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## Research article

# INFLUENCE OF MODERATE TRAINING ON GAIT AND WORK CAPACITY OF FIBROMYALGIA PATIENTS: A PRELIMINARY FIELD STUDY

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### ABSTRACT

This field study examined the influence of moderate intensity training on gait patterns and work capacity of individuals with fibromyalgia syndrome (FS). FS is a chronic condition of unknown etiology, characterized by muscle tenderness, pain and stiffness and often accompanied by depression and fatigue which seems to occur primarily in middle aged females. There is no known cure for FS but treatment often includes a prescription of mild exercise. Few studies have evaluated the effectiveness of mild exercise on work capacity and gait patterns in FS patients. Participants were 14 females (age 47.0± 7.6 y) who participated in a 10 wk community based aerobic, strength and stretching program designed for FS individuals. Subjects were evaluated pre- and post-program and at a 2 month follow up. Work capacity was estimated using a sub-maximal PWC 170 cycle ergometer test and a Borg perceived exertion scale. Gait was assessed using OptoTrack three dimensional kinematics with 16 channel analogue data acquisition system. Trunk flexibility was also assessed. No significant change in estimated work capacity or flexibility was seen between pre- post- and follow up times. Nevertheless, a significant increase in self selected walking speed ( $p < 0.05$ ) and a trend toward a more normal gait pattern that was sustained in the follow up testing was noted. We had previously also reported a significant improvement in muscle pain and other fibromyalgia symptoms in this population consequent to the training program. It was concluded that mild exercise training that does not influence work capacity or trunk flexibility can nevertheless positively influence gait mechanics and fibromyalgia symptoms in female FS patients.

**KEY WORDS:** Fibromyalgia, exercise, gait, work capacity

### FİBROMİYALJİ HASTALARININ YÜRÜME VE İŞ KAPASİTELERİ ÜZERİNE ORTA ŞİDDETLİ ANTRENMANIN ETKİSİ: BİR ÖN SAHA ÇALIŞMASI

#### ÖZET

Bu saha çalışmasında fibromiyalji sendromlu (FS) bireylerde orta şiddetli antrenmanın yürüme seyri ve iş kapasitesi üzerine etkisi incelendi. FS etyolojisi bilinmeyen, öncelikle orta yaş kadınlarda görülen yorgunluk ve depresyonun eşlik ettiği kasta hassasiyet, ağrı ve sertlikle karakterize kronik bir hastalıktır. FS tedavisi bilinmemekle birlikte tedavi sıklıkla orta şiddette egzersiz içermektedir. FS'lu hastalarda sınırlı sayıda yapılan çalışmada orta şiddetli egzersizin yürüme seyri ve iş kapasitesi üzerine olan etkisi değerlendirilmiştir. 14 kadın (yaş 47.0 ± 7.6 yıl) denek FS'lu bireyler için hazırlanmış olan geniş kitleleri hedef alan aerobik, kuvvet ve germe egzersizlerini içeren 10 haftalık bir programa katıldı. Denekler program öncesi, sonrası ve 2 ay sonrasında değerlendirildi. İş kapasitesi submaksimal PWC 170 bisiklet ergometresi testi ve Borg'un egzersiz şiddetini subjektif değerlendirme cetveli ile değerlendirildi. Yürüme 16 kanallı analog data akışı sağlayan OptoTrack üç boyutlu kinematik sistemi kullanılarak ölçüldü. Gövde esnekliği de ölçüldü. Tahmini iş kapasitesi ve esneklik öncesi, sonrası ve 2 ay sonrası arasında anlamlı değişiklik göstermedi. Bununla birlikte yürüme hızını kendi kendine belirlemede anlamlı ( $p < 0.05$ ) bir artış ve testleri takiben daha normal bir yürüme seyrine doğru değişim not edildi. Biz daha önceki çalışmamızda bu popülasyon için antrenman programını takiben kas ağrısı ve

fibromiyalji semptomlarında anlamlı bir gelişim bildirmiştik. Sonuç olarak, orta şiddetli egzersiz antrenmanı FS'lu kadın hastalarda iş kapasitesi veya gövde esnekliğini etkilememekle birlikte fibromiyalji semptomları ve yürüme mekanizmasını pozitif olarak etkileyebilir.

