# Spasticity, pain and exercise

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# Neurophysiological Basis of spasticity

- A Velocity Dependent increase in tonic **stretch reflexes**
- High tendon jerks
- Damage to myelin and axonal fibres=deterioration of upper stretch reflex (Balci,2018)
- Hyperexecitability of the stretch reflex as a component of the upper motor neuron syndrome
- Disruption of descending pathways involved in motor control
- The descending pathways control proprioceptive, cutaneous and nociceptive spinal reflexes which become hyperactive
- The corticospinal tract does not inhibit the reflexes= Hyperflexia (A part of the upper motor neuron syndrome)

(Barnes, 2011)

**Table 5.** Modified Tardieu Scale

**Muscle reaction quality (X)**

0- No resistance during passive motion
1- Minimal resistance during passive motion, no sense of catching at a certain angle
2- Feeling of catching at a certain angle (cuts passive movement, relaxes afterwards)
3- Weakening clonus (less than 10 seconds when stretching is continued and occurs at a certain angle)
4- Strong clonus (longer than 10 seconds when stretching is continued and emerging at a certain angle)
5- The joint can not be moved

**Stretching Speed:**

V1: As slow as possible, slower than the natural drop of the extremity segment due to gravity effect
V2: Extremity segment at the natural deceleration rate due to gravity effect
V3: As fast as possible, faster than the natural fall of the extremity segment due to gravity

Assessing spasticity (Balci , 2018)

**Table 3.** Ashworth Scale

| | |
|---|---|
| **0.** | Normal muscle tone |
| **1.** | Slight increase in muscle tone, minimal resistance at the end of the range of motion when the extremity is moved (less than half of the EHA) |
| **2.** | More pronounced tonus increase (the majority of the EHA) felt throughout the entire limb movement in muscle tone |
| **3.** | Significant tonus increase which makes passive movement difficult |
| **4.** | Affected extremity flexion and rigidity in extension |

**Table 4.** Modified Ashworth Scale

| | |
|---|---|
| **0.** | No tonus increase |
| **1.** | The presence of a catch-and-release feeling at the end of the range of motion or a slight tonus increase in character with minimal resistance |
| **1+.** | There is a slight increase in muscle tone observed through minimal resistance throughout the less than half of the joint range of motion |
| **2.** | Muscle tone is increased throughout the range of motion of the whole joint, but the joints can be moved easily |
| **3.** | There is significant tonus increase which makes passive movement difficult |
| **4.** | Affected parts are rigid in flexion and extension |

# Assessing spasticity (Balci,2018)

(Davis , 2020)

# Exercise and spasticity

Increase in the number of serial Sarcomers

Increase in muscle fascicle length

- Involve eccentric exercise at high velocity
- Positive strain of muscle fascicles
- Momentary deactivation in the stretched muscle

- Directly affecting **Neural control-** (constraint induced movement exercise)
- Altering properties of the muscle tendon unit such as **muscle fiber** or **fascicle length**
- Inducing Neural plasticity and effecting segmental and supraspinal levels=) **affecting threshold of tonic stretch reflex**
- A change in the **Number of Sarcomers** and associated change in fibre length due to a **change in the passive tension of a muscle**

# Mechanisms of exercise impact on spasticity

(Davis,2020)

sarcomers

Muscle tendon unit

Fascicle length

ORIGINAL RESEARCH ARTICLES

# The Effects of Electrical Stimulation Parameters in Managing Spasticity After Spinal Cord Injury

## A Systematic Review

Bekhet, Amira Hassan BSc; Bochkezanian, Vanesa PhD; Saab, Ibtissam M. PhD; Gorgey, Ashraf S. MPT, PhD, FACSM

Author Information

# Strategies for spasticity Regulation using Exercise

- Whole body vibration
- Eccentric movement
- Low- velocity based exercise
- Monitoring rest in exercise ( Active Rest)
- EMS (Electrical muscle stimulation) –(20-30 HZ, 300-500 MILISECONDS, AMPLITUDE GREATER THAN 100 MILIAMPER) (Hassan , 2019)

International Journal of
*Environmental Research and Public Health*

MDPI

*Article*

**Low-Intensity Physical Exercise Improves Pain Catastrophizing and Other Psychological and Physical Aspects in Women with Fibromyalgia: A Randomized Controlled Trial**

