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ORIGINAL ARTICLE

THE 'JIMAX' HOOK PUNCH TRAINING MODEL ASSISTED BY ANDROID FOR BOXING ATHLETES AGED 16–30 YEARS

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ABSTRACT

Background of study: This study, conducted in 2021, aimed to develop and evaluate the “Jimax” hook punch training model supported by an Android-based application for boxers aged 16–30 years. **Methodology:** The research employed the Research and Development (R&D) method adapted from Borg and Gall. The participants were amateur and professional male boxers in Jakarta within the age range of 16–30 years. The small-scale trial involved 20 athletes from two boxing clubs, while the large-scale trial included 40 athletes from four clubs. Furthermore, the effectiveness test was carried out with 20 athletes in the experimental group and 20 athletes in the control group. The instrument used in this study was the basic hook punch technique. **Results:** The findings revealed 16 variations of the “Jimax” hook punch training model for boxers aged 16–30 years. The mean N-Gain Score of the experimental group was 0.4078, categorized as moderate, whereas the control group scored 0.1194, categorized as low. The mean difference between the experimental group (9.84) and the control group (3.35) was statistically significant, with a t-value of 8.616, $df = 38$, and a significance level (2-tailed) of $0.000 < 0.05$. **Conclusion:** Therefore, the “Jimax” training model is proven to be more effective in improving hook punch skills compared to conventional training models.

Keywords: Research and Development, Jimax Hook Punch, Boxing

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INTRODUCTION

One of the most crucial factors in boxing is the ability to deliver effective punches. The hook punch is considered highly lethal when executed with proper skill, by exerting full strength and speed, maintaining the correct punching angle and distance, and optimizing muscle explosiveness. The hook punch is particularly suitable for aggressive boxers who employ rapid attacks and close-range strategies. The “Jimax” hook punch emphasizes the transfer of the center of gravity (CoG) and body weight transmission, combined with trunk rotation toward the target upon releasing the punch.

This technique generates substantial punching power capable of knocking down opponents. A powerful hook punch directed at the lower jaw or chin can cause loss of consciousness in the opponent due to the high rotational acceleration of the neck region and the resulting increase in trauma across the brain¹. Tong-lam et al. (2017) investigated the role of trunk rotation in straight punches, highlighting that boxers employ trunk rotation to convert vertical ground reaction forces into horizontal punching forces, thereby producing powerful straight punches². Similarly, in the “Jimax” hook punch, the transfer of CoG and body weight, accompanied by trunk rotation toward the target, results in a highly powerful and lethal hook punch.

Based on an analysis of the success and failure rates of hook punches performed by the Universitas Negeri Jakarta boxing team during the amateur boxing championship organized by Universitas Indonesia on April 21–22, 2016, the success rate was recorded at 32–36%, while the failure rate reached 64–68%³. In addition to being relatively infrequent and

inaccurate, the hook punches lacked sufficient power. This indicates the need to further develop boxers’ hook punch abilities, both in terms of quality and quantity, including skill and power. Moreover, an interview conducted by the researcher with former World Boxing Association (WBA) featherweight world champion (57.1 kg), Chris John, on February 17, 2021, revealed that his hook punch ability had never been measured throughout his professional boxing career.

Ratten (2020) stated that the sports industry is increasingly influenced by technological innovation for global competitiveness, encompassing various contexts such as gameplay, consumer engagement, and spectator experience. Technology in the field of sports has become increasingly critical in developing comprehensive and integrated strategies for innovation management, particularly in response to environmental changes imposed by the COVID-19 pandemic, which demanded the delivery of services through more realistic approaches. Physical and social distancing measures during COVID-19 led to the postponement of numerous boxing championships due to the resulting environmental changes⁴. This situation became one of the triggering factors behind the decline in athletes’ motivation and willingness to train, as well as psychological disturbances such as stress. Stress can recruit the immune system to alter the function of brain regions that are critical for emotional regulation. These changes explain the comorbidity of various inflammatory conditions associated with chronic stress and the psychological disorders triggered by it⁵.

The Android-assisted “Jimax” hook punch training model, equipped with sensor devices,

can help boxers maintain enthusiasm to train actively and independently in order to maximize hook punch performance. This training model incorporates components of strength, speed, power, agility, excellence with automatization, flexibility, stability, balance, and muscle endurance, supported by studies in anatomy and physiology, biomechanics, motion analysis, neuroscience, and motor learning concepts. Hook punch skills can be assessed through a basic hook punch technique instrument, while punch power can be measured using a sensor device called the Jimax Boxing Punch Tracker, which is equipped with a digital camera and the Kinovea or iMeasureU application.

