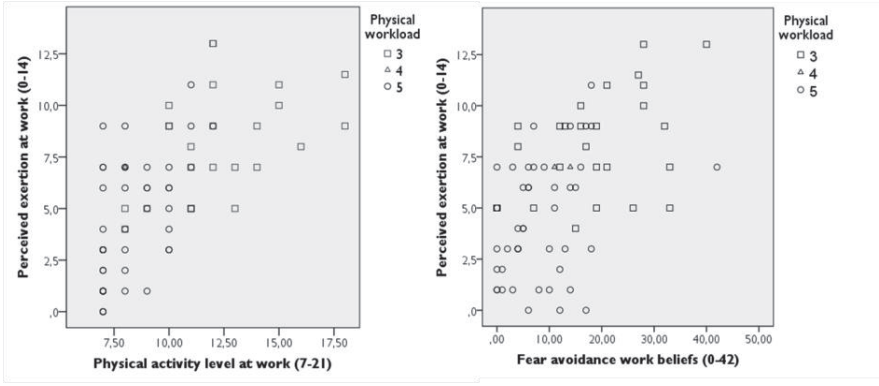

Figure 6. *Explanatory factors for perceived exertion at work in the total group of women with FM.*

*Women with FM with a medium heavy physical workload (*n = *27).* The mean perceived exertion at work was 8.0 (SD 2.6) which reflects moderately strenuous to strenuous physical exertion at work. Hand-grip force showed a fair correlation with perceived exertion at work, as did anxiety, pain, physical activity level at work, fear avoidance work beliefs, work status, and health status (FIQ total) presented in order of strength of correlation, Table 9.

Due to the limited number of women in this group, the only factors included in the model of explanatory factors were: hand-grip force and anxiety. This model explained 34% of perceived exertion at work in the group of women with FM with a medium heavy physical workload. The values are presented in Figure 7.

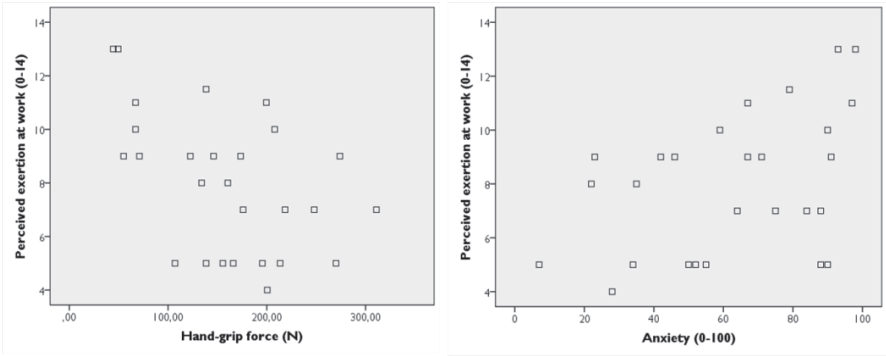

Figure 7. *Explanatory factors for perceived exertion at work in the women FM with a medium heavy physical workload.*

*Women with FM with a light physical workload (*n = *44).* The mean perceived exertion at work was 4.3 (SD 2.9) which reflects very light to light physical exertion at work. Physical activity level at work showed a moderate to good correlation with perceived exertion at work, while fear avoidance work beliefs showed a fair correlation with perceived exertion at work, Table 9. However, an outlier that scored maximum fear avoidance work beliefs contributed to the significant correlation. When the outlier was omitted, the correlation was no longer significant, see Figure 8. The only factor included in the model of explanatory factors was physical activity level at work. Physical activity level at work explained 29% of the perceived exertion at work in the FM group with a light physical workload. The values are presented in Figure 8.

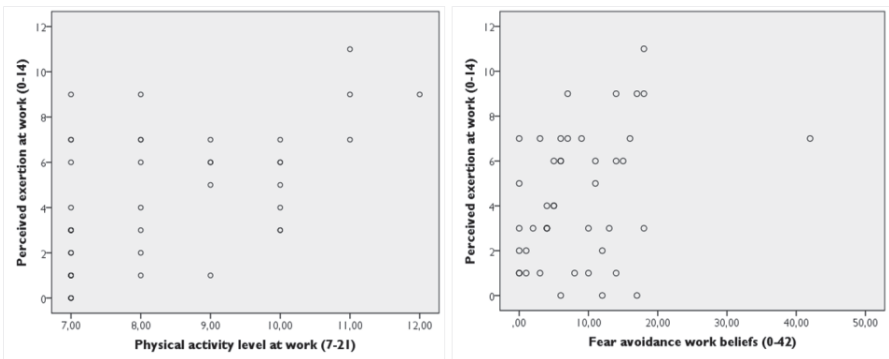

Figure 8. *Values of measures that showed significant correlations to perceived exertion at work in the women FM with a light physical workload.*

The effects of resistance exercise on muscle function, health status, and pain intensity in women with fibromyalgia (Study IV)

All participants were invited to a post-treatment examination according to an intent-to treat design and 81% of the total sample completed the examinations, 56 (84%) belonging to the resistance exercise group and 49 (76%) in the active control group. Seventeen participants (25%) in the resistance exercise group, and 20 (32%) in the active control group discontinued the intervention for various reasons. No significant differences were found when comparing the baseline characteristics, primary-, and secondary outcomes at baseline between the women who completed the post-treatment examinations and the women who did not complete the post-treatment examinations for each group respectively, Table 10. For more detailed information on baseline characteristics of the participants who completed post-treatment examinations and those who did not complete post-treatment examinations, see Table 10.