**ANAHTAR KELİMELER:** Fibromiyalji, egzersiz, yürüme, iş kapasitesi.

## INTRODUCTION

Fibromyalgia syndrome (FS) is recognized by the World Health organization and the American College of Rheumatology as a chronic, non-inflammatory rheumatoid condition which manifests as diffuse muscle pain, tenderness and stiffness (Wolfe et al., 1990). FS patients may also report symptoms of chronic fatigue, sleep disturbances and mild depression (Gremillion, 1998). Among diagnostic indicators of FS are widespread pain both above and below the waist and tenderness at 11 or more of 18 specific muscle tender point sites (Wolfe et al., 1990). The causes of FS are unknown but have been reported to be triggered by, among other things, musculoskeletal trauma or viral infection (Gremillion, 1998). FS is a multi-dimensional disorder involving neuro-endocrine and other physiological disruptions and manifesting as muscle pain and fatigue (Crofford, 1998; Mountz et al., 1998; Gremillion, 1998). There is no known cure for FS and at present only tentative treatments (Aларcon and Bradley, 1998).

In addition to various drug treatments, many FS patients use massage, chiropractic and acupuncture treatments to attempt to alleviate symptoms (Wainapel et al., 1998). However, the effectiveness of these treatments has been largely untested. Exercise training has also been advocated for FS intervention (Sim and Adams, 1999). Although results have been mixed, it has generally been concluded that aerobic training may improve general well being or FS patients without exacerbation of FS symptoms (Meyer and Lemley, 2000; McCain et al., 1988; Rossy et al., 1999). Training effects on oxygen uptake or work capacity of FS patients have been mixed, with many but not all studies reporting improvements in these measures consequent to training in FS patients (McCain et al., 1988; Clarke, 1994). Because FS patients often experience pain with exercising, compliance of FS patients with exercise programs has often been problematic (Clark, 1994). Best compliance is often found in programs of milder intensities. It is likely that lower intensity exercise programs will have less positive effect on work capacities of FS patients and hence may have less influence on other disease symptoms, despite better compliance. This question needs more rigorous testing. Of the studies that have examined the effects of various forms of

exercise training on FS, few have reported on post-training follow up measures and none have reported on the potential for training to influence the abnormal gait patterns seen in FS patients (Dawson et al., 2001). Abnormal gait patterns are characteristically seen and can be used as a diagnostic and measurement tool of disease symptoms and progress in a number of disabilities (Winter, 1988). In a previous pilot study we had noted significant abnormalities in gait of FS patients (Dawson et al., 2001). Improvement of clinical symptoms in various conditions have often resulted in improved gait patterns in those patients (Winter, 1988).

In response to the generally positive influence on FS attributed to exercise training, a number of community based exercise programs aimed at individuals with FS have emerged (Dawson et al., 2002). However, the effectiveness of these community programs have never been comprehensively evaluated (Dawson et al., 2002). We had previously reported significant improvements in pain perception and mood of FS patients consequent to participation in a community based exercise program which were retained several months after the end of the program (Dawson et al., 2002). The purpose of this study was to further evaluate the influence of participation in a moderate intensity community based exercise program for individuals with FS on estimated work capacity, trunk flexibility and gait patterns.

Since many previous studies lacked a follow up investigation of FS patients after completion of the structured exercise program. The community program evaluated in this study is designed to encourage FS patients to maintain an active lifestyle after leaving the structured exercise program, and hence maintain any benefits gained from the program itself. This is the first study to examine the effects of 2 months of self selected moderate exercise on estimated work capacity and gait patterns in FS patients following a structured exercise program

## METHODS

This study was reviewed and approved by Wilfrid Laurier University Research Ethics Board for human subjects.

### *Subjects*

A repeated measures, within group, field study research design was utilized with three measurement time points (pre-program, post-program and 2 month follow up). Twenty two volunteers, were selected to take part in the study. To maximize group homogeneity, only sedentary (no exercise for at least 3 months prior to the study) middle aged females who were currently medication free were selected to participate in the study. This criteria was used since most individual with FS are middle aged females. Since, the purpose of the study was to investigate effects of mild exercise training on FS patients, only sedentary subjects were selected. Of these subjects, 14 completed the full study and form the data base for this report. Subjects who did not attend at least 80% of the exercise classes, attend all of the testing sessions or did not continue an exercise program on their own subsequent to the structured community program were excluded from the data base.

Mean age of the subjects was  $47.0 \pm 7.6$  y (range 34-61 y). All subjects reported FS symptoms for at least 8 years prior to the study. All subjects were assessed by two trained medical practitioners prior to the study. Those selected for the study all met the American College of Rheumatology classification for FS (Wolfe et al., 1990). Participants experienced an average of  $14.6 \pm 2.6$  tender points and all met or exceeded the FS tender point classification threshold of at least 11 of 18 tender points (Dawson et al., 2002) at the start of the study.

Since this was a preliminary field study intended to provide initial assessment to a community based exercise program for FS patients, it did not have some of the controls typically seen in a laboratory based study, specifically a control group.

