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Emmanouil Marios Ornithopoulos

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**Cross training and athletic skills development in amateur and professional
boxers.**

Bachelor's thesis

Head of bachelor's thesis:

PhDr. Radim Pavelka, Ph.D.

Drafted:

Emmanouil Marios Ornithopoulos

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Abstract

Title: Cross training and athletic skills development in amateur and professional boxers.

Objectives: Based on the results of the studies and findings gained from literature, to prepare 3 cross-training programs using athletic drills for boxers, improving their boxing skills.

Methods: Method of systematic review was used in this thesis.

Results: Result of the work is the design of structural cross-training program using athletic drills for boxers, improving their boxing skills.

Keywords: *boxing, cross-training, drills, program, skills, work-out*

List of abbreviations used:

ACE – American Council on Exercise Fitness

AIBA – International Boxing Association

ATP – adenosine triphosphate

B.C. - Before Christ

CO₂ – carbon dioxide

CP – phosphocreatine

H₂ – heredity factor

HR_{max} – maximal heart rate

LPH - lumbo-pelvic-hip

O₂ – oxygen

RM – repeat maximum

SO fibers – slow oxidative fibers

VO_{2max} – maximum rate of oxygen consumption

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Introduction

Every athlete's goal is a success. Success in competition depends on the characteristics and rules of the given sport activity, which are conditioned by temporal and spatial patterns. In other words, in a motor-driven sense success means to be faster, stronger, more durable, more precise, more efficient in performance, and to achieve the desired goal, after selection based on innate predispositions, the athlete is subjected to an adaptable training process in accordance with the specific requirements of his sport. In order for this process to achieve the desired results, constant control is needed. Top sporting achievements are the result of the synergy of a number of interrelated factors (heritage, anthropological features and abilities, sports training, etc.).

The box is characterized by high demands on players, coaches and officials, and requires a high degree of readiness, deployment and concentration from all players, so that all performance requirements can then be met. From the point of view of motoring in this sport, there are many unnatural moves and that is why it is very demanding for all aspects of physical abilities and skills. In the game, individuals who not only master the technique but also those who are able to assert themselves with force, speed, special endurance, tenacity, combat ability and psychological resilience.

During a meeting, the player must work at high intensity with the rapid recovery of energy resources and maximum delays in getting fatigue. The end of the match influences the performance of the players' fatigue, which causes a reduction in the level of fine coordination and the realization of technical skills. Strength training is an inseparable part of sports training for a number of sporting disciplines. The level of individual strengths of an individual contributes to varying degrees of sport performance.

The main reasons that led me to choose the theme were primarily my personal interest in this sport field, as well as the continuous dynamics of development and its timeliness. Nowadays scientific research is necessary because it is irreplaceable in improving the physical abilities and playing skills of athletes in all sports sectors.

In this diploma thesis we will try to prepare 3 cross-training programs using athletic drills for boxers, improving their boxing skills.

1 Current state of research

1.1 Cross training

What is cross training? According to Matthews (2009) of the American Council on Exercise Fitness (ACE), cross training is characteristically defined as a method a training with several different forms of training to develop a specific component of fitness. The benefit of cross training is in the varied diversity of exercises you can select from. Cross training, used by lots of top-level sportsman, helps athletes work with various muscles groups to become physically stronger. The goal of athletes is use different fragments of their body and is the best choice for athletes training because it will decrease the risk of injury and also it assistances athletes get into shape earlier and safer, and improves an athlete's total fitness (ACE). For example, a runner for long distances can combine his training with swimming to work on endurance and strengthen diverse muscles in his legs and body. By doing this, the runner will have a better value of VO2 max, be in exceptional shape, and prevent injury due to the strengthening of all leg muscles.

1.1.1 Benefits of cross training

Cross training avoids to get in shape, decrease weight and developing muscle and it leads not only help to prevent certain medical conditions but are also an important position of treatment for diabetes, high blood pressure, high cholesterol, and heart disease (Jeffery, 2012).

