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ORIGINAL ARTICLE

Effects of Pool-Based and Land-Based Aerobic Exercise on Women With Fibromyalgia/Chronic Widespread Muscle Pain

EVA SALTSKÅR JENTOFT,[1] ANNE GRIMSTVEDT KVALVIK,[1] AND ANNE MARIT MENGSHOEL[2]

Objective. **To examine the effects of pool-based (PE) and land-based (LE) exercise programs on patients with fibromyalgia.**
Methods. **The outcomes were assessed by the Fibromyalgia Impact Questionnaire, the Arthritis Self-Efficacy Scale, and tests of physical capacity.**
Results. **Eighteen subjects in the PE group and 16 in the LE group performed a structured exercise program. After 20 weeks, greater improvement in grip strength was seen in the LE group compared with the PE group ($P < 0.05$). Statistically significant improvements were seen in both groups in cardiovascular capacity, walking time, and daytime fatigue. In the PE group improvements were also found in number of days of feeling good, self-reported physical impairment, pain, anxiety, and depression. The results were mainly unchanged at 6 months followup.**
Conclusion. **Physical capacity can be increased by exercise, even when the exercise is performed in a warm-water pool. PE programs may have some additional effects on symptoms.**
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KEY WORDS. Fibromyalgia; Exercise; Rehabilitation; Physiotherapy.

INTRODUCTION

The clinical diagnosis of fibromyalgia (FM) is based on a history of chronic widespread musculoskeletal pain and excessive tender point pain accompanied by several subjective symptoms such as fatigue, sleep problems, stiffness, gastrointestinal problems, depression, and anxiety (1). The classification criteria for FM, which have been developed for research purposes, are widespread musculoskeletal pain for at least 3 months' duration and distinct pain on digital palpation of at least 11 out of 18 defined tender points (2). FM is a fairly widespread condition. In a Norwegian female population aged 20 to 49 years, 13% were found to experience chronic widespread pain (3) and about 10% fulfilled the classification criteria for FM (4).

The etiology of FM is unknown, and the pathogenesis is unclear. Thus, causal treatment is not possible. Of the symptomatic treatments, antidepressants and sedatives have been found to have some pain-modulating effect (5). A variety of other pharmacologic and nonmedical treatment modalities have been tried, and several controlled studies have shown that aerobic exercise programs may improve physical capacity in patients with FM (6–9). Pain and fatigue were also found to be modulated by a self-paced exercise program (9).

Rehabilitation programs for patients with FM often include exercise (10–13). In our clinical experience, patients with FM prefer to exercise in warm-water pools, and a clinical benefit from performing pool-based aerobic exercise has also been suggested by others (14,15). However, the effects of aerobic exercise have only been reported in connection with land-based exercise programs. It is unclear whether similar or better effects can be achieved by training in a heated pool.

The aim of the present study was to examine whether there were any differences in symptoms, self-efficacy, self-reported physical impairment, and physical capacity in a group of FM patients performing structured pool-based and land-based aerobic exercise programs.

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[1]Eva Saltskår Jentoft, RPT, and Anne Grimstvedt Kvalvik, MD, Haugesund Sanitetsforening Rheumatism Hospital, Haugesund, Norway; [2]Anne Marit Mengshoel, RPT, PhD, National Hospital, Center for Rheumatic Diseases, Oslo, Norway.

Address correspondence to Anne Marit Mengshoel, RPT, PhD, Section for Health Science, Medical Faculty, University of Oslo, PB. 1153 Blindern, N-0316 Oslo, Norway.

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Table 1. Characteristics of women with fibromyalgia who followed pool-based exercise (PE) and land-based exercise (LE) programs

Characteristics	PE group (n = 18)	LE group (n = 16)
Age, years*	42.9 ± 8.6	39.4 ± 8.8
Duration of symptoms, years*	11.1 ± 5.7	11.1 ± 8.4
Full/part-time employed (%)	44	50
Educational level		
≤9 years of education (%)	16.5	25
10–13 years of education (%)	67	56
≥14 years of education (%)	16.5	19
Married/cohabiting (%)	61	94
Number of tender points*	13 ± 3	9 ± 3†

* Mean ± SD.
† $P < 0.001$.