- Pressure Pain Threshold (Bjarke,2020)
- Pain Perception
- Pain catastrophizing (Environ , 2020)

# Centarl chronic pain and exercise

Muscle Endurance

Neuromuscular function

Endocrine function

disability

Pain severity

chronification

# Chronic pain and exercise (Amatya, 2018)

- …” chronic pain is pain presenting continuously or intermittently for at least 3 months past the normal time of healing….” (IASP, 1994)
- Increased psychological impairment
- Depression
- Fatigue
- Poorer general health
- Exercise activates central Inhibitory Pathways (Lima , 2017)
- Secretion of serotonin and opioids in the Medulla (Long-Acting)

Pain catastrophizing assessment Questionnaire (PCAQ)

| | Not at all | To a slight degree | To a moderate degree | To a great degree | All the time |
|---|---|---|---|---|---|
| I worry all the time about whether the pain will end | 0 | 1 | 2 | 3 | 4 |
| I feel I can't go on | 0 | 1 | 2 | 3 | 4 |
| It's terrible and I think it's never going to get any better | 0 | 1 | 2 | 3 | 4 |
| It's awful and I feel that it overwhelms me | 0 | 1 | 2 | 3 | 4 |
| I feel I can't stand it anymore | 0 | 1 | 2 | 3 | 4 |
| I become afraid that the pain will get worse | 0 | 1 | 2 | 3 | 4 |
| I keep thinking of other painful events | 0 | 1 | 2 | 3 | 4 |
| I anxiously want the pain to go away | 0 | 1 | 2 | 3 | 4 |
| I can't seem to keep it out of my mind | 0 | 1 | 2 | 3 | 4 |
| I keep thinking about how much it hurts | 0 | 1 | 2 | 3 | 4 |
| I keep thinking about how badly I want the pain to stop | 0 | 1 | 2 | 3 | 4 |
| There's nothing I can do to reduce the intensity of the pain | 0 | 1 | 2 | 3 | 4 |
| I wonder whether something serious may happen | 0 | 1 | 2 | 3 | 4 |

# Assessing pain perception

statement.

| 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Never true | Very rarely true | Seldom True | Sometimes true | Often true | Almost always true | Always true |

_____ 1. I am getting on with the business of living no matter what my level of pain is.
_____ 2. My life is going well, even though I have chronic pain.
_____ 3. It's OK to experience pain.
_____ 4. I would gladly sacrifice important things in my life to control this pain better.
_____ 5. It's not necessary for me to control my pain in order to handle my life well.
_____ 6. Although things have changed, I am living a normal life despite my chronic pain.
_____ 7. I need to concentrate on getting rid of my pain.
_____ 8. There are many activities I do when I feel pain.
_____ 9. I lead a full life even though I have chronic pain.
_____ 10. Controlling my pain is less important than any other goals in my life.
_____ 11. My thoughts and feelings about pain must change before I can take important steps in my life.
_____ 12. Despite the pain, I am now sticking to a certain course in my life.
_____ 13. Keeping my pain level under control takes first priority whenever I'm doing something.
_____ 14. Before I can make any serious plans, I have to get some control over my pain.
_____ 15. When my pain increases, I can still take care of my responsibilities.
_____ 16. I will have better control over my life if I can control my negative thoughts about pain.
_____ 17. I avoid putting myself in situations where my pain might increase.
_____ 18. My worries and fears about what pain will do to me are true.
_____ 19. It's a great relief to realize that I don't have to change my pain to get on with life.
_____ 20. I have to struggle to do things when I have pain.

*Revised date (4 October 2006)*

Pain Acceptance Questionnaire (PAQ)