Benefits of cross training (Smith, 2013):

- *Improved weight loss.* Persons who want to decrease weight and body fat should involve in an exercise program that helps them to securely burn a significant amount of calories. Research has indicated that such a target, in most cases, is the best achieved when participants exercise for relatively long periods (i.e., more than 30 minutes) at a medium level of intensity (i.e., 60 percent to 85 percent of maximal heart rate frequency). Overweight people can successfully realize a reduction of body fat by mixing two or more physical activities in a cross-training routine.
- *Conditioning.* Cross training can involve movements that improve muscular fitness, as well as aerobic training. By doing a variability of workouts from another exercises, you are requesting more of your body than with an old-style,

straight-forward method. Improved workload and diversity lead to risen capability. In other arguments, by performing more with body, athletic and fitness stages have no selection but to develop. With cross-training, it's achievable to increase muscle mass, decrease body fat and gain cardio-aerobic capacity. This complete style of fitness training is called conditioning, and it's one of the benefits of cross-training. While an individual's muscular fitness improvements will classically be less than if athlete partaken only in strength training, the extra advantages of improving muscular strength and endurance can give important bonuses.

- *Developed exercise adherence.* Studies on exercise adherence signifies that numerous persons give up of exercise programs because they become bored or injured. Cross training is a secure and quite comfortable method to adjoin multiplicity to an exercise program. In the course, it can play a positive part in promoting long-term exercise observance by reducing the prevalence of injury and eliminating or retreating the potential monotony.
- *Reduced Risk of Injury.* By distributing the cumulative level of orthopedic stress over added muscles and joints, people are able to exercise with higher intensity and for longer time without extremely overloading mostly weak areas of the body (e.g., knees, hips, back, shoulders, elbows and feet). Joints, ligaments, muscles and tendons all over human body are under a marvelous quantity of stress though frequent movement, and it's crucial to let them the occasional rest. By combining routine program you offer the over-used segments of your body a chance to break and the under-used a chance to strengthen and catch-up.
- *Active Recovery.* Active recovery is the drill of operating by a different form of physical activity to recover from major training mode. For example, many top-level football players do swimming trainings and pool resistance workouts to actively recover from their on-field drills and traditional training. Also to the conditioning and prevention of injuries profits of active recovery, it has been show to truly accelerate recovery by growing blood flow and the distribution of nutrients to stressed or injured muscle tissue.

1.2 Boxing

Noble art as is called the boxing is in history one of the ancient combat sports across all of human culture. Consistent with the International Boxing Association the first evidence of boxing's beginning was discovered in Egypt and date to about 3000 B.C and boxing likely seemed in Ethiopia as early as 6000 B.C. Boxing as an Olympic sport was first time performed at the ancient Olympic Games in Greece in 688 B.C (Swaddling, 2008; Poliakoff, 1987). Boxing is a combat sport and contains of stand-up fist fighting styles such as kickboxing, Savate or French boxing, Muay-Thai, Karate, Taekwondo or any other combat sport that allows the use of feet, elbows or knee to strike. As a full contact combat sport, the goal of amateur boxing is to achieve in transporting a pure and precise hit to the challenger without being boxed in response (Guidetti, Musulin & Baldrari, 2002). Throughout an unprofessional boxing match, opponents are only permitted to use their fists (Varlik, 1982), with the prominence zone of the glove to the aim are on the opponent (i.e. any part of the front and sides of the head or body above the belt). The counting scheme is examined by five referees depending on a purpose of the subsequent standards: amount of quality punches, on the goal zone, dominance of the attack, competitiveness, technical and tactical advantage and encroachment of the rules (AIBA, 2013). Olympic boxing rules have been exposed toward numerous alterations of the session formula. The interval as well as the number of rounds, differs between categories: beginner boxers realize match in 3 rounds of 2 min each; intermediate athletes compete in 4 rounds of 2 min each and open-class boxers fight in 3 rounds of 3 min or 4 rounds of 2 min each by accord of the trainers and combatants (Davis, Letihauser & Beneke, 2014). The revitalization intervals are continuously 1 min among rounds. Fighters can succeed by several of judgements: points, referee stopping the contest (RCS), the compulsory count limit injury (e.g. dangerous cut, fracture or dislocation), knockout (KO), referee stopping the contest because od head blow (RSCH), walkover (i.e. the boxer presents himself in ring and his/her opponent fails to appear) and disqualification (AIBA, 2013). Prosper in producing a counting knock and in return to avoid getting setbacks warriors compel well-developed technical-tactical skills and great level of physical and physiological fitness (Davis, Wittekind & Beneke, 2013). It has been described that high anaerobic and aerobic power level are essential for triumph in boxing (Guidetti, Musulin & Baldrari, 2002). Boxing is considered by high-intensity movements through the rounds, with short rests that are not sufficient to supply a full recovery (El-Ashker & Nasr, 2012).