METHOD

The research method employed was a quantitative experimental design aimed at examining the effects of a specific intervention under controlled conditions, utilizing the research and development (R&D) approach developed by Borg and Gall (2007)⁶.

The resulting training model is the “Jimax” hook punch skill training model, supported by an Android-based application equipped with sensors on the head guard and punching bag, as well as a digital camera and the Kinovea/iMeasureU application to measure the accuracy and power of boxers’ hook punches. The Android application features training videos and a hook punch power measurement system supported by Arduino-based technology, referred to as the Jimax Boxing Punch Tracker, which facilitates and motivates athletes to train actively and independently.

DISCUSSION

Boxing is the oldest and earliest form of physical contact sport in the world, originating around 1619 BC on the island of Crete, a Mediterranean island. It is both a sport and a martial art in which two individuals of equal weight compete against each other in intervals known as rounds. Boxing is classified as a high-intensity combat sport that demands superior physical performance, particularly in terms of strength and punching power. Nevertheless, boxing remains a popular sport enjoyed by both men and women.

Mc Crory et al., as cited in Bisa (2020), highlighted that amateur boxing differs from professional boxing for several reasons, including athletes’ motivation, rules, and equipment. Most importantly, professional boxers face greater exposure to injuries due to longer bouts, more extensive boxing experience, the use of smaller and lighter gloves, higher scoring rewards for injurious punches, and longer careers following their amateur stage⁷. Knockouts (KOs) are rare in amateur boxing; for example, in the 2001 World Amateur Championship, only six KOs occurred out of 366 matches.

The study further reported that a single punch from a professional heavyweight champion could generate an impact force of up to 6,320 N (0.63 tons or 630 kg). For comparison, this force is equivalent to a blow delivered by a 6 kg (13 lbs) mallet swung against a target. Such an impact can result in concussion, which is complex and heterogeneous in nature, though it usually resolves clinically within 1–4 weeks. Following rest, athletes with acute concussion may be encouraged to gradually and progressively increase physical and cognitive

activities while remaining below symptom thresholds. In cases of prolonged symptoms, a multidisciplinary team experienced in concussion diagnosis and treatment should be considered⁸. Once diagnosed with concussion, athletes must not return to play on the same day and should not resume sports until concussion symptoms have completely resolved⁹.

1. Hook Punch

Punching is an essential requirement for boxers to become competitive fighters and secure victories in matches. The fundamental techniques that must be mastered in boxing include: (1) basic stance, covering body position, foot placement, arm position, and hand formation (fist); (2) footwork and balance; (3) punches (jab, straight, hook, and uppercut); and (4) defense techniques (block, ducking, weaving, and parry)¹⁰.

Among the fundamental techniques in boxing, the punching technique represents the core skill that requires continuous development and refinement. By utilizing trunk rotation in combination with the simultaneous movement of the front and rear foot during the execution of a hook punch, a boxer can generate powerful strikes while maintaining proper balance. The hook punch is specifically intended to knock down an opponent when delivered with maximum force and full speed, producing optimal muscular explosiveness and supported by correct technical execution, including the appropriate punching angle. Therefore, the strength of both the upper and lower limb muscles must be systematically trained, as they have been proven to be key determinants of successful performance¹¹.

The hook is a type of punch in which the arm is bent at a 45-degree angle from the elbow joint, utilizing the strength generated from the hips and shoulders while shifting the center of gravity toward the opponent. This punch is commonly executed at close range and is considered more risky compared to the straight punch. A hook punch directed at the opponent's chin poses a higher risk of knockout than when aimed at other body parts. The effectiveness of the hook punch also depends on the boxer's stance, whether in the orthodox (natural position) or southpaw (left-handed position) stance¹². The hook is regarded as one of the most lethal punches in boxing, executed by swinging the arm in a hooking motion, either with the right or left hand. Its primary targets are often the temple or lower jaw, with the intention of knocking the opponent down. This punch requires maximum muscle strength, precise muscular explosiveness, and effective as well as efficient pulling and striking angles. Optimal physical condition is therefore a critical prerequisite for enhancing athletic performance. In boxing, an efficient punch demands a combination of force, speed, and stability¹³. Consequently, performance in boxing is defined by the interplay of strength, speed, and stability¹⁴.

