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# Effect of Different Exercise Intensities on Induced Hypoalgesia and Pressure Pain Threshold in Non- Athletic Normal Young Adults

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**ABSTRACT**

**Background:** Pain is a frequent problem in medical practice. Several studies provided a good base in physical therapy field to use benefits of post-exercise hypoalgesia occurring after single bout of non exhaustive isometric and dynamic exercises in reduction of pain threshold in non-athletic healthy adults. **Objectives:** to examine the effect of post exercise hypoalgesia on pain threshold modulation that occurs following isometric and dynamic exercises. **Methodology:**One hundred and fifty healthy students participated in this study with age ranging between 18 and 23. The subjects were selected from Faculty of physical therapy, Deraya University. The subjects had no history of sensory or motor manifestations and were not under concurrent medications during this study. The sample was divided randomly into two equal groups; Group (1) was tested for the effect of non-exhaustive sub maximal single bout of isometric exercise on pressure pain threshold (PPT). Group (2) was tested for the effect of a single bout of short duration dynamic exercise on PPT. Dolorimeter was used to assess PPT in both groups. **Results:** Results revealed that there was a significant effect of non-exhaustive isometric and dynamic exercises application on PPT. Pressure pain threshold was elevated in both dominant non-dominant sides after isometric and dynamic exercises which lasted for ten minutes. There was no significant difference between the effect of isometric and dynamic exercises. **Conclusion:** It can be concluded that both short duration non-exhaustive submaximal isometric and dynamic exercises has hypoalgesic response which decrease pain threshold in non-athletic healthy young Adult.

**Key words:** Isometric exercise, Dynamic exercise, Pressure Pain threshold. Dololrimeter

## INTRODUCTION

Musculoskeletal pain has always been a challenge for researchers and clinicians worldwide. Pain affects physical and mental health negatively, hindering normal life activities**, (1)** and decreasing the individual's productivity besides being the main reason forcing patients to seek medical help **(2).** A variety of pain conditions are indicated for exercise treatment, generally, physical activities and exercising regularly have a positive effect on all the body functions as well as different body systems, nevertheless, it has an immediate positive effect on pain reduction even after one session of exercise **(3).** Effect of regular exercise on pain sensitivity and physical activity was investigated by many researchers and it was found that a single acute bout of any type of therapeutic exercises causes decrease in the sensitivity to a painful stimulus and increase in pressure pain threshold (PPT).**(3) (4), (5),**

Pain threshold is described as least intensity of a stimulus that is considered painful. Pain tolerance is the greatest amount of pain tolerated by an individual **(3).** Exercise induced hypoalgesia (EIH) describes a condition where perception of pain to noxious stimulus and sensitivity of pain reduce immediately after moderate or high intensity exercises **(6).** In healthy individuals who are pain free EIH increase significantly in both active and inactive individuals regardless the type of exercise used and with a duration varying from as little as one minute to 30 minutes after the exercise **(3).** The amount of EIH is dependent on the duration and the intensity of the exercise **(7).**

The required duration that could be effective in relieving pain is still not found, yet a remarkable effect could be achieved from as little as a single session of exercise **(1),** even a bout of aerobic or resisted exercise can enhance EIH **(8).** It takes place at the exercising muscle and simultaneously at other non-exercised muscles, with the effect being greater at areas near the exercised part and lesser in faraway parts **(7).** Different exercises were found to have a positive

effect in increasing PPT by 15- 20 % in the areas involved in the exercises compared to areas receiving rest **(9).** Aerobic and isometric exercises are famous for reducing sensitivity of pain **(10), (11)**

This study was conducted to examine the pressure pain threshold modulation and its effect on post exercise hypoalgesia that occurs after different exercise intensities.

## MATERIALS AND METHODS

**Study design:** Comparative study (two groups).

### Subjects

One hundred and fifty healthy students with age ranging from 18-23 years were selected from faculty of physical therapy, Deraya University. The students had no medical problems (hypertension, hypotension, and diabetes mellitus), and no history of sensory or motor manifestation and were not under concurrent medications at the time of the study.

