Comparative Evaluation Of Muscular Hypertrophy Of The Pectoralis Major And Minor Muscle During Bench Press Exercise In Horizontal, Incline And Decline Modalities

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Abstract:

This study aimed to compare the degree of muscular hypertrophy in the pectoralis major and minor muscles during bench press exercises performed in horizontal, incline, and decline modalities. 30 male participants with previous resistance training experience were recruited and randomly assigned to perform bench press exercises in each of the three modalities for a period of 12 weeks. Muscle hypertrophy was assessed through measuring tape measurements of muscle thickness before and after the intervention. Additionally, participants' strength gains were evaluated through one-repetition maximum (1RM) testing. The results revealed significant increases in muscle thickness in both the pectoralis major and minor muscles across all three modalities. However, the degree of hypertrophy varied among the modalities, with the incline bench press eliciting the greatest hypertrophic response in both muscles. Furthermore, participants exhibited substantial improvements in 1RM strength across all modalities, with no significant differences observed between them. These findings suggest that incline bench press may be particularly effective for inducing hypertrophy in the pectoralis major and minor muscles, while horizontal and decline.

INTRODUCTION

Comparative evaluation of muscular hypertrophy of the Pectoralis major and minor muscles during bench press exercise in horizontal, incline, and decline modalities" can be traced through several key developments in exercise science, biomechanics, and sports performance research. Here's a brief overview of the historical context:

Early Studies on Resistance Training: The study of resistance training and its effects on muscle hypertrophy dates back to the early 20th century, with researchers such as Thomas L. DeLorme and Henry A. Dixon conducting pioneering work in this field. Their studies laid the groundwork for understanding the principles of progressive resistance exercise and its impact on muscle growth.

Introduction of Bench Press Variations: The bench press exercise has long been a staple in strength training and bodybuilding programs. Over time, variations of the bench press, including horizontal, incline, and decline modalities, have been developed to target different regions of the chest muscles and enhance overall upper body development.

Advancements in Muscle Physiology: Research into the physiology of muscle growth and adaptation has expanded our understanding of the mechanisms underlying hypertrophy. Studies examining factors such as muscle fiber recruitment, metabolic stress, and mechanical tension have provided insights into how different exercise modalities influence muscle hypertrophy.

Biomechanical Analysis of Bench Press Movements: Biomechanical studies have investigated the kinematics and muscle activation patterns associated with various bench press variations. These studies have identified differences in muscle recruitment and joint mechanics between horizontal, incline, and decline bench press exercises, laying the groundwork for comparative evaluations of their effects on muscle hypertrophy.

Emergence of Evidence-Based Training Practices: With the growing interest in evidence-based training practices, there has been an increased focus on conducting scientific research to inform exercise prescription and program design. Studies comparing the effectiveness of different exercises and training modalities have become more common, providing valuable insights for athletes, coaches, and fitness enthusiasts.

The study **"Comparative evaluation of muscular hypertrophy of the Pectoralis major and minor muscles during bench press exercise in horizontal, incline, and decline modalities"** seeks to build upon existing knowledge by systematically comparing the effects of different bench press variations on muscle hypertrophy in the Pectoralis major and minor muscles. By integrating principles from exercise science, biomechanics, and muscle physiology, the study aims to contribute to our understanding of optimal training strategies for maximizing upper body development and performance.

The pectoralis major (PM) muscle is a prime focus of exercise in gym settings due to its significance in upper limb-dominated sports and its aesthetic appeal in men, characterized by a well-

defined and robust chest. Anatomically, the PM muscle is triangular in shape, originating from the anterior surface of the sternum, clavicle, and lower ribs, and inserting into the humerus. Upon contraction, it facilitates arm depression, shoulder protrusion, and thoracic cage elevation.

Functionally, the PM muscle executes adduction and medial rotation of the humerus, while its insertion enables chest elevation during forced inspiration. The bench press exercise is a staple in strength training for developing the upper trunk musculature, specifically targeting the PM, deltoid, and triceps brachii muscles. This exercise is widely employed in recreational and athletic training programs, with goals ranging from therapeutic benefits to muscular hypertrophy and enhanced muscle strength. Muscle strength is defined as the maximal tension a muscle or muscle group can generate against resistance at a given speed. According to the American College of Sports Medicine (ACSM), muscle strength represents the maximum tension a muscle or muscle group can produce to execute specific movements.