When delivering a hook punch, a boxer must pay close attention to the pulling angles of the mobilizing muscles responsible for arm and shoulder movement, particularly the biceps brachii, triceps brachii, pectoralis major, supraspinatus, and deltoid muscles, along with the upper leg muscles (quadriceps femoris, hamstrings), lower leg muscles (gastrocnemius, tibialis anterior), trunk muscles, abdominal muscles, as well as the flexor group muscles of the wrist and fingers, during both concentric and eccentric contractions⁷. Equally important

is the activation of stabilizer muscles to ensure proximal joint stabilization and to optimize the pulling angles of muscles during the execution of the hook punch¹⁵.

Depending on punching distance, the hook can be classified into three types: short-range hook, middle-range hook, and long-range hook. Likewise, two fist orientations are

commonly used when executing a hook: the palm-facing-you orientation for the closed (short-range) and middle-range hooks, and the palm-facing-down orientation for the long-range or far hook¹³. After delivering a hook, the boxer should promptly return to the double cover (double guard) position. The primary target for a hook that can cause a knockout is the lower jaw or chin.

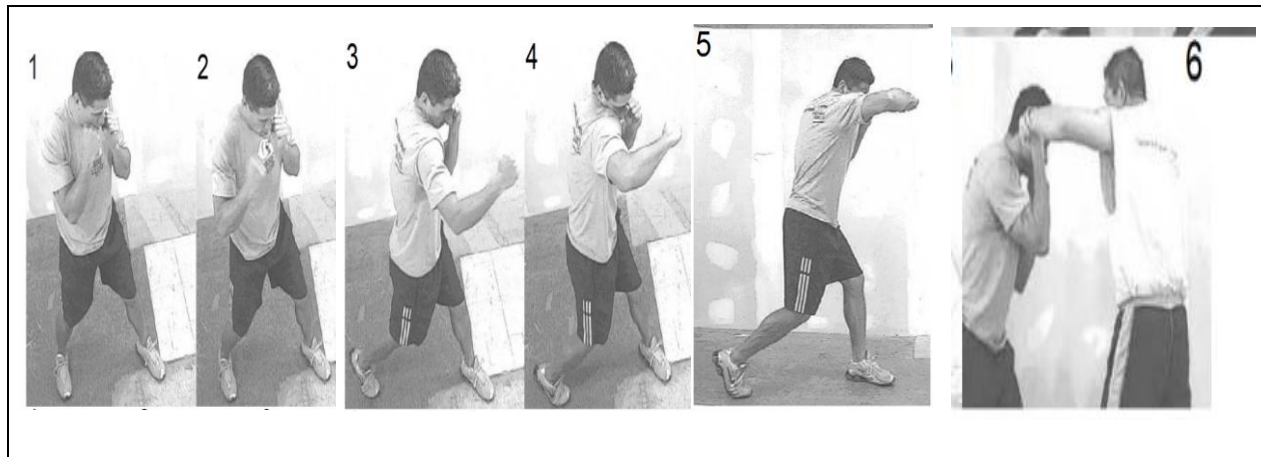


Figure 1. Mechanism of the Hook Punch^{16, 17}

The hook punch is often targeted at the head, face (including the nose, temple, and jaw/chin), and ribs. However, the most decisive target that can cause an opponent to fall unconscious is the chin or lower jaw, as the impact produces high rotational acceleration of the neck and increases trauma across multiple regions of the brain. The distinction between a punch that causes loss of consciousness and one that does not lies in the maximum pressure exerted on the affected brain regions. Such impacts can lead to concussion (*commotio cerebri*) or cerebral contusion (*contusio cerebri*), particularly involving the nerves of the brainstem (*medulla oblongata*) and cervical spinal cord (*medulla spinalis*), as well as concussive forces affecting

related joints such as the temporomandibular joint (TMJ) and the cervical spine.

Cournoyer and Hoshizaki (2019), in their study titled *Head Dynamic Response and Brain Tissue Deformation for Boxing Punches with and Without Loss of Consciousness*, aimed to compare brain tissue deformation caused by punches that induce loss of consciousness with those that do not. The findings revealed that loss of consciousness in boxing commonly occurs following a hook punch directed to the side of the lower jaw, as such strikes generate high rotational acceleration of the neck and increase trauma across all brain regions. Loss of consciousness in boxing is therefore associated with more severe levels of brain

trauma, which may also require longer recovery times¹. A knockout (KO) is more likely to result from a punch targeting the jawline, which determines the severity of brain trauma compared to other punches that do not cause unconsciousness. This understanding contributes to broader insights into the severity of brain injuries related to loss of consciousness in boxing.