### *Exercise Training Program*

Subjects participated in a community exercise program designed for individuals with FS offered by the YWCA of Kitchener-Waterloo, Ontario Canada (The Fibro-Moves Exercise Program) (YWCA, 2000). The program was offered twice weekly for 10 weeks and consisted of gentle progressive resistance land and pool based whole body exercises of one hour duration. The program consisted of a 5 min warm up followed by 30 min of exercises for cardiovascular development, 10 min of exercises for strength development and concluded with 15 min of muscular stretching and relaxation. During the cardio-vascular exercise component subjects exercised at approximately 60% of their age predicted maximum heart rates. This was periodically monitored by a trained exercise leader, by asking subjects to take and report their own heart

rates. All subjects included in the study completed at least 80% of the exercise sessions.

Following completion of the YWCA program, subjects were encouraged to maintain an active lifestyle on their own. All 14 subjects re-evaluated at the 2 month post-program follow-up had maintained a regular exercise program of 30 min per day of moderate intensity activity at least twice per week.

### *Work Capacity*

Due to concerns about compliance, safety and propensity for pain during intense physical activity, a direct measure of maximum oxygen uptake/work capacity was deemed inappropriate for this population. Instead a submaximal PWC 170 test, which estimates work capacity at a heart rate of  $170 \text{ b}\cdot\text{min}^{-1}$  was selected. This test is appropriate for estimation of sub-maximal work capacity and relative aerobic fitness in the middle-aged, clinical population used in this study (Adams, 1994). Following a brief warm-up subjects began exercising on Monarch 818 Cycle ergometers at 50 W for 3 min. Workload was increased by 25 W every 3 min and heart rates recorded via Polar Heart rate monitors. Subjects continued until they completed 100 W workload or their heart rates exceeded 80% of their age predicted maximum. Heart rates at these submaximum workloads were used to estimate physical work capacity at a heart rate of 170 BPM as previously described (Adams, 1994; Borg and Dahlstrom, 1962). Subjective perception of discomfort and effort while performing this test were also evaluated using a Borg perceived exertion scale (Borg, 1982). The rating of perceived exertion at 50 W was the recorded exertion measure. The use of both of these measures provided information not only on the effects of the exercise program on estimated aerobic capacity, but also on the subjective discomfort while exercising. Changes in either or both of these variables could indicate that the exercise program influenced functional capacity (Borg, 1982). Body weights of all subjects were also recorded.

### *Flexibility*

The subject's trunk flexibility was assessed using the modified sit and reach flexibility test (Hopkin and Hoeger, 1992). While sitting with legs straight, the participant reached toward or past their toes as far as possible. The flexibility test was completed after the participant had completed the bicycle ergometer test to ensure warm muscles and avert possible injury. Two attempts were made with the second attempt recorded as distance (cms) reached on a meter stick.

### *Kinetic Gait Analysis of Walking Economy*

A kinetic test analysis was performed using a state-

of-the-art facility that uses OptoTrack 3d kinematics with 16 channel analogue data acquisition systems, and a force-plate. During each visit, the subjects completed eight walking trials at a comfortable speed along a 7 m walkway such that their right foot made contact with the flush-to-floor force platform. Twelve active markers were attached to the pelvis (3), thigh (3), leg (3), and foot (3) to allow full 3D kinematic segment data recordings. The anthropometric, kinematic and kinetic data were analyzed to provide trial specific walking speed and hip and ankle peak moment ratios during gait. Values near 0.34 are typically seen in the clinically normal population (Winter, 1988).

#### Data Analysis

A multivariate repeated measures analysis was completed across the three time points for all measures, with checks for sphericity completed. If the overall F statistic across the three time points was significant at  $p < 0.05$ , then post-hoc dependent (paired) t-tests were completed between program start and completion and then for program completion and 2 month follow up. This allowed for the two purposes of the study to be met by first evaluating changes in the assessments due to the exercise program (pre-post t-test comparison) and whether these changes were sustained, improved or decreased over time with the self-monitored regular exercise (post-program follow-up t-test comparison).

The results of the PWC170 work capacity estimates, gait analysis, flexibility and body weight measures at pre-program, post-program and 2 month follow up time points are presented in Table 1. The estimated work capacity and flexibility results for FS patients were similar to those typically seen in untrained middle aged and older women (Adams, 1994; Hopkins and Hoeger, 1992). No significant differences ( $p > 0.05$ ) were found for body weight, perceived exertion-Borg Scale, flexibility or PWC170 estimated work capacity at pre-program versus post-program time points. Similarly, no significant alterations to any of these measures occurred during the 2 months after program completion.