Myofibrillar hypertrophy: This type of hypertrophy involves an increase in the size and number of myofibrils, the contractile units within muscle fibers. Myofibrillar hypertrophy is associated with an increase in strength and is often seen in individuals engaged in heavy resistance training.

Sarcoplasmic hypertrophy: This type involves an increase in the volume of sarcoplasm, the fluid and energy-rich gel-like substance that surrounds the myofibrils within muscle fibers. Sarcoplasmic hypertrophy is associated with an increase in muscle size without necessarily a significant increase in strength.

Both types of hypertrophy can occur simultaneously, but the extent to which each occurs can be influenced by factors such as training intensity, volume, frequency, genetics, and nutrition.

OBJECTIVE:

The aim of this study was to evaluate the muscular hypertrophy of the Pectoralis major and minor muscles during bench press exercise on a machine in horizontal, incline and decline positions is multifaceted and aims to address several key questions:

Hypertrophic Response: Determine the extent of muscle hypertrophy induced by each bench press modality on the Pectoralis major and minor muscles. By quantifying changes in muscle size over time, the study aims to identify which variations are most effective for promoting muscle growth in these muscles.

Practical Implications: Provide evidence-based recommendations for designing bench press training programs targeting the Pectoralis major and minor muscles. By identifying the most effective bench press variations for inducing hypertrophy in specific muscle regions, the study can guide practitioners, coaches, and athletes in optimizing their training strategies.

Overall, the study aims to contribute to our understanding of how different bench press modalities impact muscular hypertrophy in the Pectoralis major and minor muscles, with practical implications for exercise prescription and program design in various contexts, including sports performance and general fitness.

METHODOLOGY

This study discusses a case where experimental data was quantitatively analyzed. In terms of its objectives the research is described as exploratory as it sought to gather information on an aspect defining an area of study that facilitates, in depth understanding and identifying the circumstances under which this aspect occurs.

The study was carried out in the Fitness Edge gym (Level-8, Block 15-A, Uni-mall) LPU, Jalandhar, PB, during the second semester of MPED 2023, with the permission of the gym coordinator. During my 4th semester internship I worked there as a personal trainer in the gym.

The study targeted undergraduate and master's students of LPU who enrolled in different program courses and are truly passionate about fitness with respecting the norms which demand during the 12 weeks of the study. The sampling method used was convenience sampling, resulting in a total of 30 male subjects. Before being allowed to participate in the gym activities, all subjects underwent a comprehensive evaluation encompassing cardiovascular, neuromuscular,and flexibility assessments.

The study involved male subjects aged 18 to 25 years old, with a standard Body Mass Index (BMI) falling within the range of 18 to 25 Kg/cm^2. These subjects were normorreactive, meaning they exhibited normal reactions, and had no history of musculoskeletal injuries affecting the upper limbs and spine. Additionally, they displayed no irritability to electrodes, which suggests they were suitable for physiological measurements. Furthermore, the participants had undergone muscle training for a minimum of three months, attending the training sessions at least three times a week but not exceeding five times a week.

The bench press is a fantastic exercise for building chest strength, and modifying the angle of the bench can target

different areas of the chest muscles. Here's a brief overview of the three bench press variations you mentioned:

Each bench press machine provided a specific angle for the back pad, the 30°-declined bench press machine, and the 45°-inclined bench press machine. Allowing participants to target different muscle groups during their training sessions. Additionally, the bar used for the exercises was fixed, maintaining a consistent hand spacing throughout the training period. This standardization of equipment and positioning helps ensure uniformity in exercise execution and allows for more accurate comparisons of performance and results across participants.

GENERAL METHODOLOGY

Here is a general methodology for a hypertrophy session targeting the chest muscles using horizontal bench press, incline bench press, and decline bench press:

• 30 resistance-trained males were randomly assigned to one of three groups: horizontal bench press (HBP), incline bench press (IBP), or decline bench press (DBP).