Consciousness is determined by the continuous interaction between the qualitative functions of the cerebral cortex and the quantitative role of the ascending reticular activating system (ARAS), located from the mid-upper pons. The ARAS receives collateral nerve fibers from sensory pathways, which are then diffusely transmitted to both cerebral cortices via thalamic relay nuclei. Acting as an on-off switch, the ARAS maintains cortical awareness¹⁸.

As a result of a hook punch, the brain may suffer contusion (*contusio cerebri*), a severe head injury characterized by brain bruising, potential hemorrhage, and loss of consciousness. This condition involves damage to subcutaneous tissue in which capillaries rupture, allowing blood to diffuse into the surrounding tissue. Although the skin remains intact, swelling and reddish-blue discoloration are visible. Cerebral contusion occurs when the brain impacts against the skull. It most frequently affects the frontal and temporal lobes, though it can occur in any part of the brain. A cerebral contusion may develop within several hours or days, potentially progressing into intracerebral hemorrhage that requires surgical intervention. Another common injury is *commotio cerebri* (concussion), classified as a mild traumatic brain injury, typically marked by transient loss of consciousness lasting less

than 10 minutes following head trauma and not accompanied by structural brain damage. Boxers may experience symptoms such as headache, vertigo, nausea or vomiting, and pallor¹⁹. However, in cases of cerebral contusion, unconsciousness may last longer than 10 minutes. Brain injuries caused by such impacts may be functional or organic. When a boxer is struck, falls, and regains consciousness within 10 seconds, the disturbance is considered functional. Conversely, if the boxer remains unconscious for more than 10 seconds, the injury is classified as organic, indicated by the absence of pupillary reflexes (dilated pupils).

2. Biomechanical Analysis of the Jimax Hook Punch

The initial stance for executing the Jimax hook punch involves standing with the feet positioned diagonally in a front-back alignment, shoulder-width apart. The rear heel is raised, both knees are slightly flexed, and the torso leans slightly forward. The shoulders are abducted at a 45° angle, and the elbows are flexed at 45° (middle range). Both fists are positioned at eye level in a diagonal orientation, with the gaze directed straight ahead and the body maintained in a relaxed, non-tense condition.

During execution of the Jimax hook punch, the boxer exerts maximal force and velocity by engaging concentric and eccentric contractions of the shoulder, elbow, wrist, and finger muscles. During the transfer of the center of gravity (CoG) and body-weight transmission — with weight shifting onto the front foot to initiate the strike — the forefoot of the rear foot functions as the propulsion point. Meanwhile, the abdominal, lumbar, and trunk muscles contract isometrically and isotonicly

to anticipate movement and to act as stabilizers during rotational action. When the hook is delivered (single-cover hand position), the primary prime movers are the biceps brachii and pectoralis major; concurrently, rotation of the hips and trunk occurs (involving latissimus dorsi activity for medial rotation and adduction). Support is provided through the knee joint (quadriceps femoris action) and the ankle (gastrocnemius action), accompanied by a lateral shift of the lead foot, in-place rotation of the rear foot, and coordinated CoG transfer and body-weight transmission. The rear foot then moves forward-laterally so that the resulting punch is generated with maximal power while maintaining balance. After delivering the strike, the boxer must promptly return to the double-cover position:

1. Starting position. Head and torso upright with gaze directed straight ahead; both fists held at eye level in a diagonal front-back orientation. Both knees are slightly flexed with body weight distributed across both feet; feet are shoulder-width apart in a diagonal (front-back) stance, with the rear foot borne on the forefoot (on tiptoe). The

elbow joint is flexed at 45° and the shoulder is abducted at 45°.

2. Body-weight and center-of-gravity (CoG) transfer. Transfer of CoG and body weight forward so that weight is borne on the lead (front) foot while the rear foot remains on the forefoot.
3. Propulsion (punch execution). When releasing the hook, the arm swings toward the target in a hooking motion concurrently with a forward-lateral step of the lead foot, trunk and hip rotation, and the coordinated transfer of CoG and body weight as the propulsive force. The rear foot pivots on the forefoot. One hand remains in the single-cover position to guard against counterattacks.
4. Ending position. After delivering the punch, the rear foot quickly moves forward-laterally to restore balance so that footwork and foot positions return to parallel diagonal alignment, while both hands assume the double-cover guard.