Training of box is characterized by high intensity, intermittent activities (Arseneau et al., 2011; Bellinger et al., 1997) demanding high level of physical fitness as well as mental strength. Besides rising physical health, boxing training can also lead to improved self-confidence, self-discipline, and character development (Sokol, 2004).

1.2.1 Body composition and somatotype of boxers

Establishing the body of fighters is considered relevant for high-level competitive performance, because boxing is a weight-class combat sport. Before to every bout competitors have to follow to a body mass limit by raising the fat-free mass and reducing the quantity of body fat. The mean variety of body fat percentage extends from 9 to 16% for male and from 14 to 26% for female amateur boxers, separately, in different practice or weight categories (Chaabène et al., 2015). The mean body structure of international-level male boxers is around 12% (Smith, 2006). Ratio of body fat in both sex categories of amateur boxers is equivalent to that formerly recorded in taekwondo (Bridge et al., 2012), karate (Chaabène et al., 2012) and judo athletes (Franchini et al., 2011) and a little bit above the rates created for elite-level wrestlers (Yoon, 2002). On the basic of previous researches low amount of body fat looks like precondition for boxer's high-level performance. It has be stated that senior fighters have a higher total body mass, lean body mass and body fat compared with junior athletes (Khanna & Manna, 2006). Weight loss methods are usually follows by combat sports athletes (Morton et al., 2010; Langan-Evans, Close & Morton, 2011; Franchini, Brito & Artioli, 2012). Perón et al. (2009) showed that 100% of Olympic level boxers from Brazilian national team reported losing weight before battle. Boxers habitually decrease $5.6 \pm 1.06\%$ of their body mass before competition (Hall & Lane, 2001). Scientific research conclusions dealing with amateur boxer's somatotype are lacking and there is only one analysis showed using elite-level male boxers from India, by Khanna & Manna (2006), where scientists registered tendency for ectomorphy. Giovani & Nicolaidis (2012) discovered that elite-level boxers have a somatotype that is characterized by a higher proportion of mesomorphy that indicates a well-developed muscle mass and low body fat.

1.2.2 Aerobic load of boxers

Cardiovascular fitness is one of the most crucial features of physical fitness conditioning in Olympic boxing (Davis, Leithauser & Beneke, 2014; El-Ashker & Nasr,

2012; Smith, 2006; de Lira, Peixinho-pena & Vancini, 2013; Pierce, Reinbold & Lyngard, 2006) In this circumstance, well-developed aerobic fitness assistances the boxers to keep repetitive high-intensity movements in boxing competition, speed up the recovery procedure and preserve the boxer fit until the last round (Davis, Leithauser & Beneke, 2014; El-Ashker & Nasr, 2012; Pierce, Reinbold & Lyngard, 2006). Boxer's aerobic capacity is recognized by measuring Maximal oxygen consumption (VO_{2max}) on a permanent graded exercise test, using either cycle ergometer or a treadmill in the laboratory (Astrand & Rodhal, 1977). The general VO_{2max} mean values reported in the scientific literature diverge between 49 and 65 ml/kg/min for males and between 44 and 55 ml/kg/min for females (Chaabene, 2015) depending on boxer's level of practice, training phase, mode of testing and different weight categories. Boxing exercises could be adopted for improvement of aerobic fitness (Chatterjee, Banerjee & Majumdar, 2005). Despite the availability of well-developed measurement tools such as portable metabolic devices (i.e. K4b₂, Cosmed, Rome, Italy), measuring oxygen consumption during the match remains difficult. Davis, Leithauser & Beneke (2014) tried to measure oxygen consumption during a semi-contact boxing match and founded that total metabolism is predominantly aerobic (mean 85%), highlighting the significance for reflecting the aerobic fitness level as one of boxing's determining performance aspects. Arseneau, Mekary & Leger (2011) stated that aerobic capacity is one of the main components of boxer's physical fitness. Authors proved standards of 70% peak oxygen consumption (VO_{2peak}) through the boxing exercises (i.e. sparring and pad works, or punching on a partner's pads or mitts). It can be implied that the cardiorespiratory fitness level should be considered by coaches and sport scientists as the first yardstick toward improving and monitoring a boxer's training routine (Chaabène, 2015).