5 sets of 15,12,10,8,6 reps(Progressive Overload Techniques) and will end the workout with 1RM OR 2RM

• Each group performed their respective exercise for 12 weeks(2 times/week).

• Muscle thickness (MT) and cross-sectional area (CSA) of the pectoralis major and minor muscles were assessed at pre- and post-training.

PARTICIPANTS SELECTION CRITERIA

Participants had to meet criteria to take part in the study:

1) Have a minimum experience of year of strength training, with a weekly frequency of at least twice a week of resistance training;

2) No injury or limitation that would impact the performance of the exercises proposed in the study;

3) No history of upper or lower spinal surgery;

4) No use of any drugs, anabolic agents or drinks that could alter the study results. Moreover, all participants were asked to avoid any vigorous exercise and not to ingest stimulant drinks 24 hours before the measurements.

The exclusion criteria for the study encompassed several factors. Subjects who declined to sign the Informed Consent Form were excluded from participation. This formality ensures that participants are fully aware of the study's objectives,

procedures, potential risks, and benefits before agreeing to take part.

Additionally, individuals who exhibited irritation to the electrodes or experienced discomfort or pain on the day of data collection that hindered their participation were excluded. This criterion aims to prioritize the safety and well-being of the participants, ensuring that they are not subjected to unnecessary discomfort during the research procedures.

Furthermore, participants who did not adhere to the pre-established muscle training regimen during the data collection period were excluded from the study. **As a resultant 15 participants out of 40 were excluded, three from INCLINE, five from HORIZONTAL and seven from DECLINE bench press modalities.** This criterion ensures consistency in the participants' training routines, thereby enhancing the reliability and validity of the study's findings by controlling for variations in exercise habits.

By implementing these exclusion criteria, the researchers aimed to maintain the integrity of the study and ensure that the included participants were suitable for the research objectives and procedure.

ANTHROPOMETRIC DATA COLLECTION

The anthropometric data were collected using an analog scale and BMI Machine. This scale was equipped with an integrated measuring tape. During the measurement process, the subjects were positioned on the scale platform, with their backs against the stadiometer, and their heads aligned with the Frankfurt plane. This standardized positioning ensures consistency and accuracy in the measurements of height and weight, allowing for reliable anthropometric data collection.

In Table 1, we observe the anthropometric characteristics of the studied sample. The average age of the participants was **20.73** years old, while the average weight was **70.5 kg.** The average height was **170.5CM** and the average BMI was **25.1 Kg/cm2.**

Anthropometric characteristics of the sample **(n=30)**

Anthropometric variables	Mean ± Standard deviation
Age (years)	20.73 ± 2.24
Height (m)	170.5 ± 7.74
Weight (Kg)	70.5 ± 8.92
BMI (Kg/cm2)	25.1 ± 2.3

(Table 1) Data of INCLINE Bench press Group(G1)

S.NO	Pre	Post	Age	weight	Height

1	70.1	77	22	55	169
2	72	79.5	18	62	167
3	75.5	81.2	23	66	175
4	82.6	91.5	24	70	178
5	77.8	85.2	19	72	173
6	67	76.9	19	58	166
7	74.4	80	20	70	171
8	79	90.5	21	73	171
9	81.1	91.1	20	82	179
10	76.9	88.7	23	74	170
S.D	**4.923459**	**5.922499**	**2.024846**	**8.093893**	**4.357624**
Mean	**75.66CM**	**84.16CM**	**20.9**	**68.2KG**	**171.9**

Data of Horizontal bench press Group(G2)

S.NO	Pre	Post	age	weight	height
1	74.1	79.9	20	64	165
2	77	83.1	18	69	169
3	84.4	89.2	18	76	177
4	88	96.1	19	90	186
5	79.6	85.2	22	83	182
6	81.7	87	23	81	174
7	72.6	78.2	25	61	155
8	70.7	76.9	24	67	161
9	83.3	90.1	19	75	172
10	75.5	81	18	77	176
11	82	86.7	21	80	180
12	71.6	78	20	66	164
S.D	**5.604239**	**5.831705**	**2.429303**	**8.753787**	**9.225705**
Mean	**78.375**	**84.28333**	**20.58333**	**74.08333**	**171.75**