Based on the above description, the sequence of movements in the Jimax hook punch is illustrated in the figure below:



Figure 2. Four Phases of the Jimax Hook Punch

3. The Influence of Body Mass on the Outcomes of the Jimax Hook Punch

An athlete's body mass plays a critical role in determining boxing weight categories, ranging from the minimum flyweight class at 47.627 kg to the heavyweight class above 90.719 kg²⁰.

A study by Neha, Ajita, and Rajdeep Kaur (2010), titled Comparison of Selected Physiological Variables Among Different Weight-Category Indian Elite Male Boxers, aimed to compare selected physiological parameters across different weight classes (lightweight, middleweight, and heavyweight). The findings revealed significant differences in anaerobic capacity indices between lightweight and heavyweight categories. Therefore, efforts should be made to enhance the anaerobic strength of heavyweight boxers²¹.

Excess body weight resulting from fat mass significantly affects an athlete's agility and the ability to perform movements effectively and efficiently²². By maintaining a body fat percentage within the recommended standards, a boxer will be more agile and capable of moving swiftly, both in delivering punches and in evading them. Agility is a defining characteristic of boxers who rely on the hook punch—typically aggressive fighters who attack quickly and perform effectively at close range. On the other hand, higher body mass can be advantageous for a boxer when it is attributed to muscle rather than fat, as greater muscle mass provides stronger propulsion during punches through the transfer of the center of gravity (CoG) and body-weight transmission toward the opponent or target.

4. The Concept of Motor Learning in the Jimax Hook Punch

The concept of motor learning in the Jimax hook punch is grounded in several theories, including:

1. The Stimulus–Receptor Theory, which posits that every movement results from stimuli received by receptors located throughout the body, whether exteroceptive or proprioceptive. Human senses play a critical role in the process of generating skill-oriented movements, ranging from simple skills to advanced motor skills. Sensory function is fundamental to movement success, as movement represents the outcome of information processing based on sensory input. Mastery of higher-level motor skills depends on the individual's ability to detect, receive, and utilize sensory information. Most of the information necessary for skill acquisition originates from the environment²³. Each receptor provides more than one type of sensory input; for instance, muscle spindles convey information about joint position, muscle velocity, muscle tension, and limb orientation relative to gravitational force. Unlike vision and audition, which deliver specific sensory modalities, kinesthesia encompasses a complex combination of inputs from multiple receptors, which must be integrated by the central nervous system²⁴.

2. Closed-Loop and Open-Loop Theory (Response–Effector). One way to conceptualize how sensory information functions in motor behavior is by comparing it to a closed-loop control system, which is defined as a circular or recursive process. A closed-loop control system is understood as a continuous system in which the output or

action is determined by the executive, carried out by the effector, and fed back to the comparator in the form of sensory information or feedback. Each piece of information is compared against the desired condition, and any errors are transmitted to the executive level for correction. Once a decision is reached, the system relays the planned action to the effector mechanism for movement execution²⁵.

The command to achieve the desired goal is sent from the executive to the effector mechanism, which consists of several components. This command is relayed to lower centers in the nervous system located in the spinal cord, resulting in muscle contractions and joint movements. During movement, various forms of proprioceptive feedback also arise. Proprioceptive feedback originates from the forces generated in contracting muscles, pressure applied by objects in contact with the skin, and joint receptors signaling changes in body position²³.

Importantly, closed-loop control is not the only feedback mechanism used in movement regulation, as lower-level reflex loops also contribute to motor control. In certain cases, many fast and powerful motor behaviors—such as punching, kicking, and throwing—are controlled by an open-loop system without conscious monitoring. In such tasks, performers have limited time to process information about movement errors and must therefore plan their actions precisely in advance. This stands in contrast to closed-loop control, in which movements are slower and heavily dependent on continuous feedback from multiple sources.

Open-loop control is particularly relevant when environmental conditions are stable and predictable, with no changes requiring modification of the planned movements once initiated. The brain's information/impulse system incorporates both closed-loop and open-loop mechanisms. The closed-loop system involves internal error transmission processes, meaning that once an incorrect decision is made by the brainstem, it is difficult to suppress or reverse. By contrast, the open-loop system governs skill execution in which errors occur outside of the stimulus–response process. Environmental predictability during performance provides the basis for classifying motor skills into open skills and closed skills.