PATIENTS AND METHODS

Patients. In Norway general practitioners diagnose and recommend treatment modalities for patients with FM, and they often prescribe participation in exercise groups. This study was conducted by a physiotherapist and a rheumatologist in a hospital rheumatology unit, and the patients were referred to the study by general practitioners. Women aged 20–60 years who fulfilled the American College of Rheumatology (ACR) classification criteria (2) were included. Although inflammatory rheumatic diseases, hypothyroidism, and heart and lung diseases do not constitute exclusion criteria for the classification of FM, women with these diseases and pregnant women were excluded.

Forty-seven female FM patients were included in the study. Three withdrew from the study before baseline testing. Forty-four patients were then randomized by lot to either a pool-based exercise (PE) group (n = 22) or a land-based exercise (LE) group (n = 22). Two women in the PE group did not meet for any of the exercise sessions. In the LE group 2 participants were diagnosed as having inflammatory rheumatic diseases during the exercise period. Protocol violation was defined as attendance at fewer than 50% of the exercise sessions. This applied to 4 patients in the LE group and 2 patients in the PE group. Those who were wrongly included, those who did not meet at all, and those who did not attend at least 50% of the exercise sessions were excluded from the statistical analysis (n = 10). Thus, the results apply to 18 patients in the PE group and 16 in the LE group. The mean age in the PE group was 42.9 ± 8.6 years, versus 39.4 ± 8.8 years in the LE group (not significant). The mean duration of pain was 11 years in both groups. The characteristics of the groups are shown in Table 1.

Design. The study had a parallel group design, in which the outcomes of pool-based and land-based exercise programs were compared. There are no studies examining the variability of symptoms in FM. However, in the planning of the present study we postulated that there might be some variation. We therefore considered that the mean of 2 assessments would probably be a more valid baseline value than a single assessment. Thus, the data referred to as week 0 correspond to the mean values of these 2 assessments. The exercise period was 20 weeks, and the patients were reexamined at the end of this time (week 20) and at followup 6 months after completing the exercise program (week 46). The patients were informed about the times of reexamination before the exercise period began, and they were encouraged to continue to exercise regularly after the end of the 20-week exercise program. The outcome variables were examined by 2 trained physiotherapists who were blinded for the patients' group affiliation. All patients were examined and reexamined by the same physiotherapist.

Exercise program. A standardized exercise program based on the Norwegian Aerobic Fitness Model (16) was used. The aim of the program was to improve cardiovascular capacity with minimal risk of injury. Each exercise session lasted 60 minutes and consisted of body awareness training, ergonomics, warm-up exercises, aerobic dance, cooling down exercises, muscle stretching exercises, strengthening exercises, and relaxation training. The exercises followed a certain pattern and each part lasted a predetermined time (Figure 1). The exercises consisted of dynamic muscle work, and they were accompanied by music.

The Norwegian Aerobic Fitness Model was used in its original form for the LE group. A modified version of the model, adapted to the restrictions imposed by water, was used for the PE group. The training intensity and the muscle groups activated were as similar as possible in the 2 groups. In at least 40–50% of the 60-minute exercise sessions, the training intensity was kept within 60–80% of the maximum heart rate for the age of each patient. A pulse watch recorder monitored the heart rate at least twice during the whole exercise period, and the exercise intensity was found to be within the desired limits. The exercise program was performed twice a week for 20 weeks for both groups. The PE group trained in a pool with a water temperature of 34°C. A gymnastic hall with normal room temperature and a wooden floor was used for the LE group. A physiotherapist (ESJ) instructed and administered the exercise sessions in both groups.

Effects on symptoms and self-efficacy. The Fibromyalgia Impact Questionnaire (FIQ) was used to assess pain severity, daytime fatigue, morning tiredness, stiffness, anxiety, and depression, as well as the number of days of feeling good (17). The patients marked the severity of symptoms on 10-cm visual analog scales (VAS) where 10 symbolized the most severe symptoms. The number of days of feeling good during the previous week was graded 0–7. Exercise-induced pain was defined as the difference in intensity of local pain before and after the assessment of shoulder muscle endurance. The local pain intensity was marked on a 10-cm VAS (18).