Adverse effects were reported by 5 participants, all in the resistance exercise group, who chose to discontinue the intervention due to increased pain, but two of these participants completed post-treatment examinations. The mean attendance rate at the resistance exercise sessions was 71% and 64% at the relaxation therapy sessions (ranging from 0 to 100 percent in both groups). No significant baseline differences between the resistance exercise group (n=56) and the active control group (n=49) were found regarding background data, primary outcome and secondary outcomes, Table 10 and study IV.

Forty-two participants (62.7%) in the resistance exercise group reached exercise loads of 80% of 1 RM while 7 participants (10.4%) reached exercise loads of 60% of 1 RM. Baseline values in the women in the resistance exercise group that managed to reach exercise loads of 80% of 1 RM (n=42, 63%) showed significantly better physical capacity represented by 6MWT (p= 0.040) and health status represented by FIQ total score (p= 0.029) than the women in the resistance exercise group that did not reach exercise loads of 80% of 1 RM (n=25, 37%), Table 11.

Table 10. *Characteristics of the study population including comparison of characteristics between the resistance exercise group and the relaxation therapy group. For descriptive purposes, characteristics of participants who discontinued the study and did not complete post-treatment examinations are presented as drop-outs for each group respectively.*

Measures	**Resistance exercise (n=56)** Mean (SD) Median (min;max)	**Resistance exercise drop-outs (n=11)** Mean (SD) Median (min;max)	**Relaxation therapy (n=49)** Mean (SD) Median (min;max)	**Relaxation therapy drop-outs (n=14)** Mean (SD) Median (min;max)	**p Value**
Age (years)	51.07 (9.14) 52 (25;64)	49.45 (8.92) 48 (33;63)	53.08 (9.31) 56 (22;64)	48.64 (10.93) 46 (26;63)	0.14
Symptom duration (years)	11.52 (9.50) 10 (0;35)	8.68 (7.99) 7.0 (1;25)	9.95 (7.43) 10 (0;30)	7.66 (6.94) 6 (0;25)	0.47
Tender points (nr)	15.70 (1.92) 16 (11;18)	16.09 (1.97) 17 (13;18)	15.41 (2.10) 16 (11;18)	15.79 (1.67) 16 (12;18)	0.58
Body mass index (BMI)	27.41 (5.11) 26 (21;41)	27.32 (6.4) 24 (19;40)	28.26 (5.21) 27.25 (18;39)	30.09 (5.65) 31 (20;43)	0.17
LTPAI (h)	5.58 (5.13) 4 (0;28)	5.82 (2.68) 7 (2;11)	5.92 (5.16) 4 (1;24)	5.36 (9.33) 3 (1;38)	0.74
Pharmacologigal treatment					
NSAID, paracetamol					
Yes	46 (82%)	7 (64%)	33 (67%)	11 (79%)	0.11
Opioids for mild to moderate pain					
Yes	11 (20%)	2 (18%)	7 (14%)	5 (36%)	0.45
Antidepressants					
Yes	28 (50%)	4 (36%)	16 (33%)	8 (57%)	0.075
Anticonvulsives					
Yes	4 (7%)	0	2 (4%)	0	0.68
Sedatives					
Yes	9 (16%)	2 (18%)	9 (18%)	3 (21%)	0.80
Education					
≤ 9 years	7 (13%)	1 (9%)	12 (25%)	3 (21%)	
10-12 years	24 (43%)	10 (91%)	16 (33%)	6 (43%)	
>12 years	25 (45%)	0	21 (43%)	5 (36%)	0.84
Living with an adult					
Yes	38 (68%)	7 (64%)	30 (61%)	10 (71%)	0.54
Born in Sweden	49 (88%)	11 (100%)	43 (88%)	13 (93%)	0.56
Work status					
0%	19 (37%)	4 (36%)	16 (35%)	6 (46%)	
20-49%	1 (2%)	1 (9%)	2 (4%)	2 (14%)	
50%	11 (22%)	2 (18%)	10 (22%)	1 (7%)	
51-79%	7 (14%)	1 (9%)	7 (14%)	1 (7%)	
100%	13 (26%)	2 (91%)	10 (22%)	3 (21%)	0.96
Sick leave / disability pension					
25%	8 (14%)	1 (9%)	5 (10%)	0	
50%	14 (25%)	2 (18%)	8 (16%)	1 (7%)	
75%	2 (4%)	0	1 (2%)	2 (14%)	
100%	17 (30%)	4 (36%)	16 (33%)	6 (43%)	1.00