Open skills are performed in variable and changing environments, requiring flexible responses that prevent performers from fully planning movements in advance. Conversely, closed skills consist of consistent movement patterns performed in environments that are unchanging or relatively stable²⁶. The ability to select stimuli and interpret environmental and interpersonal reactions is critical across many aspects of life; in sports, it plays a central role in achieving victory. This ability underpins perceptual–cognitive skills, which encompass a range of cognitive functions such as attention, visual discrimination, anticipation, problem-solving, and decision-making.

To achieve optimal performance, athletes must be able to direct their focus to the most relevant cues (e.g., specific body parts) in order to select and predict useful information from the environment for understanding both opponents and teammates. To accomplish this, athletes must concentrate, analyze, and recognize subtle kinematic indicators well before taking any action. Combat sports such

as boxing are no exception to these demands. As open-skill sports, combat disciplines are defined as interceptive activities in which athletes must coordinate and interact with external opponents, either with or without an object. These sports are characterized by sudden environmental changes, requiring athletes to adapt to new situations at every moment²⁷.

3. Muscle Memory Theory. According to the myonuclear domain concept, there is assumed to be a linear relationship between the total number of myonuclei and the size and/or volume of a muscle fiber. Although the myonuclear domain theory was rapidly adopted by many researchers, it continues to be debated in the field. For example, within this paradigm, the myonuclear domain is expected to remain (relatively) constant, with additional nuclei supplied by satellite cells during muscle fiber hypertrophy and the loss of nuclei (through apoptosis) during muscle fiber atrophy. However, more recent animal studies have demonstrated that myonuclei do not appear to be lost under various models of muscle atrophy²⁸. Until recently, memory was primarily associated with brain function. However, recent findings in biology indicate the existence of another equally important form of memory—muscle memory—located throughout muscle tissue. While brain memory is formed through knowledge, muscle memory is developed through training. Muscle memory is associated with the sheath that surrounds muscle cells, composed of myelin.

In the human body, myelin is white in color, often referred to as the “white matter” of the brain. As an insulator, myelin functions to increase the speed of information flow (in the form of impulses) and transmit it across muscle

tissue. The thicker the myelin layer, the more efficiently information circulates, allowing movements to be performed more quickly and automatically.

Muscle memory refers to the ability to reproduce specific movements unconsciously, acquired through repeated practice of those movements. Simply put, it is the body’s memory of activities that have been performed. Muscle memory enables athletes to regain strength and muscle mass more quickly than during initial training. Thus, muscle memory is an outcome of learned motor skills rather than mere muscle growth. Gladwell (2008) argued that achieving muscle memory requires approximately 10,000 hours of practice to master a skill. However, the benefits of muscle memory in hypertrophy training may be realized in significantly less time²⁹.

Research further shows that when muscle fiber size decreases during training cessation, the number of myonuclei remains stable for extended periods, even up to three months of inactivity. If an athlete must take a break from gym or sports activities, maintaining protein intake is crucial, as increased protein consumption helps reduce the loss of lean body mass during inactivity. For example, active individuals who discontinue training for 12 weeks may still regain their one-repetition maximum (1RM) capacity within just eight weeks of retraining²⁶.

To achieve maximum strength at the level of one repetition maximum (1RM), less than eight weeks of retraining is required. A 12-week retraining period has been associated with hypertrophy of type II muscle fibers, which also promotes an increase in satellite cells

(+72%, $p = 0.036$) and myonuclei (+13%, $p = 0.048$) within type II fibers. Changes in the cross-sectional area of type II fibers were positively correlated with changes in the number of myonuclei, resulting in a stable myonuclear domain. Strength and power gains, along with fiber-type adaptations, were partially retained after 12 weeks of detraining, thereby enabling rapid recovery of 1RM performance upon retraining. The number of myonuclei tended to follow individual changes in the size of type II muscle fibers, providing support for the myonuclear domain theory²⁸. Lee et al., (2018) reported that in muscles subjected to physiologically relevant resistance training, the number of myonuclei increased and was maintained during long-term detraining. Furthermore, the acquired myonuclei contributed to muscle hypertrophy and mitochondrial biogenesis during subsequent retraining. Collectively, these findings demonstrate a potential cellular mechanism supporting the notion that exposing young individuals to resistance training provides long-term benefits by facilitating the recovery of metabolically active muscle later in life.

