

# **STUDY PROTOCOL**

## **Official Title:**

Acute Effects of Bench Press and Machine Chest Press Exercises on Pectoralis Major Muscle Mechanical Properties in Resistance-Trained Athletes

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## **Principal Investigators:**

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## **1. SCIENTIFIC BACKGROUND**

Resistance training exercises are widely used to improve muscular strength and hypertrophy. Among these exercises, the bench press and machine chest press are commonly utilized for targeting the pectoralis major muscle. Although both exercises aim to activate similar muscle groups, differences in movement pattern, stabilization demand, and mechanical loading may result in distinct neuromuscular responses.

Muscle mechanical properties such as stiffness and tone can be objectively assessed using myotonometry. These parameters provide valuable information regarding muscle function, viscoelastic behavior, and acute responses to exercise. However, the extent to which different chest press variations influence these mechanical properties remains unclear.

Understanding the acute effects of these exercises on muscle mechanical characteristics may contribute to optimizing resistance training strategies and exercise selection.

## **2. OBJECTIVES AND HYPOTHESES**

### **2.1 Primary Objective**

To compare the acute effects of bench press and machine chest press exercises on pectoralis major muscle stiffness and tone.

### **2.2 Hypothesis**

It is hypothesized that different chest press variations will produce distinct acute changes in muscle mechanical properties, particularly stiffness and oscillation frequency.

## **3. STUDY DESIGN**

This study was designed as a randomized parallel-group experimental study. Participants were randomly assigned to either a bench press group or a machine chest press group.

All participants completed a single-session resistance exercise protocol. Muscle mechanical properties were assessed before and immediately after the exercise intervention.

The outcome assessor was blinded to group allocation.

## **4. PARTICIPANTS**

### **4.1 Study Population**

A total of 16 male resistance-trained athletes participated in the study.

#### **4.2 Inclusion Criteria**

- Male participants
- Aged between 20 and 40 years
- Minimum of 5 years of resistance training experience

#### **4.3 Exclusion Criteria**

- History of upper extremity injury within the last 12 months
- Previous upper extremity surgery
- Use of performance-enhancing substances

### **5. METHODS**

#### **5.1 Exercise Protocol**

Participants performed a standardized resistance training protocol consisting of four sets of ten repetitions at 80% of one-repetition maximum (1RM), with 2-minute rest intervals.

- Bench Press Group: Barbell bench press exercise
- Machine Chest Press Group: Machine chest press exercise

#### **5.2 Assessment of Muscle Mechanical Properties**

Muscle mechanical properties of the pectoralis major were assessed using MyotonPRO. Measurements were performed before and within 90 seconds after completion of the exercise protocol.

The following parameters were analyzed:

- Oscillation frequency (muscle tone)
- Stiffness
- Decrement
- Relaxation time
- Creep

### **6. OUTCOME MEASURES**

#### **Primary Outcomes**

- Change in muscle stiffness
- Change in oscillation frequency (muscle tone)

#### **Secondary Outcomes**

- Change in muscle decrement
- Change in relaxation time

- Change in creep

## **7. STATISTICAL ANALYSIS**

Data were analyzed using the SPSS 27.0 software package. The normality of the data distribution was assessed using the Shapiro-Wilk test; all parameters were found to exhibit a normal distribution ( $p > 0.05$ ). To examine the effect of exercise type on muscle mechanical properties, a Mixed-Design Analysis of Variance (ANOVA) was applied, where time (pre-test, post-test) was defined as a within-subject variable and group (BP, MCP) was defined as an between-subject variable. The primary focus of the analysis was the Time  $\times$  Group interaction effect, reflecting whether the two exercise protocols produced different changes in muscle mechanical properties from pre-test to post-test. For parameters where a significant Time  $\times$  Group interaction was detected, within-group pre-test–post-test differences were examined using a paired-samples t-test, and Bonferroni correction was applied for multiple comparisons. For ANOVA, effect sizes were reported as partial eta squared ( $\eta^2$ ) and interpreted as small ( $\eta^2 = 0.01$ ), moderate ( $\eta^2 = 0.06$ ), and large ( $\eta^2 \geq 0.14$ ) (Richardson, 2011). For within-group paired comparisons, effect sizes were calculated as Hedges'  $g$  and interpreted as small ( $< 0.35$ ), moderate ( $0.35\text{--}0.80$ ), and large ( $> 0.80$ ) (Rhea, 2004). The statistical significance level was set at  $p < 0.05$ .

## **8. ETHICAL CONSIDERATIONS**

The study protocol was approved by the Giresun University Ethics Committee for Social Sciences, Natural Sciences, and Engineering Research (Approval No: 09/17). The study was conducted in accordance with the Declaration of Helsinki, and all participants provided written informed consent prior to participation.