### Instrumentation

- Handheld dynamometer (Preston, 07012, New Jersey) was used to offer submaximal exercise resistance.
- Dolorimeter algorimeter (Baseline, 56217, Danbury) was used to assess the pressure pain threshold (PPT).

### Procedures

This study was conducted at faculty of physical therapy, Deraya University. The study has been approved by the Ethical Committees of faculty of physical therapy, Cairo University NO.P.T.REC/012/002994. The subjects were divided randomly into two equal groups; The first group (G1) was tested for the effect of isometric exercise on pressure pain threshold (PPT) and the second group (G2) was tested for the effect of dynamic exercise on PPT.

All subjects signed a consent form to participate. Weight and height were recorded and body mass index (BMI) was calculated to exclude obese subjects. All subjects underwent a history taking about previous illnesses, medications and\or any clinical sufferings. The participants were asked to stop any regular exercise one day before testing procedures. Dolorimeter and dynamometer applications were explained to the participants and one or two trails were performed without actually taking measurements to assure full understanding of how it worked. The PPT test was conducted with participant seated with dominant arm resting at $90^0$ of elbow flexion in supinated position. The dolorimeter was vertically pressed onto specific mark on forearm. The rate of applied force was approximately 1kg. The participant was instructed to verbally indicate when increasing applied pressure turned to pain. The resultant number was then recorded.

The study included two successive visits. In first visit, maximum dominant hand grip strength (MDHGS) and resting PPT were tested. The MDHGS were tested by a handheld dynamometer (three successive tests were taken with ten minutes of rest between them) then the maximum result was recorded as MDHGS. The resting PPT of each participant was tested by a dolorimeter. The subjects sat quietly in laboratory for seven minutes in a comfortable back-arms chair. The participant was prepared for the dolorimeter application by marking a small circle with a radius of 1 cm on the forearms (seven cm. distally to cubital fossa and one cm. medially to the forearm medline). The Applied Force Pain Threshold (AFPT), by the dolorimeter, was obtained 30s after rest period, in both dominant and non-dominant forearms. The dolorimeter application was repeated three successive times (over the original marking, one cm. above it and one cm. below) and the mean value was recorded. In second visit, post exercise PPT was estimated for both isometric and dynamic exercises:

**Isometric exercise for G1**:

Participant sat comfortably on a back-arms chair for seven minutes with elbow flexed $90^0$ with forearm resting supinated on chair arms. Submaximal isometric contraction of dominant hand was achieved by using handheld dynamometer. This contraction (40%-50%) was calculated by using Dynamometer and the participant was asked not to proceed out of the range during squeezing. The participant was asked to do submaximal contraction by consistently squeezing on Dynamometer by their dominant hand for 60 seconds. Immediately after releasing, Dolorimeter pressure force was applied to measure the PPT, in both dominant and non-dominant forearms. The dolorimeter measurements were also taken ten min after exercise for both sides.

**Dynamic exercise for G2**:

Participant sat comfortably on a back-arm chair for seven minutes with elbow flexed $90^0$ and forearm resting supinated on chair arms. Submaximal dynamic contraction of the dominant hand was achieved by using the (40-50%)

handheld Dynamometer same as in isometric exercise test. The participant was asked to do the submaximal contraction by squeezing on the dynamometer by their dominant and non- dominant hand and releasing it respectively for 60 seconds. Immediately after the last release, Dolorimeter pressure force was applied to measure the PPT, in both dominant and non-dominant forearms. The dolorimeter measurements were also taken ten min after the exercise from both sides.

**Statistical analysis**

Unpaired t-test were conducted for comparison of the subject characteristics between groups. Chi-squared test was conducted for comparison of sex distribution between groups. ANOVA with repeated measures was conducted for comparison of PPT between pre treatment, immediate post treatment and 10 minutes in each group; and unpaired t test was carried out for comparison between groups. The level of significance for all statistical tests was set at $p < 0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for windows (IBM SPSS, Chicago, IL, USA).

## RESULTS

**- Subject characteristics:**

Table (1) showed the subject characteristics of the isometric and dynamic exercises groups. There was no significant difference between groups in age, weight, height, BMI and sex distribution ($p > 0.05$).