The tender points located in accordance with the ACR classification criteria for FM (2) were counted. Tender point pain was tested by a dolorimeter as the highest

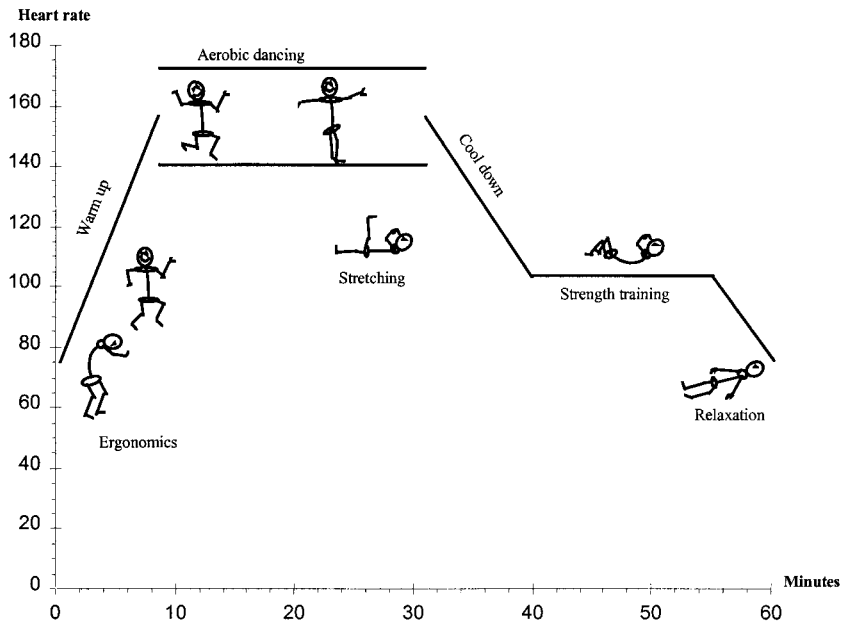

Figure 1. The Norwegian cardiovascular fitness model (ref. 16) applied to females with fibromyalgia/chronic widespread muscle pain.

pressure tolerated on the tender points (pain tolerance) located in the middle of the right trapezius muscle, the right elbow muscles, the left trochanter, and the left knee fat pad.

According to the theory of self-efficacy (19), patients' beliefs in their own capability influence what they actually do. Previously, high self-efficacy has been found to be associated with high physical capability and low pain intensity in patients with FM (20). Self-efficacy was measured by a Norwegian translation of the Swedish version of the Arthritis Self-Efficacy Scale (21).

Effects on physical function. Self-reported physical impairment was assessed as the ability to perform 10 daily physical activities according to the FIQ (17). The responses were scaled from 0 (always able to do them) to 3 (never able to do them). These scores were calculated as a sum score according to the guidelines given by Burckhardt and colleagues (17). Physical capacity was examined by assessments of cardiovascular capacity, walking time, grip strength, and endurance of the shoulder muscles.

Cardiovascular capacity was defined as maximum O_2 uptake and was tested on a bicycle ergometer (Monark Ergomedic 829E, Monark AB, Vardberg, Sweden) according to Aastrand's indirect method of assessing oxygen consumption (22). Cycling was performed for 6 minutes at a resistance level of 300–725 kpm. The pedaling frequency was 60 revolutions per minute. An electrocardiogram monitored the heart rate. After 4–6 minutes of exercise the heart rate had reached a steady state level. Maximum O_2 uptake (given as ml O_2/kg $\times$ min) was calculated by a computer program from the data on heart rate at the steady state level, bicycling intensity during exercise, weight, age, and sex.

Grip strength was tested by a hand-held manometer (Martin Vigorimeter, Gebruder Martin, Tuttlingen, Germany) and measured in kPa. The dominant hand was tested. The test was performed in a sitting position with the upper arm parallel to the trunk, the elbow at 90° of flexion, and the forearm and hand in zero position. The test was performed 3 times, and the highest value was noted (23).

Endurance time of the shoulder muscles of the nondominant arm was tested. While seated the subjects were told to hold a sheet of paper easily against the wall with a pencil. The arm was positioned at 30° of flexion in the shoulder joint and 90° of flexion in the elbow. The test was interrupted at the moment when the paper fell down, or when the pencil moved more than 1 cm (24). The endurance time was measured in seconds.