This study also provides conceptual evidence of the biological processes underlying the importance of nuclear-mitochondrial interactions during muscle growth³⁰. For a movement to be permanently encoded in muscle memory, it must be repeated approximately 1,500 times. In other words, repeatedly practiced movements become reflexive once they are clearly imprinted within the nervous system through intentional or unintentional repetitive actions (automatization). Within the interaction between brain and muscle motor capabilities, the process is described as observe, orient,

decide, act (OODA). Each time an individual performs a new physical activity, the body engages in this OODA process via motor neurons. Muscle memory thus plays a crucial role in mastering new techniques. Approximately 1,500 repetitions are required for a hook punch to be recorded accurately in muscle memory, ensuring proper execution without difficulties in the future. However, the process is not without challenges, as muscle memory also encodes errors. For example, if a boxer incorrectly performs the hook punch 500 times, the erroneous pattern will also be stored and reinforced in memory.

4. Jimax Boxing Punch Trackers

The sensor device used to measure the power of the hook punch in this study is referred to as the Jimax Boxing Punch Tracker, which is equipped with a digital camera and the Kinovea or iMeasureU application. This instrument was designed with Arduino support and integrated with an Android application as its user interface. The Arduino-based punch power measurement device is mounted on the punching targets, specifically the boxing head guard and the heavy bag. The system employs an Arduino Nano with an ATmega328 processor to process data from a force-sensing resistor (FSR), which records punch strength based on the magnitude of the boxer's hook punch force. The processed data are then displayed on a smartphone screen via an Android application developed using MIT App Inventor. Data transmission to the Android application is facilitated through a Bluetooth HC-05 module, while the device is powered by a 9-volt battery. The hook punch motion is simultaneously recorded with a digital camera, and the footage is analyzed using Kinovea or iMeasureU software to determine the speed of the punch. By combining force and velocity

measurements, the power of the hook punch can thus be accurately calculated. The output of the boxing punch power measurement device consists of both hardware and software components. The hardware includes an Arduino Nano embedded with a program via the Arduino IDE, connected to an FSR sensor, a Bluetooth HC-05 module,

and a 12-volt battery, all of which are installed within the punching bag and head guard. The software is installed on an Android smartphone, featuring a main interface that displays the boxer's name, height, weight, and measurement results, along with user instructions such as connect (start), register, save results, and disconnect (stop).

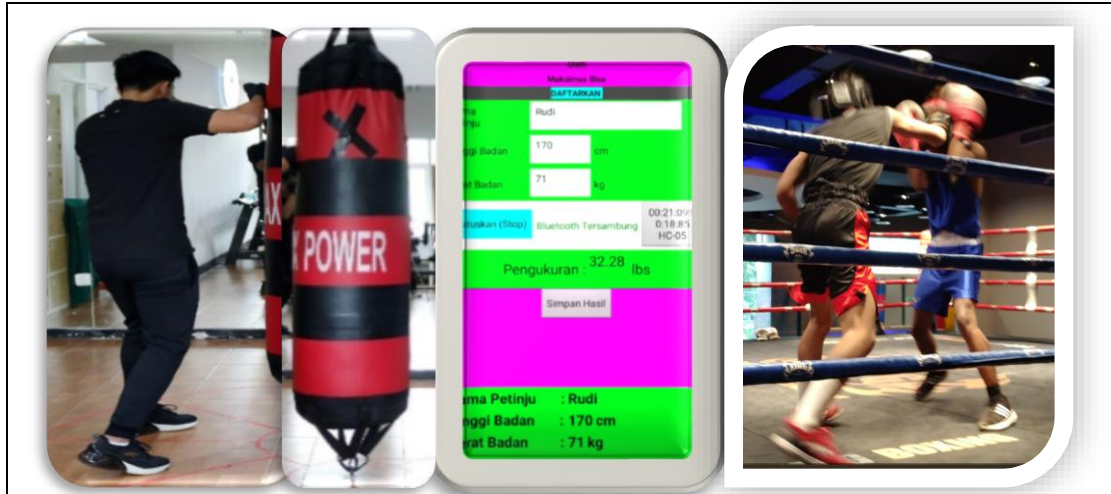


Figure 3. Display Interface of the Jimax Boxing Punch Tracker

5. Jimax Hook Punch Training Model

The Android-assisted “Jimax” hook punch skill training model consists of five main models, each with its own variations, resulting in a total of 16 models:

a. Jimax 1 (Footwork) with four variations:

- 1) In-out
- 2) Cross position
- 3) On-two step
- 4) Formula “V”

This training model is highly effective for enhancing footwork skills and improving the coordination between foot and hand movements (movement automatization).

b. Jimax 2 (Hook Variation) with three variations:

- 1) Short hook
- 2) Middle hook
- 3) Long hook

This training model is particularly effective for improving hook punching skills and for developing automatization in distance control when applying different hook punch variations.

c. Jimax 3 (Shadow Boxing) with two variations:

- 1) Combination punches at an elbow flexion angle of 45° and a shoulder abduction angle of 45°
- 2) Combination punches at an elbow flexion angle of 90° and a shoulder abduction angle of 90°

This training model is highly effective for improving punching skills, achieving excellence through movement automatization, and optimizing joint positioning. It can also contribute to increasing VO₂max.

d. Jimax 4 (Heavy Bag Punch) with three variations:

1. Combination of jab and hook punches (short, middle, long) on the sensor-equipped heavy bag
2. Trunk rotation, transfer of CoG, body-weight transmission, and foot movement
3. Single and double cover

This training model is particularly effective for enhancing the strength, speed, and power of the hook punch, as well as achieving excellence through automatization of movements and CoG positioning.

e. Jimax 5 (Sparring) with four variations:

- 1) Sparring
- 2) Hook punches targeted at the jaw/chin equipped with a head guard sensor
- 3) Trunk rotation, transfer of CoG, body-weight transmission, and foot movement
- 4) Single and double cover (counter and defense, or continuous attack)

This training model is highly effective for developing adaptability and automatization during competition, while also contributing to improve VO₂max.

RESULT AND CONCLUSION

Based on the differences in the mean scores of hook punch skills between the experimental group and the control group, resulting from the implementation of the Android-assisted

“Jimax” hook punch training model, the outcomes can be illustrated in the diagram below:

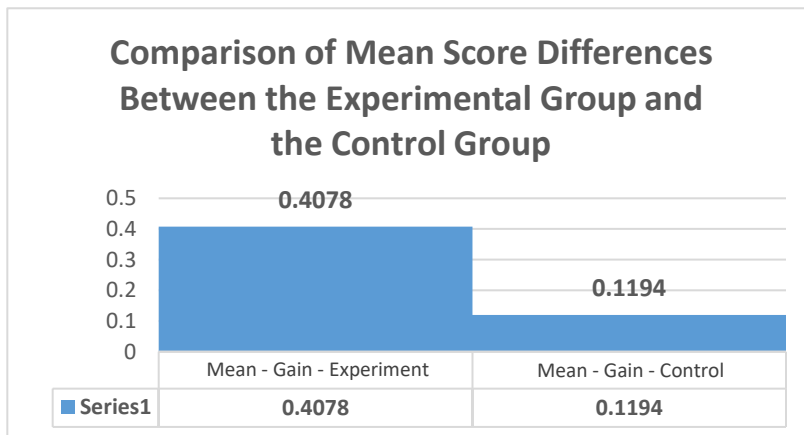


Figure 4. Bar Chart of the Comparison of Mean Score Differences Between the Experimental Group and the Control Group

Based on the effectiveness test of the “Jimax” hook punch training model for boxers aged 16–30 years in improving hook punch skills, the N-gain value for the experimental group was 0.4078, which falls into the moderate category. It can therefore be concluded that the “Jimax” hook punch training model is feasible to be implemented in training and is effective in enhancing the hook punch skills of boxers within this age range.

The data further show differences in the mean pre-test and post-test scores of the experimental group. The mean pre-test score was 75.595 (assessed at 75.55), categorized as “good” in terms of basic hook punch technique. After applying the 16 variations of the “Jimax” hook punch training model, the mean post-test score increased to 85.430 (assessed at 85.30), categorized as “very good.” These findings clearly demonstrate an improvement in athletes’ basic hook punch technique. Thus, the five main models with 16 variations of the “Jimax” hook punch training model are proven to be effective in improving the hook punch skills of boxers aged 16–30 years.

Based on the t-test calculation with $df = 19$, where the critical t-value was 2.093 (at a 0.05 significance level) and the obtained t-value was $14.154 > 2.093$, the null hypothesis (H_0) was rejected. Therefore, it can be stated that the hook punch skills of boxers aged 16–30 years improved significantly through the application of the “Jimax” hook punch training model. Furthermore, the results of the Independent Samples Test showed that the calculated t-value of 8.616 exceeded the critical t-value of 2.086, indicating a significant difference between the hook punch skill outcomes of the experimental group and the control group.

Thus, the “Jimax” training model was demonstrated to be more effective and significant in enhancing hook punch skills compared to conventional training methods.

Conflict of Interest: The author declares no conflict of interest in this research.

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