1.2.3 Anaerobic load of boxers

The design of activity of boxing competition is intermittent and characterized by short-period, high-intensity bursts of activity scattered with phases of lower intensity or breaks initiated by boxer's clinching or the referee's interruption (Davis, Leithauser & Beneke, 2014; Chatterjee, Banerjee & Majumdar, 2005; Siegler & Hirscher, 2010; Smith, Dyson & Hale, 2000). The relationship between activity and rest has been disclosed to be circa 3:1 (Khanna & Manna, 2006). Model action-to-rest expects a well-developed anaerobic fitness level (Khanna & Manna, 2006; Jackson & Pollock, 1978; Chatterjee, Banerjee &

Majumdar, 2005; Kumar et al., 2012; Świeicki, Klukowski & Hübner-Woźniak, 2013) to join the energetic obligation of that activity correctly. The 30-s Wingate anaerobic test is generally well-known as the most valid way for evaluating capacity of work using both the adenosine triphosphate and phosphocreatine (ATP-PCr) and glycolytic systems (Zupan, Arata & Dawson, 2009). Hübner & Woźniak et al. (2006) implied that relative maximum and average upper and lower extremity muscular strength assessed via the 30-s Wingate anaerobic test were significantly higher in wrestlers compared with boxers. These results demonstrate to the consequence of anaerobic fitness development in boxing performance as in other combat sports. Because the main target of boxers is to achieve in delivering clean, correct and powerful punches to the opponent, the valuation of upper extremity muscular strength is key (Chaabène, 2015).

1.2.4 Strength profile of boxers

Boxers should have well-built muscle strength to successfully achieve the physical or technical-tactical obligations of boxing bout (Guidetti, Musulin & Baldari, 2002; Kravitz et al., 2003; Chatterjee, Banerjee & Majumdar, 2005; Świeicki, Klukowski & Hübner-Woźniak, 2013; Piorkowski, Lees & Barton, 2011; Walilko, Viano & Bir, 2005; Valentino, Esposito & Fabozzo, 1990). Punching power is supreme to a fighter's victory and one of the key indicators of boxing. Smith (2006) assessed the hitting power relative to straight and hook punches to the head and body within senior elite-level amateur boxers. His results demonstrated that straight striking at both the head and the body was more strengthfully when performed by the rear-hand compared with the lead one and the diversity in punching strength seems to be due to the extra strength made by the leg during the rear-hand punch when equaled with the lead-hand one (Fritsche, 1978; Filimonov et al., 1983). Degree of trunk rotation and the lengthier distance over which the punch is performed can be another potential descriptions behind this dissimilarity (Hickey, 1980). Filimonov et al. (1983) said that skilled-level boxers have better contributions from their legs to the punch compared with the other factors (i.e. arms and trunk). It seems that the strength generated by both the upper and lower extremities is a key determinant of punching strength Pierce et al. (2006), counting hitting strength within a live boxing match, revealed that almost all punches were delivered at powers clearly lower than those recorded in the laboratory setting (Smith, 2006). This observation can be caused by active nature of the ring (i.e. the enemy is a moving target who can avoid block, and partially

evade the hit) and boxer producing the better cumulative power and the better number of punches won by unanimous decision regardless of their weight category class (Pierce et al., 2006). Pierce et al. (2006) also described that speed and technique of the punch, as well as size and muscle mass could influence the power which is basic for realizing high-level boxing performance. Exactly identifying the rate of contribution from upper and lower extremity strength as well as trunk rotation toward the maximal punching power obliges further examination.

Muscular strength is the ability to generate high amounts of power in relatively short periods of time (Kawamori & Haff, 2004; Newton & Kraemer, 1994). If the boxer want to be effective in punching it requires a high level of both speed and strength, what is crucial component of boxing punch (Pierce et al., 2006, Walilko, Viano & Bir, 2005). In this setting, it has been proposed that the ability to produce high-level muscular strength is considered one of the major fundamental prerequisites underlying successful performance among elite boxers (Lenetsky, Harris & Brughelli, 2013). A punch is an enormously dynamic and short movement that occurs over a very brief period of time (Atha, Yeadon & Sandover, 1985); thus it is mostly a role of the high-energy phosphate system (Obmiński, Borkowski & Sikorski, 2011). Giovanni & Nicolaidis (2012), reported that the maximal strength of the upper and lower extremities, as measured by the strength-velocity test, are significantly associated with each other ($r = 0.70$) it means that boxers with greater maximal strength in the lower extremity also present greater maximal strength in the upper extremity. These explanations signal the meaning of training programs that tend to develop both the upper and lower extremity muscular strength of boxers.