Walking time was measured in seconds by having the patients walk an indoor distance of 100 m as fast as possible without running.

Data analyses. The data were mainly normally distributed. They are given in means and standard deviations (SD). The Fischer exact test and *t*-tests were used for the analysis of normally distributed data. Non-normally distributed and categorical data were analyzed by the Wilcoxon tests. P values ≤ 0.05 were considered statistically significant.

RESULTS

Baseline assessments. Before starting the exercise programs the patients (n = 34) were examined twice, and statistically significant differences were found between some of the outcome variables. With respect to number of tender points, the mean ($\pm$ SD) at the first assessment was 10.9 $\pm$ 3.5, versus 12.0 $\pm$ 4.0 at the second baseline assessment ($P = 0.03$). The mean number of days of feeling good was 1.8 $\pm$ 1.8 versus 2.6 $\pm$ 2.2 ($P = 0.01$). FIQ morning tiredness was 7.8 $\pm$ 2.0 versus 6.6 $\pm$ 2.7 ($P = 0.02$), and FIQ stiffness was 8.0 $\pm$ 2.0 and 7.0 $\pm$ 2.4 ($P = 0.001$). In the further presentation of the results, week 0

Table 2. Effects on symptoms and self-efficacy from pool-based (PE) and land-based (LE) exercise programs in women with fibromyalgia*

Effect variables	PE group (n = 18)			LE group (n = 16)		
	Week 0	Week 20	Week 46	Week 0	Week 20	Week 46
FIQ† days of feeling good (0–7)	1.8 ± 1.8	3.7 ± 1.7‡	3.3 ± 2.4	2.6 ± 1.7	3.4 ± 2.0	4.1 ± 2.3
FIQ† pain (0–10)	6.9 ± 1.7	5.6 ± 2.3‡	5.2 ± 2.4	5.8 ± 2.0	5.2 ± 3.1	3.9 ± 2.7
FIQ† daytime fatigue (0–10)	7.3 ± 1.8	5.9 ± 2.8‡	5.6 ± 2.8	6.4 ± 2.6	4.9 ± 2.9§	5.6 ± 3.3
FIQ† morning tiredness (0–10)	7.8 ± 1.7	7.1 ± 2.6	7.2 ± 2.3	6.6 ± 2.1	6.0 ± 3.2	6.2 ± 3.1
FIQ† stiffness (0–10)	7.8 ± 1.8	6.2 ± 2.6‡	6.6 ± 2.8	7.3 ± 2.4	5.5 ± 2.7§	5.1 ± 2.7
FIQ† anxiety (0–10)	4.3 ± 3.4	3.6 ± 3.5§	4.1 ± 3.0	3.3 ± 2.3	3.6 ± 2.9	2.7 ± 2.7
FIQ† depression (0–10)	3.9 ± 2.9	2.6 ± 2.6§	3.1 ± 2.6	3.1 ± 3.0	2.8 ± 2.9	2.3 ± 2.5
Exercise-induced pain (0–10)	23.0 ± 23.3	17.7 ± 21.0	13.6 ± 21.7	22.1 ± 19.8	17.6 ± 21.6	23.6 ± 23.6
Self-efficacy, pain (10–100)	51.9 ± 13.6	52.3 ± 16.3	52.9 ± 17.7	51.1 ± 19.4	53.6 ± 20.5	54.1 ± 19.8
Self-efficacy, other symptoms (10–100)	59.2 ± 16.2	63.0 ± 18.7	61.4 ± 16.4	60.1 ± 22.2	60.3 ± 21.8	64.2 ± 23.2

* Mean ± SD. Results are given at baseline (week 0), after a period of exercise (week 20), and at 6 months followup (week 46).
† FIQ = Fibromyalgia Impact Questionnaire.
‡ Within-group differences compared with baseline, $P < 0.01$.
§ Within-group differences compared with baseline, $P = 0.05$.

corresponds to the mean values of the 2 baseline assessments.

The PE and LE groups. Eighteen patients in the PE group and 16 patients in the LE group completed the study according to the study protocol. At baseline the PE group had a significantly higher number of tender points than the LE group ($P < 0.001$). The 2 groups also differed significantly at baseline for tender point pain in the trapezius muscle ($P = 0.007$) and at the trochanter ($P = 0.03$). Adjustments for these differences were made in the statistical analysis. No other significant differences were found between the 2 groups at baseline (Table 1).