**Table (1):**Basic characteristics of participants.

| | Isometric group | Dynamic group | p-value |
|---|---|---|---|
| | Mean ± SD | Mean ± SD | |
| **Age (years)** | 20.09 ± 1.78 | 20.26 ± 2.1 | 0.58 |
| **Weight (kg)** | 64.2 ± 4.46 | 63.73 ± 5.33 | 0.56 |
| **Height (cm)** | 163.62 ± 6.84 | 165.24 ± 6.95 | 0.15 |
| **BMI (kg/m²)** | 24.07 ± 2.3 | 23.44 ± 2.6 | 0.12 |
| **Sex, n** | | | |
| **Males** | 45 | 50 | 0.39 |
| **Females** | 30 | 25 | |

**SD, standard deviation; p-value, level of significance**

-Effect of treatment on PPT

**Within group comparison**

Within-group comparison revealed a significant increase in PPT immediate post exercise and 10 minutes post exercises compared with that pre exercises of dominant and non dominant hands in both groups ($p < 0.001$); also, there was a significant increase in PPT 10 minutes post exercises compared with that immediate post exercise of dominant and non dominant hands in both groups ($p < 0.01$). (table 2).

**Between group comparison**

There was no significant difference in PPT between groups pre treatment ($p > 0.05$). There was no significant difference in PPT immediate post exercise and 10 minutes post exercises of dominant and non dominant hands between isometric and dynamic exercises groups ($p > 0.05$). (Table 2).

**Table (2):**Mean PPT of dominant and non dominant hand at pre-exercise, immediate post exercise and 10 min post exercise of isometric and dynamic exercises groups.

| PPT | Pre treatment | Immediate post exercise | 10 min post exercise | p-value | | |
|---|---|---|---|---|---|---|
| | mean ± SD | mean ± SD | mean ± SD | Pre vs immediate | Pre vs 10 min post | Immediate vs 10 min post |
| ***Dominant hand*** | | | | | | |
| **Isometric** | 5.84 ± 2.77 | 8.19 ± 2.42 | 8.29 ± 2.41 | 0.001 | 0.001 | 0.01 |
| **Dynamic** | 5.89 ± 2.66 | 8.04 ± 2.76 | 8.18 ± 2.69 | 0.001 | 0.001 | 0.001 |
| | ***p = 0.9*** | ***p = 0.71*** | ***p = 0.6*** | | | |
| ***Non-Dominant hand*** | | | | | | |
| **Isometric** | 5.34 ± 2.77 | 7.74 ± 2.46 | 7.84 ± 2.45 | 0.001 | 0.001 | 0.01 |
| **Dynamic** | 5.41 ± 2.75 | 7.61 ± 2.93 | 7.76 ± 2.9 | 0.001 | 0.001 | 0.002 |
| | ***p = 0.87*** | ***p = 0.77*** | ***p = 0.74*** | | | |

**SD: Standard deviation P >0.05: Non- significant P<0.05: Significant**

## DISCUSSION

The results of this study showed that there is no significant difference between the isometric and dynamic exercises in the Pressure pain threshold. And that both types of exercises decreased the PPT and increased the Exercise-induced hypoalgesia. PPT was investigated by many researchers after exercises, some of which agreed with this study's results and the other found no effect of exercises on the level of PPT. Different suggested theories exist to explain how moderate exercises help increase the pain threshold following the exercises, the most proposed mechanism is the stimulation of endogenous opioids system during exercises, other studies suggest that opioid and serotonergic mechanics regulates central pain inhibition following isometric exercises.