Data is presented as mean (SD), median (min;max), or the number (n) and percent (%)
LTPAI: Leisure time physical activity instrument, NSAID: non-steroidal anti-inflammatory drug

Table 11. *Comparison of baseline values between the participants in the resistance exercise group who reached exercise loads of 80% and participants in the resistance exercise group who reached exercise loads up to 60%.*

	Resistance exercise (experimental)		
	Baseline values of participants reaching loads of 80% (n=42)	Baseline values of participants reaching loads ≤ 60% (n=25)	Comparison of baseline values between groups
Measures	Mean (SD) Median (min;max)	Mean (SD) Median (min;max)	**p- value**
Age (years)	50.26 (9.65) 51 (25;64)	51.7 (8.1) 52 (33;63)	0.68
Symptom duration (years)	11.44 (8.31) 10 (0;35)	10.4 (9.0) 8 (0;30)	0.47
Tender point count (nr)	15.57 (1.92) 16 (11;18)	16.08 (1.91) 17 (12;18)	0.30
BMI	26.75 (4.2) 26 (21;36)	28.5(6.7) 27 (20;41)	0.48
LTPAI (h)	4.87 (3.87) 4 (0;18)	6.9 (5.9) 6 (1;28)	0.17
Primary outcome			
Isometric knee-extension force (N)	347.3 (106.2) 344 (114;643)	301.2 (110.7) 305 (111;585)	0.11
Secondary outcomes			
Health status (0-100)	57.3 (12.7) 55.2 (31;81)	65.9(15.8) 64 (40;95)	**0.029**
Current pain intensity (VAS)	49.5 (22.1) 54 (12;89)	48.8 (27.19) 50 (5;100)	0.68
6MWT (m)	573.7 (70.3) 570(376;766)	527.7 (75.5) 548 (360;655)	**0.040**
Isometric elbow-flexion force (kg)	13.1 (5.3) 13 (2;26)	12.9 (5.7) 13 (3;32)	0.76
Isometric hand-grip force (N)	168.4 (70.4) 162 (34;319)	150.7 (65.6) 169 (62;315)	0.30
SF36 PCS (0-100)	31.7 (7.5) 31 (12;49)	30.3 (8.8) 30 (18;49)	0.32
SF36 MCS (0-100)	39.8 (11.9) 41 (10;59)	34.0 (12.1) 35 (13;61)	0.10
PDI (0-70)	34.3 (11.6) 34 (12;69)	36.9 (13.4) 39 (8;62)	0.40
CPAQ total (0-120)	66.0 (14.5) 64 (35;99)	59.5 (18.0) 59 (19;106)	0.13
$FABQ_{physical}$ (0-24)	9.0 (5.9) 9 (0;23)	12.6 (7.1) 13 (2;24)	0.23
$FABQ_{work}$ (0-42)	16.1 (12.3) 14 (0;42)	20.0 (13.9) 21 (0;39)	0.37

6MWT: 6 minute walk test, SF36 PCS: Short Form 36 Physical Component Scale, SF36 MCS: Short Form 36 Mental Component Scale, CPAQ: Chronic Pain Acceptance Questionnaire, PDI: Pain Disability Index, FABQ: Fear Avoidance Beliefs Questionnaire.
Data is presented as mean (SD) and median (min;max).
Significant p-values are shown in bold text.

Significant improvements were found for isometric knee-extension force (p<0.010), health status (p=0.038), current pain intensity (p=0.033), 6MWT (p= 0.003), isometric elbow-flexion force (p= 0.02), pain disability (p= 0.005), and pain acceptance (p= 0.043) in the resistance exercise group (n=56) when compared to the control group (n=49). The improvements were supported by significant improvements in within-group analyses of the resistance exercise group, presented in Study IV, Table 2. Patient global impression of change (PGIC) differed significantly (p= 0.001) in favor of the resistance exercise group at post-treatment examinations.

A total of 91 (70%) participants completed the follow-up, 48 (72%) in the resistance exercise group and 43 (68%) in the active control group respectively. No significant differences between the resistance exercise group and the active control group were found for change from baseline to the 13-18 month follow up. The only significant within-group improvement in the resistance exercise group that was found at follow-up was for pain acceptance (CPAQ) (p= 0.044), presented in Study IV, Table 3.