# Assessing Pain Perception

**Table 2.** Effect of the intervention on the psychological constructs, perception of pain, and quality of life.

| | Physical Exercise Group | | | Control Group | | |
|---|---|---|---|---|---|---|
| | Pre-Treatment | Post-Treatment | Effect Size (d) | Pre-Treatment | Post-Treatment | Effect Size (d) |
| Pain catastrophizing | 27.31 (11.55) | 20.00 (10.86) * | 0.65 | 28.25 (13.32) | 27.06 (10.91) | - |
| Anxiety | 11.81 (3.54) | 9.94 (3.57) * | 0.53 | 12.19 (4.07) | 11.19 (3.69) | - |
| Depression | 31.13 (9.06) | 23.81 (7.93) * | 0.86 | 29.31 (11.55) | 27.94 (11.14) | - |
| Stress | 25.31 (7.18) | 22.88 (7.51) * | 0.33 | 24.50(6.34) | 24.75 (7.22) | - |
| Pain acceptance | 38.00 (14.33) | 42.94 (7.96) * | 0.43 | 39.38 (14.67) | 40.81 (13.54) | - |
| Pressure pain threshold (kg/cm$^2$) | 1.75 (0.98) | 2.07 (1.03) * | 0.32 | 1.76 (0.42) | 1.50 (0.59) * | 0.51 |
| Quality of life | 71.47 (14.21) | 61.49 (17.65) * | 0.62 | 62.44 (17.33) | 67.07 (15.87) | - |

Data are expressed as mean (SD), d: Cohen's d effect size reported only when the differences between times were significant, *: $p < 0.05$.

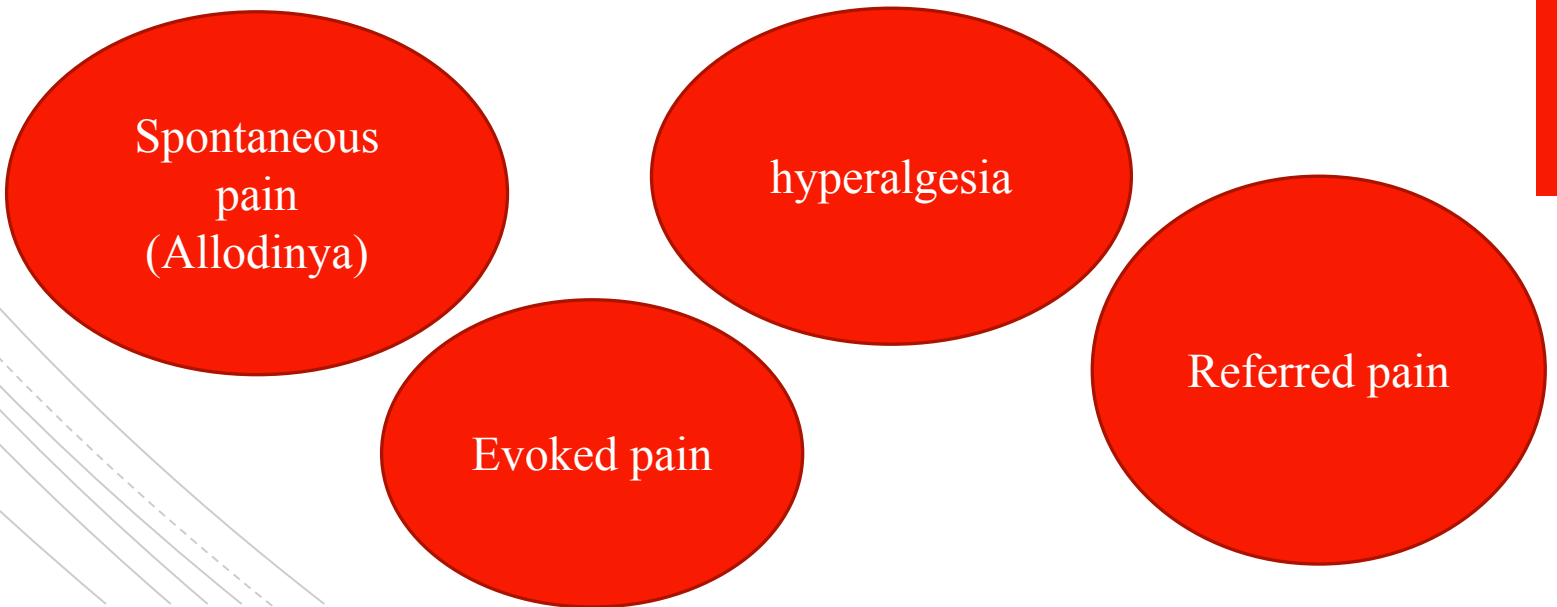
**Table 1.** 10-exercise circuit included in the physical exercise group protocol.