Many researchers used isometric exercises to prove that opioid system is not the only system responsible for increase in the hypoalgesia following the exercise**. (6), (12)**Some studiesagreed with our results when they investigated PPT in exercised muscles and at distant muscle pre exercise, five minutes' post and fifteen minutes post exercise, they concluded that there is a significant decrease between pre and post exercise either immediately, after five minutes or fifteen minutes post bicycling exercises in both the exercised muscles as well as the remote muscles. **(13),** another study performed isometric exercise and found that pressure pain tolerance increased significantly in females rather than in males, suggesting gender influence on pressure pain threshold. **(14)**

Isometric exercise was found to decrease temporal summation showing the importance of exercises as a rehabilitation procedure as demonstrated by Vaegter when comparing bicycling to isometric in arm and leg exercises, he found both to be effective in increasing pressure pain threshold in addition the isometric exercises reduced the visual analogue scale scores with no systematic differences found between high and low intensity exercises. **(11)**

It was proved that physical activities regardless of their types can produce EIH. Exercising for a single session has proved to be effective in reducing pain sensitivity in individuals who are free from any condition causing pain**. (15)** In one study the researchers used isometric hand grip for the upper extremity (brachioradialis) and 30 minutes run for the lower extremity (vastuslateralis), to investigate the effect of conditioned pain modulation and EIH and found increased pressure pain threshold in both exercised parts. But after 30 minutes the upper limb EIH was reduced in athletes compared to non-athletes, which they suggested could be due to difference in perceiving of exercise effort for athletes. **(16)** While in another study**,** quiet rest was compared to wall squat isometric exercise, and it was found that wall squats was more significant than quiet rest regarding the EIH effect. **(9)**

Researchersfound evidence that cold pressor stimulation with aerobic exercises increased the pressure pain threshold in both men and women who are physically active as well as those who are not physically active, **(17)** meanwhile submaximal isometric exercises can increase cold pressor pain tolerance significantly during the exercise condition, it didn't affect pain intensity as mentioned by**. (18)**

Test retest reliability of the exercise induced hypoalgesia in an exercised muscle and a non exercised muscle was investigated after performing aerobic exercises represented in bicycling and found that the magnitude of the EIH

response was greater in the 2nd compared to the 1st session of exercise. **(19)** Another study agreed with this results too regarding the exercised muscle but proved no evidence of EIH regarding the non-exercised muscle**. (20)**

Another study investigated the perception of heat in adolescent male who are pain free using intense physical exercise and found that it reduces the amount of heat perception, they also suggested that the adolescents who are physically active are less prone to suffer chronic pain later in their lives. **(21)**In one study, the main focus**,** was to investigate psychosocial influence on EIH still they used submaximal isometric exercise for 3 minutes and found an increase in EIH, a significant decrease in the pain sensitivity and an increase in pressure pain threshold with good mood and family environment**. (22)**

As for the studies on patients with painful conditions, the effect of physical activity (aerobic exercises) was investigated on healthy adolescent females as well as adolescent females with low back pain and found that endogenous pain inhibitory mechanism stimulated by exercises are effective in healthy pain free adolescent females but failed to show any effect on females with chronic low back pain. **(23)**

A study investigated the EIH on chronic osteoarthritis and concluded that EIH was dysfunctional when applying aerobic and isometric exercises in knee osteoarthritis with abnormal conditioned pain modulation**. (24)** another study found impairment in the EIH in individuals with low back pain when testing the -erector spinae muscle-pain sensitivity after repetitive back movements. They explained that it was not necessarily because low back pain that patients lack descending pain inhibition and decreased EIH, rather it might be due to sensitization of the erector spinae muscle due to fatigue after the task. **(25)**

Some researchersdisagree with our results too as they found that there were increased pain sensitivity and decreased pain threshold after light physical exercises applied to painful areas in patient with chronic neck-shoulder pain, **(2)i**mpairment in EIH in patient with chronic pain and muscloskeletal chronic pain, **(26), (27),** but others found **that**EIH increased in patients with clinical ostoarthiritis knee pain. **(28)**

**Competing interests**

The authors declare that we have no competing interests (financial and nonfinancial). We declare that the research was conducted in absence of any commercial relationships that could be constructed as a potential conflict ofinterest.

## CONCLUSION

The results of this study indicated that there is a significant effect of different exercise intensities for both non-exhaustive isometric and dynamic exercises on PPT and the induced hypoalgesia. The results also showed that there is no difference between the effect of isometric exercise and the dynamic exercise on PPT. It can be concluded that short duration non-exhaustive isometric and dynamic exercise are associated with hypoalgesic responses in dominant and non-dominant sides in non-athletic healthy young adults.

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