Additional results (unpublished data)

The analysis of correlations between work status and aspects of health in women with FM showed fair correlations (159) between work status and: 6MWT, activity limitations (FIQ physical function), pain disability, and physical health related quality of life (SF36 PCS). Work status showed weak correlations (159) with knee extension force, pain, pain acceptance, and health status (FIQ total), Table 12. The analyses of differences between working and nonworking women with FM showed better physical capacity in terms of 6MWT, less pain, less activity limitations, better pain acceptance, less pain disability, and better physical health-related quality of life (SF36 PCS) in the working women than in the nonworking women, Table 12.

Table 12. *Additional analysis of between group differences and correlations of work status and aspects of health in the study population of Study IV.*

	Between group comparison			**Correlation analysis**
Aspects of health (ICF)	**Working women (n=73)**	**Nonworking Women (n=45)**		**Correlations with work status (n=118)**
	mean (SD)	**mean (SD)**	**p-value**	**r_s (p-value)**
Body function, performance based test				
6MWT (m)	562.2 (67.7)	528.2 (68.5)	**0.039**	0.28 (**0.002**)
Knee extension force (N)	324.5 (103.9)	295.8 (107.3)	0.25	0.20 (**0.034**)
Body function, ratings				
FIQ pain (0-100)	58.5 (20.4)	69.8 (17.3)	**0.004**	-0.27 (**0.003**)
Activity and participation				
FIQ physical function (0-100)	37.1 (22.7)	48.4 (23.6)	**0.013**	-0.28 (**0.002**)
CPAQ	66.7 (15.3)	56.8 (17.2)	**0.005**	0.23 (**0.015**)
PDI	32.5 (11.3)	39.9 (12.7)	**0.001**	-0.32 (**0.001**)
Health status				
FIQ total (0-100)	61.4 (14.9)	65.2 (15.0)	0.11	-0.19 (**0.041**)
SF36 PCS (0-100)	32.2 (7.5)	27.7 (8.4)	**0.005**	0.31 (**0.001**)
SF36 MCS (0-100)	38.4 (12.1)	38.6 (12.3)	0.90	0.05 (0.60)

6MWT: 6 minute walk test, FIQ: Fibromyalgia Impact Questionnaire, CPAQ: Chronic Pain Acceptance Questionnaire, PDI: Pain Disability Index, SF36 PCS: Short Form 36 Physical Component Scale.
r_s= Spearmans rho
significant p-values are shown in bold text

DISCUSSION

The concept of work ability is relational, multidimensional and includes several individual aspects, such as aspects of health, as well as aspects related to work and the environment. Thus, work ability in women with FM is complex and can be studied from many different perspectives. This thesis focused on aspects of work and health in women with FM, from a physiotherapeutic perspective, using quantitative methods for comparing groups, investigating relationships and explanatory factors, measuring changes over time, and qualitative methods for exploring the experiences of women with FM.

The participants in the studies of this thesis were recruited from primary health care and by advertisements in daily newspapers. The mean age of the participants was quite similar in studies II-IV, however somewhat lower in study I, most likely due to the difference regarding age in the inclusion criteria. The symptom durations as well as tender point counts were fairly similar in studies I, III, and IV, however not specified in study II. About 40% of the participants in study I and about 58% of the participants in study IV worked to some extent, which is within the range of international reports of work ability in FM (16). However, in study II and III, only working women were included.

Aspects of health in relation to work status in women with FM

Working women with FM reported better health than nonworking women with FM in dimensions of body function and overall health status, predominately regarding symptoms, quality of life, and health status. Pain (FIQ pain) was the only independent explanatory factor for work. In the additional analysis, however, in addition to pain, mental fatigue and physical health related quality of life (SF36 PCS) were also found to be independent explanatory factors for work. Pain has previously been reported to predict remaining in a work role for women with FM (59) and pain has previously been found to be a critical factor for work in rheumatic diseases (71, 164). Our results indicate that women with FM having moderate pain generally could be expected to work. Some women appear to be able to work despite severe pain, which raises the question if there are workplace related factors that support their ability to work (68, 165). A recent study of differences between working and nonworking women with FM has reported significantly more severe symptoms in the nonworking women.

However, the most important difference between the groups was reported to be social support from colleagues and employers (166).

The working women in our study displayed a significantly better disease specific health status (FIQ total, eight-item) than the nonworking women. An earlier study on work disability in FM reported that FIQ total score was found to predict work disability (58), indicating that health status is of importance for work in FM. Physical health-related quality of life (SF-36 PCS) was significantly higher in the working- than in the nonworking women in our study, which is in line with a previous study of FM (167). However, the quality of life of workers in our population, assessed by SF-36, was very low as compared to a national sample (168). Impaired health status assessed by SF-36 has earlier been associated with work disability in rheumatoid arthritis (RA) (164), systemic lupus erythematosus (SLE) (169) and musculoskeletal pain (170).