1. Preacher curl while standing, palms facing forward
2. Leg extension while seated by lifting a sandbell
3. Bilateral dumbbell front raise while standing
4. Standing hip abduction with a soft elastic band
5. Chest lateral pull-ups while standing
6. Dumbbell shoulder external and internal rotation while standing
7. Sitting down and standing up from a chair without using arms
8. Throwing a ball above the head and catching it
9. Standing calf raise
10. Low Step-ups

Environ,) (2020

# Neuroptic pain (Zhang,2021)

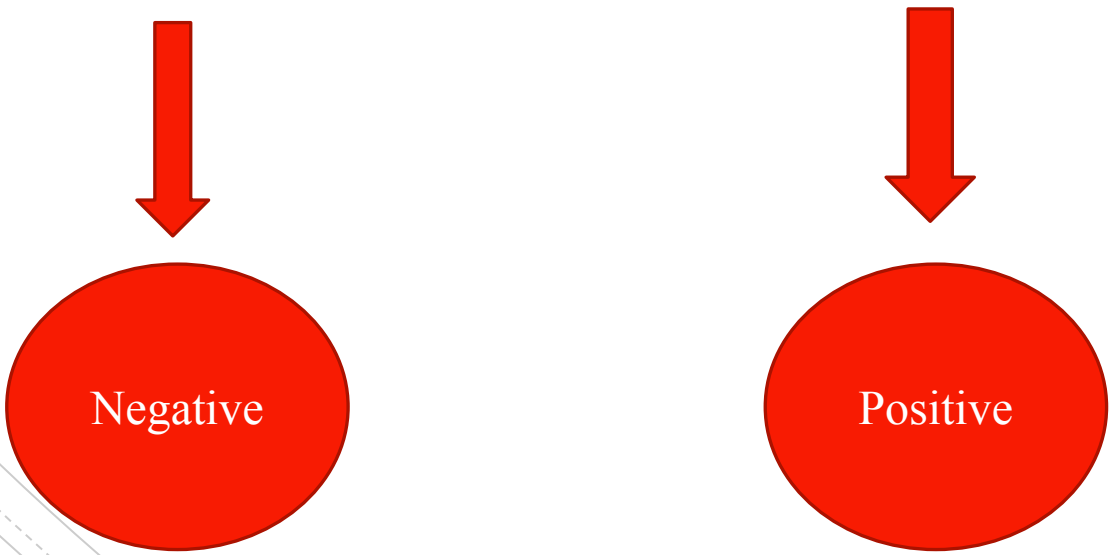
- Pain driven by a lesion or disease of the somatosensory nervous system.
- Damage to the innervation of peripheral nurves.