Effects on symptoms and self-efficacy. No between-group differences were found in these variables after 20 weeks of exercise (Table 2). The PE group showed statistically significant within-group improvements in pain ($P = 0.006$), daytime fatigue ($P = 0.002$), stiffness ($P = 0.003$), anxiety ($P = 0.04$), depression ($P = 0.04$), and the number of days of feeling good ($P < 0.001$). The LE group showed statistically significant within-group improvements in daytime fatigue ($P = 0.02$) and stiffness ($P = 0.02$). The improvements were unchanged at the time of followup in both groups. A significant reduction in the number of tender points ($P = 0.02$) was found after 20 weeks in the LE group, but this had risen again at the assessment in week 46 ($P = 0.04$). No changes were seen in tender point pain or self-efficacy scores in either group.

Physical function. The LE group had improved their grip strength after 20 weeks compared with the PE group ($P = 0.02$). No between-group differences were found in other variables (Table 3). The PE group had a significant improvement in self-reported physical impairment ($P < 0.05$). Increased cardiovascular capacity was found in both the PE group ($P = 0.02$) and the LE group ($P = 0.004$). Improved walking time was also seen in both the PE group ($P = 0.003$) and the LE group ($P = 0.002$). These improvements could still be observed at week 46, apart from a reduced cardiovascular capacity in the LE group ($P = 0.001$) and reduced grip strength in the PE group ($P = 0.03$). During the 6 months after completing the exercise program 85% participated regularly in physical activities at least once a week.

DISCUSSION

Improved grip strength was seen in the LE group compared with the PE group after 20 weeks of exercise. In both groups, within-group improvements were found in daytime fatigue, stiffness, cardiovascular capacity, and walking time. Within-group improvements were also seen in the PE group with respect to self-reported physical impairment, number of days of feeling good, pain, anxiety, and depression.

Except for the difference in grip strength at the end of the exercise period in favor of the LE group, no significant differences between the groups were found. In both exercise groups significant improvements in cardiovascular capacity and walking time were observed. This supports the hypothesis that physical capacity can be improved in FM patients by exercise, even when exercising in a warm-water pool. The improved physical capacity found in the present study is in accordance with studies comparing exercise with no exercise in FM patients (25–27). Thus, there is fairly strong evidence that patients with FM can perform exercise programs at an intensity level high enough for them to improve their physical capacity. The PE group also improved with regard to self-reported physical impairment, number of days of feeling good, pain, anxiety, and depression. As far as we know, no comparable studies addressing the question of the possible additional beneficial effects of exercising in a warm-water pool have been made with FM patients. Thus, more studies are needed. Patients with rheumatoid arthritis have reported pain reduction (28), increased exercise tolerance (29), and reduced joint tenderness (30) after exercise in a warm-water pool.

The mean age of patients included in previous studies of

Table 3. Effects on physical capacity and self-reported physical impairment from pool-based (PE) and land-based (LE) exercise programs in women with fibromyalgia*

Effect variables	PE group (n = 18)			LE group (n = 16)		
	Week 0	Week 20	Week 46	Week 0	Week 20	Week 46
Self-reported physical impairment (0–10)	4.2 ± 1.7	3.4 ± 1.7‡	3.0 ± 1.9	3.8 ± 2.0	3.1 ± 2.0	2.5 ± 1.9
Shoulder muscle endurance time, seconds	171 ± 158	258 ± 291	263 ± 301	161 ± 98	227 ± 156	220 ± 161
Grip strength, kPa†	27.2 ± 4.3	28.1 ± 5.5	26.6 ± 5.0¶	28.0 ± 5.0	31.3 ± 3.9§	30.4 ± 5.6
Cardiovascular capacity, O_2 ml/kg × min	30.7 ± 7.7	34.1 ± 8.4‡	32.0 ± 7.9	33.4 ± 13.6	39.3 ± 12.9§	33.2 ± 10.3#
Walking time, seconds	59.8 ± 6.6	57.2 ± 6.9§	57.4 ± 8.7	60.4 ± 14.3	54.8 ± 9.2§	55.3 ± 8.7