Performance based tests of physical capacity did not differ between the groups, and both groups presented lower capacity than the average population, which is in concordance with previous reports (11, 13, 132). However, in the additional analyses of study IV presented in the thesis, the 6MWT was significantly better in the working women than in the nonworking women, and showed a fair correlation to work status. These results indicate that physical capacity is of importance for work in women with FM. Previous reports of the importance of physical capacity for work have shown that the 6MWT is a good predictor for return to work for women with chronic low-back pain (171) and that performance-based tests of physical capacity are predictive for work participation in women with chronic musculoskeletal pain (172). However, the physical work demands also influence the work ability, especially in persons who have an impaired physical capacity. Earlier studies have reported the importance of the physical work environment for the ability to work from the perspective of women with FM (69, 165), and other rheumatic diseases (173). One must also keep in mind that being at work does not necessarily mean having good health, although ill-health and sickness absence are strongly related (174). Health presence as well as sickness presence are possible alternatives for being work present (120) and there is no way to distinguish the two in this study.

The results from study I are based on cross-sectional data and the questions of cause and effect and changes over time remain unanswered. The results could be considered a confirmation of the adequacy of who is approved with sick-leave benefits and who is not. The results could also be considered a statement of the obvious, referring to the theory of the healthy worker effect which suggests that healthier individuals are more likely to remain in the workforce (175). On one hand, the results of the present study agree well with this theory. On the other hand, work has been reported to be beneficial for the health status in women (176) and sick-leave has been reported to be associated with premature death in both women and men, in the general population (177) as

well as in musculoskeletal disorders (178), implying that work is beneficial for health. Also, the results from study I provide details on which aspects of health that differ between working and nonworking women with fibromyalgia and, in addition, explanatory factors for work, which could be considered to be of importance when planning rehabilitation or interventions to promote work in this population.

Promoters for sustainable work

The participants seemed to hold a careful balancing act where well-functioning strategies were experienced as necessary for managing work, in the short- and long term, without risking overload. This can be understood against the background of impaired physical capacity (11-13) and activity limitations in women with FM (14, 15). The balancing act also seems to reflect the multidimensional complexity of work ability, which has been described as a balance between the individual's physical and mental capacity, social functioning, knowledge and skills, values, attitudes, motivation and work satisfaction, in relation to physical and mental work demands, the work environment and work community (62).

Work was highly valued for many reasons. The individual meaning of work was pragmatic in some aspects while other aspects related more to self-actualization. The social meaning of work concerned inclusion and acceptance on a group level as well as in society. The participants related to earlier experiences of sick leave and exclusion and a fear of not fitting into the societal norms of the working citizen. Our results support earlier studies of FM and chronic musculoskeletal pain that have found the meaning of work and values placed on work to be of importance for staying at work (69, 179). Also, the perception of leading a meaningful life is suggested to be of importance for a person's sense of coherence and health (180). A sense of coherence reflects a person's sense of meaningfulness, sense of comprehensibility, and sense of manageability (180) and has previously been reported to be a preventive factor for sickness absence in the short- and long term in women in the general population (120).

Strategies developed and used by the participants enabled them to manage their work, and life. Physical activity was described both as a short-term strategy for alleviating symptoms and an important long-term strategy for maintaining or building stamina to cope with work. To improve physical capacity or to stay fit by engaging in physical activity has previously been reported to be a successful strategy for work in women with FM (70), and in people with chronic musculoskeletal pain (179). An interesting finding in our study was that 10 of the 27 participants reported having made a career change when work demands were too high, in order to avoid overload and be able to continue their work life. Some had changed jobs within the same organization while others had

completely changed their career, which in some cases meant years of competence development. The career changes often meant leaving a physically strenuous or stressful job. This finding is in concordance with an earlier study of persons with chronic musculoskeletal pain, reporting change of jobs as a successful strategy for staying at work (179), but has to the best of our knowledge not been described earlier in women with FM. Mobility in the labor market could be a solution for sustainable work for some people. However, the importance of knowledge about the sick-listed person's resources in relation to the labor market and the work place has been emphasized in a previous report (181). The report suggests measures to facilitate job-mobility to be included in intervention programs to reduce long-term sick leave in some sick-listed people while others would be expected to benefit more from work place adjustments to be able to return to their previous job (181). Most participants in our study worked part-time to make time for recovery; regardless of whether they chose to work fewer hours every day or full days every other day, this appeared to be a successful strategy for sustainable work. The opportunity to shorten the working day has previously been reported to be associated with better self-assessed work ability in women working in different occupational sectors in Sweden (182). An intriguing finding among the individual strategies enhancing work ability in our study was the development of personal qualities, which to our knowledge, has not previously been described in women with FM. The participants described that self-awareness of limited work capacity started the development process of personal qualities required when exposed to physical and psychosocial work demands. It seemed to be a continuous process of insight, mental development and new type of skills. The process of building personal skills could be expected to be applicable not only to promote work ability but to promote health in other areas of life as well (183). All individual strategies are developed within a specific context and many of the strategies developed and used by the participants were dependent on their specific work situations and the amount of influence they had on their work situation. These are conditions that are largely dependent on the management, the colleagues and the organization at work.