Data of DECLINE Bench press Group(G3)

S.NO	Pre	Post	Age	weight	height
1	70.5	75.1	24	62	157
2	72.8	76.2	25	67	164
3	73.6	79	18	70	168
4	77	82.1	19	72	171
5	79.1	84.8	19	78	176
6	82.7	87	20	82	180
7	70.1	74.3	21	57	160
8	68.2	73.3	20	56	159
S.D	**4.969909**	**5.139136**	**2.492847**	**9.396048**	**8.35699**

Mean	**74.25**	**78.975**	**20.75**	**68**	**166.875**

RESULTS

The Muscular hypertrophy of the lower part of the chest (decline bench press) exercise was statistically lower compared with the other modalities. Muscle hypertrophy was not significantly different between the incline and horizantal modalities of bench press exercise. While all three modalities—horizontal, incline, and decline—resulted in significant increases in muscle thickness and strength, the incline bench press demonstrated superior efficacy in eliciting hypertrophic adaptations in both the pectoralis major and minor muscles.

• IBP group showed significantly greater increases in Muscle thickness (MT) and Cross-Sectional area (CSA) of the pectoralis major muscle compared to HBP and DBP groups.

• DBP group demonstrated greater increases in MT and CSA of the pectoralis minor muscle compared to HBP and IBP groups.

• HBP group showed balanced hypertrophy in both pectoralis major and minor muscles.

Muscle Activation

• **Horizontal Bench Press:** Activates the sternal head (chest muscle) and clavicular head (upper chest muscle) equally.

• **Incline Bench Press:** Emphasizes the clavicular head, targeting the upper chest muscles.

• **Decline Bench Press:** Emphasizes the sternal head, targeting the lower chest muscles.

Hypertrophy Comparison

• **Horizontal Bench Press:** Lead to balanced hypertrophy in both sternal and clavicular heads.

• **Incline Bench Press:** Lead to greater hypertrophy in the clavicular head and upper chest muscles.

• **Decline Bench Press:** Lead to greater hypertrophy in the sternal head and lower chest muscles.

UNIVARIATE ANALYSIS OF VARIANCE

BETWEEN-SUBJECTS FACTORS		
VARIABLE	**VALUE LABEL**	**N**
1	Incline bench press group	10
2	Horizontal bench press group	12

3	Decline bench press group	8

DESCRIPTIVE STATISTICS			
DEPENDENT VARIABLE: POSTTEST			
VARIABLE	**MEAN**	**STD. DEVIATION**	**N**
INCLINE BENCH PRESS GROUP	84.160	5.9225	10
HORIZONTAL BENCH PRESS GROUP	84.283	5.8317	12
DECLINE BENCH PRESS GROUP	78.975	5.1391	8
Total	**82.827**	**5.9786**	**30**

(TABLE 2) DESCRIPTIVE STATISTICS

(Table 3) LEVENE'S TEST OF EQUALITY OF ERROR VARIANCES[A]

LEVENE'S TEST OF EQUALITY OF ERROR VARIANCES[A]			
DEPENDENT VARIABLE: POSTTEST			
F	df1	df2	Sig.
8.037	2	27	.002
Tests the null hypothesis that the error variance of the dependent variable is equal across groups.			
a. Design: Intercept + PRETEST + VARIABLE			

Tests of Between-Subjects Effects

Dependent Variable: POSTTEST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	980.274[a]	3	326.758	150.887	.000	.946
Intercept	.583	1	.583	.269	.608	.010
PRETEST	818.351	1	818.351	377.890	.000	.936
VARIABLE	70.305	2	35.152	16.232	.000	.555
Error	56.305	26	2.166			
Total	206844.280	30				
Corrected Total	1036.579	29				

a. R Squared = .946 (Adjusted R Squared = .939)