1.3 Athletic skills

Movement abilities are developed depending on the changes of the organism, but also on the personality of the individual. When choosing athletic activity, it is very important to adapt to the possibilities and needs of the athlete. Conditional preparation, one of the training components, is primarily focused on influencing the athlete's physical abilities. Physical capabilities are undoubtedly one of the most important factors in most sporting activities. At present, the process of developing physical fitness and performance becomes art, whose task is to prepare an athlete's body to meet the demands of top sport without any health damage.

1.3.1 Definition and characteristics of speed capabilities

Speed as a physical magnitude - a path in time - is a descriptive characteristic of motion. Many sports performances are characterized by a high to maximum speed of movement from the physical point of view. This is done with the maximum effort, maximum intensity that the ATP-CP system provides. It can not take long without interruption within 10-15 seconds. These are movements essentially without resistance or with little resistance (except gravity or environment). In general, the motion activity thus defined is considered to be a manifestation of conditioning (hybrid) assumptions - velocity movement abilities. (Dovalil, 2009). It is not easy to explain the basics of speed, to list the biological, psychological and other assumptions that determine the rapid execution of individual movements, movement activities, and more complex movement actions. The component is many and there is no one special biological correlate or speed explanation system. Here are some of the dominant assumptions according to Schnabel et al. (2003):

- Muscle system - high FT fiber ratio in muscles, up to 90% in top sprinters, possibility to simultaneously activate a large number of motor units, ability to quickly change muscle tension, contractions and release of both synergists and antagonists, high elasticity and muscle stretching
- Nervous system - speed of conducting anxiety, rate of transmission of information in the operating of neuromuscular activity.
- Energy system - high creatine phosphate supply, rapid ATP resynthesis.
- Psychic assumptions - quick and accurate creation of the concept of movement, high concentration, high emotional stability.

Speed ability has great importance not only for athletic disciplines, but is also important for other sports areas. Speed skills can only be influenced in part, because of course genetic factors play their role here. Athletic activity takes place in anaerobic conditions. The energy we draw from the muscle reserves allows us to work very intensively, but only for a short period, which is about 10-15 s. The period for the development of speed capabilities is the age between 10th and 13th-14th year. By the tenth year of life, it is better to develop locomotive speed and later begin to devote to the development of force-

speed capabilities. For the development of speed skills it is good to start short runs, jumps, throws (Jeřábek, 2008).

1.3.1.1 Types of speed capabilities

Martens (2006) divides speed:

1. Reaction velocity
 - Simple reaction rate - associated with the initiation of movement on a given stimulus. The stimulus may be tactile, acoustic, visual
 - Selective reaction ability - it is also associated with the start of movement in the shortest possible time, but we have to choose the most suitable solution from multiple options - typical for sports games
2. Action - realization speed capabilities
 - Acceleration speed - achieve maximum speed (treadmill)
 - Frequency speed - the ability to perform as many repetitive movements as possible - so-called cycles.
 - Speed with change of direction - speed associated with change of direction (sports games, shuttle run, star run)

1.3.1.2 Overview of athletic training tools and classification for individual types

- Special running exercises - (lifting, skipping, skidding, kicking, cross-country punching, running of the arms) - frequency
- Acceleration from walking and trotting to maximum speed - acceleration
- Starts from different positions on stimuli - tactile, acoustic, visual - reactions
- Run with wind support in the back or on the inclined plane - supramaximal speed - frequency
- Falling, semi-gentle starts, flight sections up to 30 m - acceleration, frequency
- Run on site at maximum frequency for 5, 10 s - Frequency
- Run to the stairs, run against resistance, run with load - frequency
- Low starts from starting blocks up to 30 m - acceleration, reaction
- Running speed to maximum - acceleration, frequency
- Boat run - short, pyramidal run, star run - speed with direction change

1.3.2 Definition and characteristic of strength

Strength is considered to be the basic and decisive ability of an individual without which other abilities in motor activity can not be manifested at all. We define the power as the ability to effectively use the muscular force to overcome various resistances (Marković, 2008). Gajda (2004) states that strength capabilities allow a movement activity to overcome or maintain external resistance or muscle contraction strength according to the task assigned. (Lehnert et al., 2010) We can express our strength as an ability to produce maximum muscle strength during free contraction under defined conditions, with the strength of a low heredity factor ($h^2 = 0.50$), which means that we can greatly improve it by training (Marković, 2008). We pay particular attention to the natural strengthening of children, to which helmets such as overpressure, dragging, jumping, jump, climbing help us. We involve all muscle groups and joint areas. Thus, the aim of the physical activity focused on the basic development of power capacities is, according to Měkota & Novosad (2005):