Forty-one percent of the participants were employed in administration, which often meant physically non-strenuous work tasks, possibilities for varying work tasks and posture during the work day and, most often, possibilities for taking pauses when needed. These conditions appeared to give an opportunity for the recovery that was required to manage the risk of overload from work, suggesting that a favorable work environment is important for sustainable work in women with FM. Earlier studies have also reported the importance of a favorable physical work environment for work from the perspective of women with FM (69, 165).

A favorable psychosocial work environment was found to be a promoting factor for sustainable work. One important aspect was that the support of

management and colleagues meant opportunities for adjustments of work schedules and work tasks and possibilities for receiving help, which enabled the participants to manage the risk of overload at work. These results are supported by a recent study reporting that the social support from colleagues and employers was the most important variable when differentiating between working and nonworking women with FM (166).

Many participants had experienced support from health-care services as promoting their ability to manage their work. The support from health-care services has previously been described to be of importance for staying at work with chronic musculoskeletal pain (179). A previous narrative study of work ability in women with FM emphasizes the need for early rehabilitation interventions and describes experiences of moving back and forth between full work ability and disability where a lack of early rehabilitation interventions was typical (17). In our study, having needs and rights recognized by the Social Insurance Agency when needing assistance in setting limits for workload was critical for some participants to be able to keep working. The Swedish Social Insurance Agency's tools for providing financial aid for reduced work hours gave the opportunity for recovery in the long term, which reduced the risk of overload at work. The role of the Swedish Social Insurance Agency as a promoter for sustainable work in women with FM needs to be acknowledged.

The study population was homogeneous with respect to diagnosis and participation in work life. A limitation in the recruitment process is that no data were collected from the women who chose not to participate in the study, which could conceal a possible response bias. However, heterogeneity of the study population (163) in terms of variations in age, pain impact, type of occupation and work hours covered a wide spectrum of perspectives and enriched the focus group discussions. Focus group interviewing was a suitable method for gathering data (158), as the participants openly shared their experiences and reflections with each other during relaxed discussions. A short data collection period (four weeks), standardized start and completion of the interview sessions, the use of an interview guide and the role of the co-moderator were measures to achieve dependability (163) in the data collection. The transcribed interviews were analyzed separately and jointly by the authors, and the independently developed codes and categories were found to be very similar. The results were supported by the five participants taking part in discussions of analysis interpretations which increased credibility of the interpretations (163). When the analysis of the category of meaning of work was presented, two full-time workers described that they had no other choice but to continue working full-time due to their private economy, emphasizing that income was an important meaning of work to them. As authors, we consider the results of this study to be relevant in planning rehabilitation for women with FM or other long-lasting pain disorders to promote sustainable work. However, the transferability of the results to other contexts must be judged by the reader (163).

Perceived physical exertion at work

The finding that perceived physical exertion at work was elevated in women with FM compared with healthy women was not surprising, given that the women with FM displayed an impaired physical capacity in this study, as expected and in concordance with previous reports (11-13, 49, 55, 184). However, the result was important since it was the basic assumption for further analysis of correlations with, and explanatory factors for perceived physical exertion at work.

The physical workload and the physical activity level at work, describing how much or little the person lifted, carried and moved around at work, showed the highest correlations with perceived exertion at work, both in the women with FM and in the healthy controls. Furthermore, the physical activity level at work was the strongest explanatory factor for perceived exertion at work for the total group of women with FM, and the only explanatory factor for perceived exertion at work in the women with FM with a light physical workload. Thus, regardless of disease or health, the physical activity level at work and the physical workload appear to be central for perceived exertion at work and, as it seems, also for the ability to work as physical workload has previously been reported to be a prognostic factor for duration of sickness absence in musculoskeletal disorders (85). Light perceived exertion at work has been reported to improve the prognosis for recovery from chronic pain in the low back and neck/shoulders, in healthcare workers (185). Further, high perceived exertion at work has been shown to be associated with the development of pain in the neck and upper extremities of professional computer users (186). Hence, a favorable physical work environment in terms of less physically strenuous work, which was experienced as a promoting factor for work by women with FM in Study II (187), would be thought to decrease perceived exertion at work and thereby promote continued work in women with FM.

Hand-grip force and anxiety were the strongest explanatory factors for perceived exertion at work in the women with FM with a medium heavy physical workload. The results indicate hand-grip force as a critical factor for perceived exertion at work which supports previous findings of strong associations between hand-grip force and work capacity in women with rheumatoid arthritis (188). Also anxiety seems to be important for perceived exertion at work, which supports previous findings of associations between mental health and physical exertion at work in FM (189). The results of our study imply that women with FM with a medium heavy physical workload might be exposed to physical demands exceeding their physical capacity. The mean ratings of perceived exertion at work reflected moderately strenuous to strenuous physical exertion at work, levels that have previously been reported to be a risk factor for long-term sickness absence in healthcare workers of the general population (83). For women with FM with a medium heavy physical

workload, an improvement in muscle function, and especially hand-grip force, would be anticipated to enhance their ability to perform strenuous work tasks and thereby increase their opportunities for a sustainable work life. This finding opens new perspectives for choice of treatment for this group and further studies are needed to explore whether an improvement in physical capacity would increase work ability in women with FM with physically demanding work.