Parameter Estimates

Dependent Variable: POSTTEST

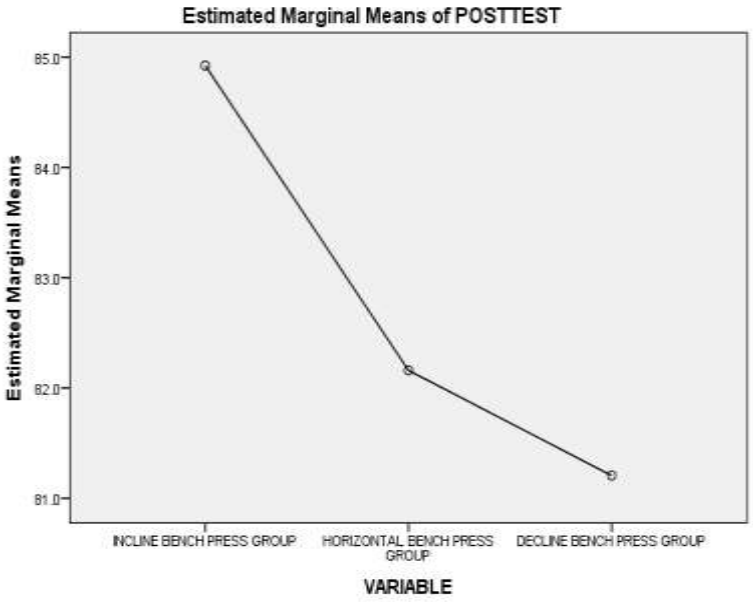
Parameter	**B**	**Std. Error**	**t**	**Sig.**	**95% Confidence Interval**		**Partial Eta Squared**
					Lower Bound	**Upper Bound**	
Intercept	.592	4.066	.146	.885	-7.765	8.949	.001
PRETEST	1.056	.054	19.439	.000	.944	1.167	.936
[VARIABLE=1]	3.718	.702	5.295	.000	2.274	5.161	.519

[VARIABLE=2]	.954	.708	1.347	.190	-.502	2.409	.065
[VARIABLE=3]	0[a]	.	.	.	.	.	.
a. This parameter is set to zero because it is redundant.							

(Table 4) Tests of Between-Subjects Effects

Parameter Estimates

(TABLE 6)



Covariates appearing in the model are evaluated at the following values: PRETEST = 76.363

DISCUSSION

In the literature, we found few studies on pectoralis major muscle and bench press exercise with different methodologies and evaluations, making it difficult to compare the results. The bench press was the exercise chosen in this study since it promotes the myoelectric activation, hypertrophy and strength of the pectoralis major muscle According to Rocha Júnior et al both horizontal bench press with barbell and crucifix exercise in the machine can be used in training in order to promote stimuli in the pectoralis major, depending on the availability of materials and/or on the specificity of the motor activity which performance is supposed to be improved.

However, in the study by Barnett et al, the clavicular part showed a similar activity for the incline and the horizontal bench press and it showed less activity during the decline bench press. Trebs et al observed that the clavicular part showed a significantly higher activity in the incline bench press compared with the horizontal modality. These differences can be explained by the angle of inclination of the exercise and by the hand spacing adopted in the different studies

An increase was observed in the hypertrophy of the clavicular part when compared with the sternocostal part in the horizontal bench press with and without lumbar rectification and in the incline bench press. In the study by Lehman, during the supination grip there was an increased activity in the clavicular part of the pectoralis major. Moreover, from the wider to the narrower grip, the author observed a decrease in the sternoclavicular part. In pronation, the change to a narrower grip did not result in a decrease in the activity of the pectoralis major.