* Mean ± SD. Results are given at baseline (week 0), after a period of exercise (week 20), and at 6 months followup (week 46).
† Greater increase in grip strength in the LE group than in the PE group from baseline to week 20, $P < 0.05$.
‡ Within-group differences from baseline to week 20, $P < 0.05$.
§ Within-group differences from baseline to week 20, $P < 0.01$.
¶ Within-group differences from week 20 to week 46, $P < 0.05$.
# Within-group differences from week 20 to week 46, $P < 0.01$.

exercise (6–9) was from 33 to 46 years, and the mean disease duration was 8 to 11 years (6–9,27). Both characteristics are within these ranges in the present sample. Mean pain intensity on a VAS scale at baseline in the reported studies ranged from 5.6 to 8 cm, compared with 5.8 to 6.9 cm in our study. Thus, our sample seems to be comparable with those in previous studies. However, all of the study samples are of fairly young women with FM, and it is unclear whether the results obtained from these studies can be applied to an older population of women with FM, or to men with FM.

Previously, Buckelew and colleagues (20) reported that a high self-efficacy score is associated with reduced pain and low physical impairment in patients with FM. These authors (26) also found improved self-efficacy after an exercise program. This was not confirmed in the present study or in the study by Martin and colleagues (6). The programs probably need to include strategies that directly address self-efficacy.

As far as we know, no studies have been published on natural variations in symptoms in FM. For this reason we made 2 baseline assessments rather than 1. Our results demonstrate that the symptoms may vary even over a couple of weeks, whereas the physical function variables showed stability. This observation is important to keep in mind when evaluating treatment efficacy. If a treatment is efficient, the differences should be greater than the natural variability. It may be questioned whether the 2 baseline assessments in the present study were enough to show the real variability of symptoms in the patient group. However, we suggest that the mean values of several assessments are a more valid baseline value than the value from only 1 assessment. In the present study the significant differences between week 0 and post-exercise values were greater than the differences between the 2 baseline assessments with respect to the differences in number of days of feeling good, pain, daytime fatigue, stiffness, depression, and anxiety.

There are shortcomings in the present study that may influence the possibility of demonstrating between-group differences. In the first place the small samples increase the possibility of false negative findings. Another problem is whether adequate outcome variables have been chosen. As the patients with FM themselves seem to pay considerable attention to pain and fatigue, it seems reasonable that at least these variables are relevant clinical outcome parameters. As in the present study, parameters of physical capacity have been included in previous exercise studies (6–9). One may also question whether the methods chosen are sensitive enough to detect differences. FIQ, VAS, the Arthritis Self-Efficacy Scales, and the assessments of physical capacity have been applied in previous controlled clinical trials in FM and have been shown to demonstrate changes. Thus, the methods used seem to be appropriate, but the sample size is probably an important shortcoming in the detection of between-group differences.

Another question that may be raised is whether the PE and LE groups were comparable. At week 0 the groups differed significantly with respect to number of tender points, with the PE group having the higher mean number. A large number of tender points has been considered to be an indicator of severity in patients with FM (31). This may suggest that the patients in the PE group were more severely impaired by their chronic pain condition than those in the LE group. However, there were no between-group differences in the other variables that also reflect health status, such as symptoms, self-reported physical impairment, or physical capacity. Therefore, the groups seem to be comparable with respect to health status measurements.

All of the patients had chronic widespread pain and had been judged by physicians to have FM on the basis of a clinical examination and the ACR criteria. In spite of that, some patients had fewer than 11 tender points at the 2 baseline assessments performed by the physiotherapists. The number of tender points was also significantly different at the 2 baseline assessments. A possible explanation

can be low interrater and intrarater reliability. However, this may also reflect variability in number of tender points in the patients. If there is a natural high variability in tender points, one may question whether tender point count is an appropriate diagnostic tool. This needs further examination.

In summary, the results from the present study support previous evidence that patients with FM can improve their physical capacity by exercise. Exercise in a warm-water pool may have additional positive effects on self-reported physical impairment and symptoms such as pain, depression, and anxiety compared with exercise performed in a gymnasium. Further studies are needed to confirm the possible extra beneficial effects of pool-based exercise.

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