In study III, pain did not seem to be a critical factor for perceived exertion at work in the women with FM, although, pain showed a fair correlation (r_s 0.44, p= 0.02) with perceived exertion at work in the women with FM with a medium heavy physical workload. However, pain was found to be the only independent explanatory factor for work in study I (190). Pain has previously been described to be an underlying factor for anxiety, fear avoidance, and impaired physical capacity in FM (53, 191). The complexity of pain and interactions between subjective and objective findings require further investigation.

The study population was classified by their physical workload in the analysis of explanatory factors for perceived exertion at work. A moderate correlation (r_s 0.70, $p < 0.001$) between categories and reported physical activity level at work supports the relevance of the chosen model of classification. Furthermore, the moderate correlations between perceived exertion at work and reported physical activity level at work indicate that perceived exertion at work in women with FM adequately reflects the level of physical activity at work and lends validity for using the physical activity at work index (PHYI) in future studies of women with FM. There were no women with FM in the study population who had a heavy or heavy repetitive physical workload, while 60% of the women with FM had a light physical workload, 37% had a medium heavy physical workload, and 3% had a light repetitive physical workload. It is possible that women with FM who undertake heavy manual labor are scarce due to long-term sick leave or disability pension, which has been suggested in previous studies (16, 58, 81). More than half of the women with FM in the study population (53%) were on part-time sick leave or disability pension. Women with FM who have a heavier physical workload seem to be at a higher risk for future sick leave, however this requires further investigation.

The women with FM had a significantly lower level of education than the healthy women, which could affect the perception of exertion at work, since a higher level of education often means having more control over one's work situation and possibilities for more flexibility at work. However, when adjusted for differences in education, the significant difference of perceived exertion at work between groups remained, indicating that education was not a critical factor for the perception of exertion at work.

Person-centered progressive resistance exercise

In the randomized controlled study (study IV), seven percent (n=5) of the women in the resistance exercise group reported adverse effects (i.e. increased pain) and three of them did not complete the post-treatment examination. Adverse effects in this study are in line with a previous study of resistance exercise in women with FM (192). The low number of reported adverse effects and very few drop-outs due to increased pain indicate that this exercise program is feasible for women with FM and that the majority tolerated the exercise well, as experiences of aggravated symptoms is a risk for women with FM when engaging in exercise (53). The progression of the resistance exercise program is assumed to be an important factor for the success, since starting at low loads with gradual introduction to heavier loads has been shown to be a method for avoiding exercise-induced pain (106) and the results are in concordance with previous studies of resistance exercise in women with FM which use the same mode of progression (107, 108). Regarding the dosage and type of exercises included in the program, it is mainly based on the recommendations for healthy novice adults (109). The person-centred approach (110) to the exercise program, based on self-efficacy principles (111), focusing on building a partnership between the participant and the physiotherapist seemed to promote the participants' ability to take charge of the exercise program and its' progress and they appeared to gain confidence for the management of exercise.

Significant improvements in favor of the resistance exercise group compared to the active control group were found for performance based tests of physical capacity including isometric knee-extension force, 6MWT, and isometric elbow flexion force. The significant between-group differences were supported by significant within-group improvements in the resistance-exercise group, which also showed improved hand-grip force in the resistance exercise group. The mean improvement in isometric knee-extension force was smaller in our sample than in the two previous studies (108, 193), and the reasons for this may to some extent be related to differences in the measurement equipment. Improvement in the 6MWT has previously been reported in women with FM performing resistance exercise (194). However, this is the first RCT of resistance exercise in women with FM showing improvements in 6MWT and strength in upper extremities represented by biceps strength compared with a control group. Given that (i) the physical capacity of women with FM is impaired (11-13, 49, 55, 184) also shown in Study III (195), (ii) that work ability is a balance between individual resources and work demands (62), (iii) that physical demands at work that exceed the physical capacity of the individual has been reported to be a prognostic factor for longer sickness absence in musculoskeletal disorders (85), and that, (iiii) physical capacity in terms of hand-grip force and the 6MWT are closely related to work ability in chronic pain conditions (171, 188), this program of resistance exercise could also be assumed to be beneficial for the

ability to work for women with FM, especially for the women working in medium heavy physical work, where hand-grip strength was shown to best explain perceived exertion at work in Study III (195).