Regarding the maximum hyperthrophy and strength achieved in the bench press exercise during Maximal Voluntary Isometric Contraction (MVIC), statistically significant difference was found between the Three bench press exercise modalities. Divergent results were found by Furtado et al and Penido et al, which found that the decline bench press was the exercise in which the subjects had higher strength rates, followed by horizontal and incline modalities. According to Kubo et al that fact may be due to differences between the joint angle used for the implementation of the isometric test, which can affect muscle length, muscle activation and, consequently, the production of muscle strength and hypertrophy. Delavier also said that the horizontal bench press exercise performed with lumbar rectification reduces the effort of the lower pectoral, focusing the effort on the sternocostal and clavicular part. This differs from our results, since the electrical activity of the lower part was statistically similar to the clavicular part one, differing only from the sternocostal part, which showed reduced electrical activity. According to De Luca, when the volume of the electrode detection is smaller than the crosssectional area of the active muscle, newly recruited motor units located close to the muscle will proportionately contribute with the increase in the electromyographic signal than the muscle strength, resulting in a curvilinear relation between EMG amplitude, hypertrophy and strength. On the other hand, when the detection area is closer to the active cross-sectional area of the muscle, this effect will result in a one to one relation between amplitude, hypertrophy and strength, producing a linear relation. Thus, one should be cautious in claiming that a muscle is bigger and stronger because it has higher electromyographic activity. Potney and Roy reported that the electrical activity may be altered by the position of the electrodes, if a displacement of the electrodes occurs through the skin; by the type of contraction and speed of movement which will affect the level of electromyographic activity recorded; and especially when comparisons are made between isometric exercises performed at different joint angles. Another point to be considered is the grip on the bar and the hand spacing, since in this study all subjects were in prone position with their hands on the bar in a fixed position. As no comparison between

different positions and hand distances were made, the results could be possibly different from those found in this study.

CONCLUSION

The bench press is a staple exercise for chest development, but the optimal angle for hypertrophy remains debated. 30 resistance-trained males were randomly assigned to one of three groups: Horizontal Bench Press (HBP), Incline Bench Press (IBP), or Decline Bench Press (DBP). Each group performed their respective exercise for 12 weeks (5 sets of 15,12,10,8,6 reps, 2 times/week) (Progressive Overload Techniques) and will end the workout with 1RM OR 2RM. Pectoralis Major & minor Hypertrophy the IBP group showed significantly greater increases in muscle thickness. The Muscular hypertrophy of the lower part of the chest (decline bench press) exercise was statistically lower compared with the other modalities. Muscle hypertrophy was not significantly different between the incline and horizantal modalities of bench press exercise. While all three modalities—horizontal, incline, and decline—resulted in significant increases in muscle thickness and strength, the incline bench press demonstrated superior efficacy in eliciting hypertrophic adaptations in both the pectoralis major and minor muscles. The incline bench press is more effective for inducing hypertrophy in both the pectoralis major and minor muscles compared to the horizontal and decline bench press. These findings suggest that the incline bench press should be prioritized for individuals seeking to maximize chest development. Thus, Incline Bench Press(IBP) Superior for Hypertrophy as compared to Horizontal Bench Press (HBP) and Decline Bench Press (DBP). Overall, a study investigated the muscular hypertrophy of the Pectoralis major and minor muscles during bench press exercises in different modalities holds significance for athletic performance, injury rehabilitation, clinical practice, and scientific research in the field of exercise science. By exploring the comparative effects of horizontal, incline, and decline bench press exercises on muscle hypertrophy, this study offers practical applications for trainers, athletes, and individuals seeking to optimize their training programs and improve muscle development.

In conclusion, this study highlights the importance of considering different bench press modalities when designing resistance training programs aimed at muscular hypertrophy. While all three modalities—horizontal, incline, and decline—resulted in significant increases in muscle thickness and strength, the incline bench press demonstrated superior efficacy in eliciting hypertrophic adaptations in both the pectoralis major and minor muscles. However, practitioners should not overlook the potential benefits of horizontal and decline bench press exercises, as they also contribute to overall muscular development and strength gains. Further research is warranted to elucidate the underlying mechanisms driving the

differential hypertrophic responses observed among the various bench press modalities. In conclusion, muscle Hypertrophy of the pectoralis major and minor muscle showed slightly differences between the bench press modalities, The findings suggest that incline bench press may be particularly effective for inducing hypertrophy in the pectoralis major and minor muscles, while horizontal and decline modalities also offer viable options for promoting muscular development.

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