The results for self selected walking speed and the hip/ankle ratio are also presented in Table 1. Analysis of the mean normalized progression velocity data revealed significant differences in self selected walking speed before and after intervention ( $p = 0.036$ ). This improved walking speed was maintained but not improved with 2-months of regular exercise ( $p = 0.299$ ). Although not statistically significant, the exercise participants demonstrated improvements in their hip/ankle ratio pre-program ( $0.67 \pm 0.32$ ) to post-program ( $0.59 \pm 0.21$ ), moving more toward hip/ankle strategies used by typical asymptomatic individuals (0.34) (Winter, 1988). These improvements in speed and near significant improvements in hip/ankle ratios tended to be sustained at 2-months follow-up.

## RESULTS

**Table 1.** Pre- program, post-program and 2 month follow up measures on FS patients. Data are mean (SD).

	Pre-program (n = 14)	Post-program (n = 14)	2 month follow up (n = 14)
Mass (kg)	77.7 (11.8)	79.0 (13.2)	77.7 (12.3)
Perceived exertion-Borg scale (1-20)	14.2 (1.8)	13.9 (1.7)	13.0 (2.4)
Trunk flexion (cm)	28.1 (9.0)	24.9 (8.9)	28.2 (7.3)
P 170 work capacity (Watts)	112 (34)	120 (31)	136 (43)
Self-selected walking speed ( $m s^{-1}$ )	1.27 (0.17)	1.37 (0.19)*	1.32 (0.24)
Hip/ankle ratio (unitless)	0.67 (0.31)	0.59 (0.22)	0.64 (0.16)

\* significant difference from pre to post program ( $p < 0.05$ ).

## DISCUSSION

The primary finding of this field study suggests that a community based, modest intensity training program may positively influence aspects of gait in FS patients. Specifically, self selected walking speed was significantly increased in these individuals. There was also a non-significant trend toward a more normal hip-ankle ratio in walking. We had previously reported a significant decrease in number

of tender points and muscle pain in these FS patients consequent to the training program (Dawson et al., 2002). This suggests that post-training, the subjects may have experienced less movement discomfort, thereby resulting in an enhanced walking speed and a trend toward a more normal hip-ankle ratio in their gait pattern. While these improvements tended to be maintained, after 2 months of self administered physical activity, further research is needed confirm these tentative trends. Several other studies have

also shown positive results of exercise on symptoms of FS (Martin et al., 1996; McCain et al., 1988). However no previous study has reported on the potential for exercise to influence gait or self selected walking speed.

It is significant that some potential improvements in movement, as well as the previously reported reductions in muscle tender points and soreness (Dawson et al., 2002) occurred consequent to a training regimen that did not result in significant increases in predicted work capacity and trunk flexibility or reductions in body weight. It is likely that exercise intensities employed in the YWCA Fibro-moves program were of insufficient intensity to elicit significant adaptations in predicted work capacity. This is not necessarily surprising given the exercise limitations of individuals with FS and the fact that the program is marketed as "gentle exercise" (YWCA, 2000). This may be of importance to FS patients since many of them cannot tolerate intense exercise due to exercise induced exacerbation of muscle discomfort, and would discontinue the program if higher intensities of exercise were employed (Clarke, 1994).

Hence some functional benefits may be obtained for individuals with FS even from exercise programs of modest intensity, which they can tolerate without eliciting major muscular discomfort. Further, it is possible that some of these benefits may be retained if the FS patient continues to exercise on their own after the completion of a community based supervised exercise program. More research with a greater subject pool and of longer duration is necessary to confirm these preliminary observations and trends.

This was a preliminary field study intended to assess the effectiveness of a community based exercise program in influencing FS. As such, it lacked some of the controls inherent in a more rigorous laboratory based study, particularly a control group. Nevertheless, findings from field studies can provide useful preliminary information for further more detailed follow up studies. They can also provide valuable feedback to the providers of community based programs who often lack any critical analysis of the effectiveness of their programs. Hence, while the data from this study cannot yet be considered conclusive, it does suggest that the positive trends seen should be investigated further.

## CONCLUSIONS

Findings from this preliminary field study suggested that improvements in walking patterns may occur in female FS patients consequent to participation in a community based exercise program of moderate

intensity. There was also a trend to maintain some of these improvements over 2 months of self selected exercise subsequent to the community program. The community based exercise program did not induce any changes in estimated work capacity, trunk flexibility or body weight. This suggested that even moderate intensity exercise which is well tolerated in FS patients may induce positive improvements in some FS symptoms without necessarily improving overall fitness. More research with larger numbers of subjects are needed to confirm these preliminary findings. However the potentially positive trends seen in this study should encourage further research in this area and the continuation of provision of community based exercise programs for FS patients.

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