The mean improvement in current pain intensity in the resistance exercise group represented an improvement of 23% which is considered a clinically important difference (196). Within-group improvements of pain (192, 194, 197) and FIQ total score (192, 197) have previously been reported in women with FM engaging in resistance exercise. However, this is the first RCT of resistance exercise in women with FM that reports improvements in pain intensity and FIQ total score compared with a control group. Since pain was found to be the only independent explanatory factor for work in Study I (190), and has previously been reported to predict remaining in a work role for women with FM (59), and also to be a critical factor for work in rheumatic diseases (71, 164), improvement in pain could be assumed to promote work ability in these women as well.

Significantly improved pain disability (PDI) after the resistance exercise intervention indicated improvement in participation in activities of everyday life. This reflects that the intervention focusing on enhancement in self-confidence and pain management during the exercise sessions was also of use in the daily life of the participants. This interpretation is in line with a previous report showing that self-efficacy is a good determinant of disability in chronic musculoskeletal pain (198). Furthermore, significantly improved pain acceptance, CPAQ, was found in the resistance exercise group compared with the active control group. Acceptance of pain has been suggested to be associated with less disability and better functioning in patients with chronic pain (152). Pain acceptance (CPAQ) was the only significant improvement found at follow-up after 13-18 months in the resistance exercise group, which implies that the intervention promoted a process of pain acceptance that has long-term effects. However, the long-term follow up only included self-reported questionnaires.

A probable reason for the lack of other long-term effects is that the physical activity levels declined to the baseline levels after the end of the intervention period. Some of the reasons given by participants for not continuing exercising were expensive gym memberships, need of continued supervision and guidance, and difficulties in prioritizing exercise in daily life. Similar lack of long-lasting effects and difficulties for women with FM to maintain their levels of resistance exercise after the end of intervention have previously been reported (197). A longer period of guidance and support might be one way of increasing the prospects for long-lasting effects.

Clinical implications

Our results indicate that aspects of body function, disease specific health status and physical aspects of quality of life are better in working women with FM than in nonworking women with FM and that pain is of importance for the ability to work. These results can be considered when planning rehabilitation for women with FM, focusing on physical functioning with emphasis on pain management.

Working women with FM appear to have developed individual strategies to enhance their work ability and to avoid overload from work. Support from health-care professionals as well as from employers in the process of the development of such strategies is suggested to be of importance to promote sustainable work. The influence of the physical and psychosocial work environment should also be addressed and the employers should be included in the process of creating conditions for sustainable work such as adjustments in work tasks to better match the physical capacity of the individual, and strategies for handling physical demands at work. Based on our results that hand-grip force was the strongest explanatory factor for perceived exertion at work in the women with FM with a medium heavy physical workload, this group would be expected to benefit from improving their muscle strength to enhance their ability to manage their physical workload.

A 15 week, supervised, person-centered, resistance exercise program with individually adjusted loads and progression according to each participant's resources is feasible, successful and can be recommended for women with FM to improve muscle function, health status, pain intensity, and participation in daily life activities. However, strategies to support long-term regular exercise should be developed to ensure longstanding health effects.

CONCLUSIONS

Working women with FM reported better health than nonworking women with FM in body functions and overall health status, in terms of pain, fatigue, stiffness, depression, disease specific health status and physical aspects of quality of life. Pain was found to be the only independent explanatory factor for work.

In the focus group study of working women with FM, the meaning of work and individual strategies were found to be important individual promoters for sustainable work while a favorable work environment and social support outside work were found to be important environmental promoters for sustainable work. Most promoting factors involved the identification and use of internal and external resources to manage the risk of physical and mental overload, which was a careful balancing act performed by the women, that to some extent was dependent on their specific work situation. The working women with FM appeared to have developed well-functioning strategies to enhance their work ability. The development of such strategies should be supported by health-care professionals as well as employers to promote sustainable work in women with FM.

Women with FM perceived an elevated physical exertion at work. Perceived exertion at work in the women with FM was explained by their physical workload and physical activity level at work, as anticipated, but also by their hand-grip force, anxiety, and fear avoidance work beliefs. Promotion of sustainable work in women with FM should include adjustments in work tasks to better match the capacity of the individual, and strategies for handling physical demands at work.

Person-centered progressive resistance exercise performed twice a week for 15 weeks showed to be a feasible mode of exercise for women with FM and can be recommended for improving muscle function, health status, pain intensity, pain management and participation in activities of daily life.

FUTURE PERSPECTIVES

We found that body functions and overall health status were better in the working women with FM than in the nonworking women with FM. However, longitudinal studies are needed to explore if working women with FM maintain their health, or if it deteriorates over time. Also, it would be interesting to see if an intervention focusing on the development of individual strategies for work and efforts to make the work environment more favorable would bring the elevated perceived exertion at work of the women with FM closer to the levels of healthy women.

The resistance exercise intervention was feasible and improved muscle function, health status, pain intensity, pain management, and participation in activities of daily life. However, strategies to support long-term regular exercise need to be developed to ensure longstanding health effects.

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