- Improving the innervation capabilities of the muscular apparatus of intramuscular and intermuscular coordination
- Increasing the energy potential of hypertrophy of muscle structures
- The supply of sufficient energy amount to the muscular apparatus

Power capabilities have their sensational period somewhat later. This is due in particular to the production of sex hormones and growth hormones that significantly affect the potential for strength development. The maximum strength level is greatly dependent not only on your training load, but also on the level of hormone production. Therefore, the rate of development of strength is quite individual, but the highest gains are achieved in girls between 10 and 13 years, in boys between 13 and 15 years. In the case of non-sporting women, the post-17th-18th year of force development ceased, with non-sporting men around 18-20 years old. The most important thing is the age of puberty (about 15-16 years), where we can start with more demanding strength training. Until then, only some strength training is appropriate, but it is not intended to achieve large masses (Perič, 2012). Muscle exercises must be preceded by thorough warm-up and integration. After completion of the strength training, a block of compensatory and balancing exercises should be followed (Perič, 2012).

1.3.2.1 Types of strength and power capabilities

1. Static power - uses isometric reactions (manual dynamometry, shudder, etc.)
2. Dynamic power
 - Explosive (explosive) power - is characterized by maximum acceleration at medium and lower resistances (throw of spheres, jump from place)
 - Fast power - it is characterized by a maximum acceleration but the maximum speed of movement at low and medium resistance (running, cycling, skating)
 - Slow power - is characterized by constant speed of movement at boundary resistances (weightlifting, power trilogy)
3. Endurance strength - Defined as the ability to maintain muscle contraction for a set period of time (rowing, swimming, cross-country skiing)
4. Maximum strength - is understood as the highest value of force that can be developed in an isometric relationship, or with which it can still be moved against the greatest resistance regardless of the rate of its development.

1.3.2.2 Methods of development and classification of individual species

- Maximum effort method - development of absolute and maximum power. It is based on overcoming the highest resistance. The repeat maximum (RM) is 1 - 3, the movement speed is relatively small, the rest between the series 2 - 5 min.
- Repeated effort method - builds on multiple contractions and has several options:
 - Overcoming the maximum resistance with a focus on high to maximum speed of movement (sometimes called Dynamic Efforts) - development of Rapid and Explosive Strength
 - Multiple repetitions (practically to fatigue) with low resistance (RM over 20), with moderate speed - development of endurance force
 - Repeat with submaximal resistance (RM 5-10) at any speed, the speed of motion practically does not matter. - development of absolute power
- Isometric method - development of absolute strength, using static exercises. Developed force acts against resistance, muscles work in isometric mode. Self-contractions last 6 to 12 seconds with a gradual increase in effort, and a stringent sequencing is required to increase the attempts. To develop a force

that would include the entire motion range, it is appropriate to perform a series of isometric contractions at different positions of the entire motion range.

- The method of eccentric effort (also eccentric contractions) - the development of absolute force, works with an external resistance whose value is higher than the maximum force value in a given motion. The work of the muscles is braking in this case, the movement of the muscles slows some movement. The power exerted by pressure or pulling against external resistance, which overcomes it with slow movement. This method requires a special booster.
- The shock method - the development of explosive and rapid power, is based on the principle of sudden, suddenly applied muscle load by eccentric activity before their concentric activity. Active work is taking place at the moment of amortization and stimulates the rapid development of muscle tension. The amortization should be as short as possible, and the positions corresponding to the special exercise must be chosen.
- The isokinetic method - the development of explosive and rapid force, was based on the experimentally verified fact that in the muscles burdened by the burden whose weight during the movement can not change, their maximum strength is not always stimulated and the effectiveness of the training is lower. For example, when exercising with a dumbbell, the greatest effort is made at the beginning of movement, and then the inertia begins to apply, resulting in a partial decrease in effort. Similarly, when stretching the rubber expander, the resistance increases and the maximum effort is needed at the end of the movement.