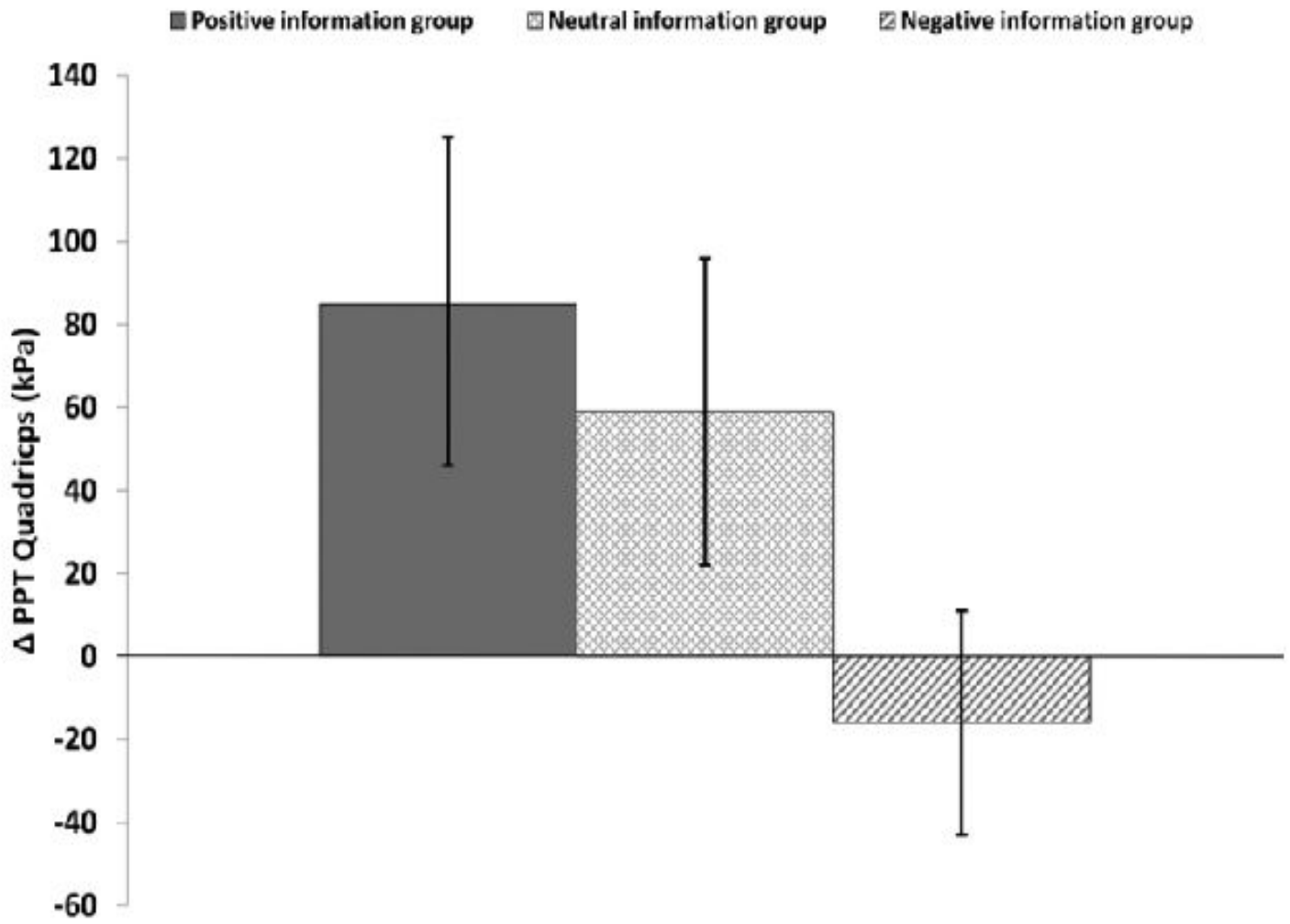
# Power of Words: Influence of Preexercise Information on Hypoalgesia after Exercise—Randomized Controlled Trial

HENRIK BJARKE VAEGTER[1,2], PETER THINGGAARD[3], CASPER HØJ MADSEN[3], MONIKA HASENBRING[4], and JONAS BLOCH THORLUND[3,5]

- Explanation about the effect of exercise on the pain




Patient education preexercise and pain (Bjarke ,2020)


Positive information group
Neutral information group
Negative information group
140
120
100
80
60
40
20
0
-20
-40
-60
Δ PPT Quadricps (kPa)

# RESULTS

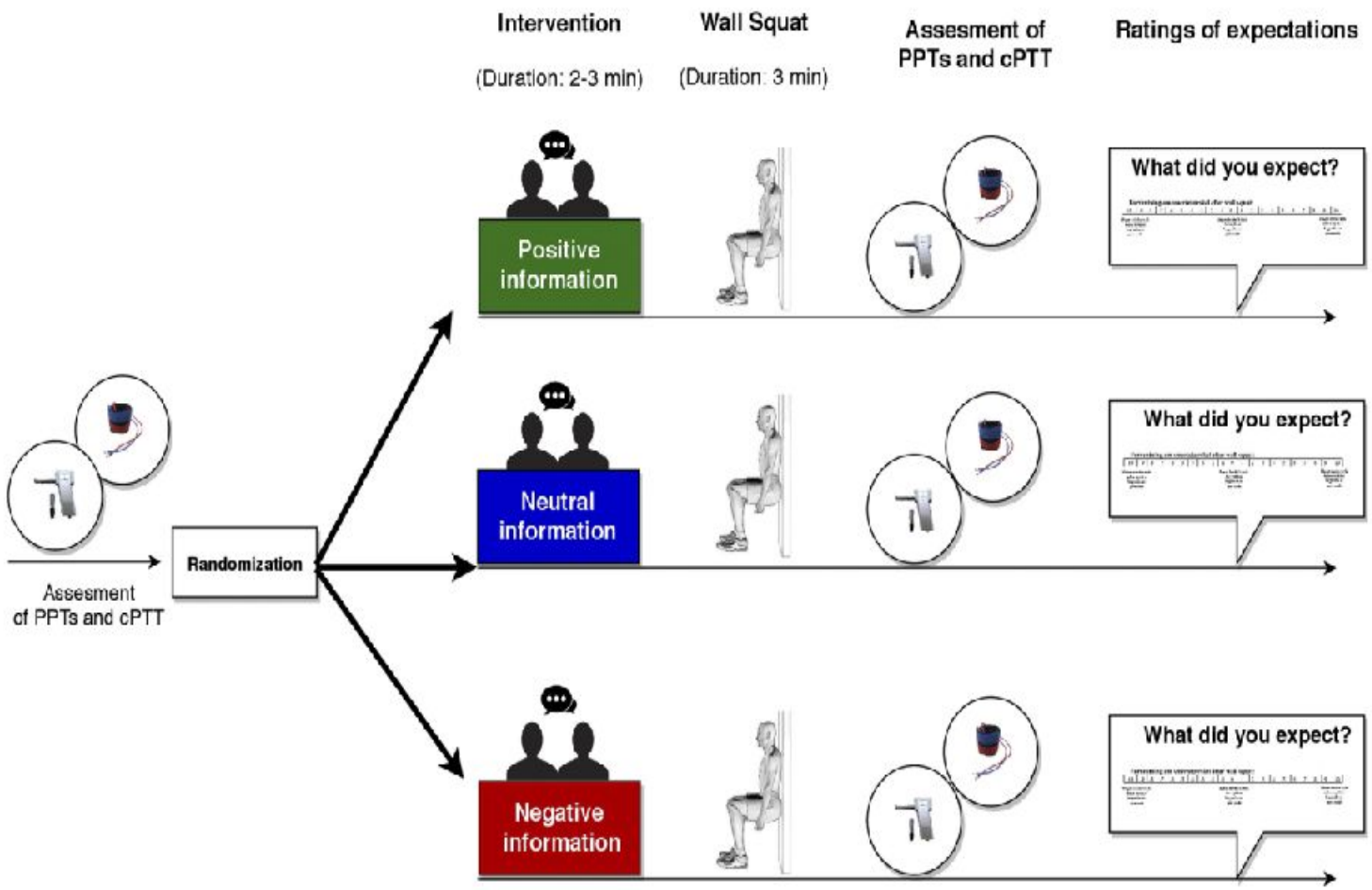



FIGURE 1—Illustration of the experimental procedure. PPT were assessed at the thigh and shoulder with handheld algometry, and cPTT were assessed at the lower leg with computer-controlled cuff algometry. PPT and cPTT were assessed before randomization and after the information interventions.

# Expectations And Pressure Pain Threshold (PPT)

- Robot –assisted gait training and strength training (Hedel, 2014)
- Voluntary Isometric contraction (Constantino, 2017)
- Short Home- based exercise (Grubic Kezele, 2019)
- Aquatic and Tai-Chi (Perez de la cruz, 2017)
- Symptoms Related Exercise (Albert and Manniche, 2013)
- Physiotherapist led- Aerobic Exercises (Tumuslime, 2019)

# Types of exercises Reducing pain

J Physiol 595.13 (2017) pp 4141–4150



SYMPOSIUM REVIEW

# Does exercise increase or decrease pain? Central mechanisms underlying these two phenomena

Lucas V. Lima, Thiago S. S. Abner and Kathleen A. Sluka

*Department of Physical Therapy and Rehabilitation Science, Pain Research Program, University of Iowa, Iowa City, IA 52242, USA*

- Fatigue may Enhance Pain
- Pain might be a factor in reducing adherence to regular exercise and rehabilitation leading the patient to a sedentary lifestyle (Damsgard, 2010)
- Muscle Fatigue promotes changes in the central nervous system that cannot only be explained in the muscle itself
- BECAREFUL how you frame the information you give the patient , make sure it fits his expectations, cognitive abilities and physical abilities!

## Pain and Fatigue Interactions (Lima , 2017)