1.3.2.3 Overview of athletic training tools and classification for individual types

- Weightlifting relocation, clean and jerk, snatch, - explosive and rapid power
- Squats, half-squats, barbell step ups, lunges - complex, depends on the intensity of the number of repetitions
- Explosions jumps on the bench - explosive, fast power
- Frogs - fast, explosive power
- Reflections – multiple, one leg, alternating - explosive, fast,
- Holdings in different positions (pullups, push-ups, squat, etc.) - static force
- The dumbbell expressions - fast, explosive

- Medicinal throws of both hands, single-hand, in lean, standing in different directions and positions - explosive, fast
- Skipping over the buck, the Swedish box, over the obstacles, the jumps from the elevated to the elevated place - fast, explosive
- Walking in the squat, jumping to the stairs, burpees - fast, explosive, endurance force
 - Note - almost all resources for power development can also develop endurance power - it depends only on the weights of resistance and the number of repetitions we choose

1.3.3 Definition and characteristics of endurance abilities

The complex of endurance abilities, short-term endurance, is the basic pillar of physical fitness, an important component of health-oriented fitness. It is a prerequisite for success in many sports. Compared to other fitness capabilities, endurance has a superior status and is best scientifically supported (Měkota, 2005). Endurance abilities are the prerequisites for a person to perform a longer exercise activity with a certain intensity. It can be understood as resistance to fatigue and a great share of the enduring nature of the exercises has a free individual's effort. In their development, the training of endurance skills is not only a pleasant affair, it is necessary to choose the appropriate motivation (Votík, 2005). Influencing endurance capabilities is relatively easy, unlike other fitness capabilities, because the adaptability of endurance systems is greater. The effect can be expected in a few weeks. Endurance training as a whole is not possible because the load applied activates aerobic or anaerobic processes. The level of endurance capabilities is determined by a transport system consisting of a complex organ systems and their interdependent functions ensuring both an increased supply of O₂ and energy sources to the working muscles and other tissues, as well as the removal of CO₂ and their metabolites. The controlling role plays the nervous system (Bedřich, 2005).

Endurance performance is always dependent on these other factors, according to Lehnert at al. (2010):

- the economics of motion-driven technology
- how to cover energy needs

- the ability to receive O₂
- optimum weights
- the level of free concentration aimed at overcoming fatigue
- the development of the type of persistence that is decisive for the type of exercise performed
- how to cover energy needs

The significance of endurance as a basic conditioning ability can be briefly characterized by Měkota & Novosada (2005) as follows:

- is a crucial physical fitness for fitness and health
- a large number of sports disciplines are based on an endurance base
- in locomotive disciplines aimed at overcoming distance, the requirements for the development of special endurance are increased as quickly as possible
- in track and field and sports games endurance allows to increase racing pace
- in coordination sports where there are high demands on concentration, the stability of the mastered technique increases
- in all disciplines, increased stamina increases training and racing loads
- the level of persistence is closely related to the reduction of the recovery phase and to accelerating the recovery of energy sources
- in the framework of health training it creates the prerequisites for dealing with stress situations and for primary and secondary prevention of cardiovascular diseases

The main assumptions that determine the level of endurance capacities according to Měkota & Novosad (2005) are:

- genetic and somatotype assumptions
- the predominance of SO fiber in agonists
- performance and efficiency of systems providing transport and exchange of oxygen and carbon dioxide
- regulatory plasticity of metabolic processes
- an effective combination of agonists and antagonists with an emphasis on the importance of antagonists relaxation
- automation of motor skills based on the high level of the acquisition of realized physical activity

Energy for motor performance is obtained from ATP (adenosine triphosphate), which is stored in muscle cells. Depending on the duration and intensity of the movement, the energy is released in a different way. The aerobic zone of power envelope under load requires a sufficient O₂ supply. Anaerobic zone of energy coverage insufficient O₂ intake and lactate formation. Metabolic zones of energy demand are defined by an immediate predominance of the share of one of the basic energy systems. (Mékota & Novosad, 2005).

1.3.3.1 Types of endurance

Kučera & Trucusou (2000) divides endurance into four groups according to duration and energy performance capability:

1. Speed endurance: power takes up to 20 seconds, power is covered from anaerobic glycolysis
2. Endurance short-term: power takes 20 seconds to 2 minutes, energy is covered by a lactate system
3. Endurance medium-term: power takes 2 to 11 minutes, energy is a cover lactate and aerobic systems
4. Endurance: long lasting: power takes 11 to 90+ minutes, power is covered aerobic system

Endurance can also be divided by the number of muscles involved:

- local (less than or equal to 1/3 muscle mass)
- global (involving more than 1/3 muscle mass)

Endurance can be divided according to the external manifestations of:

- static (endurance in a certain position eg pullups)
- dynamic (repetitive movement eg. running)

1.3.3.2 Methods of development

To improve endurance performance, the intensity is recommended at least at 60% VO₂ max. The intensity of the load may be the maximum pulse rate frequency. Its value depends on the amount of muscle involved in the load. It is necessary to find the maximum heart rate value (HR_{max}) for each sport separately, using a sport-tester, which also serves as a means of controlling values HR during training. Cacek and Grasgruber (2008) report that run to 65% max. Hr corresponds to the load level at 50% VO₂ max, 75% max. HF

60% VO₂ max. And 85% max. TF 80% VO₂ max. VO₂ max increases through the endurance training relatively quickly. During the first 3-4 months after the start of endurance training, VO₂ max. increases by 15-20%. The cause of the improvement of the VO₂ max value in the first months is the increase in the volume of the heart, blood plasma, red blood cells, blood flow, density and magnitude of mitochondria, oxidative enzyme activity and usually also by decreasing body weight. To improve endurance performance, the intensity is recommended at least at 60% VO₂max. The intensity of load can be a maximum pulse rate frequency. Its value depends on the amount of muscles involved in the load. It is necessary to find maximum of heart rate value (HR) for each sport separately using sport-tests, which also serves as a means of controlling values HR during training. Cacek & Grasgruber (2008) report that running to 65% of max HR corresponds to the load level at 50% VO₂max, 75% mx. HR 60% VO₂max and 80% max HR 80% VO₂max. VO₂max increases through the endurance training relatively quickly. During the first 3-4 months after the start of endurance training, VO₂max increases by 15-20%. The cause of the improvement of VO₂max value in the first months is the increase in the volume of heart, blood plasma, red blood cells, blood low, density and magnitude of mitochondria, oxidative enzyme activity usually also y decreasing body weight.

Daniels (2005) distinguishes the methods of endurance development into:

- Basic training (light and continuous runs)
- Training the marathon tempo
- Pace training in the anaerobic rate area
- Interval training method
- Repetitive training method

According to Cacek & Grasgruber (2008), the methods of endurance development are divided into 3 basic groups:

- Interval methods
- Continuous methods
- Repeat methods

Kučera & Truksa (2000) divided the methods of endurance development according to other methodologies distinguish:

- Continuous methods
- Interval methods
- Control methods

At the first glance, there is a methodology for dividing endurance development methods into minor differences, but in a more detailed division into basic groups and subgroups the division does not differ significantly.

1.3.4 Coordination

Coordination is the ability to reduce unnecessary movements or simply tune up the boxer's tools. Some sources state that coordination is the ability to make specific moves with minimal effort as quickly as possible. When developing coordination skills, it is necessary to use the widest possible range of training resources. For athletes who manage the exercises automatically, they are no longer developing, but sportsmen are in the stabilization phase. Coordination against other physical abilities needs a double time, so we need to devote more time to it. Coordination creates a prerequisite for successful motor learning (Táborský et al., 2007). Coordination skills can be distinguished: kinetic-differentiation, reaction, spatial-orientation, equilibrium, rhythmic and connectivity.

- Kinesthetic-differentiation coordination is the ability to control movements in time, space and dynamics. It gives us the premise of high precision, alignment, precision not only of individual movements but also of movement as a whole. This ability is best developed at the age of 6-9 years. In boxing, this ability is used in many activities, so its immense significance.
- Reaction ability not only allows you to get started quickly, but also perform a certain physical activity. We divide it into a simple and complex one.
- Space-Oriented Coordination is the ability to quickly and correctly determine your position in space. It develops at the age of 9-14.
- Balance is the ability to preserve it, or to restore it quickly when it comes to it disruption. It is divided into dynamic and static. It develops at the age of 8-12 years.
- Rhythmic ability is the ability to realize the movement in its own, or to perform movements with the specified external rhythm. It develops at the age of 8-11 years. The importance of boxing is in a conscious change of pace in solving match activities.
- The ability to connect is the highest coordination ability in boxing. A number of training aids such as sticks, poles, cones, running belts, cross-country ladders etc. are used to increase (Foran, 2001)

1.4 Cross training improving boxers skills

The sport of boxing seats a premium on aerobic endurance, foot speed, and upper extremities power. Boxers were among the primary athletes to cross-train, using running to increase their aerobic fitness. They habitually have done abdominal work to strengthen their trunk muscles to better engage the power of opponents' punches. Boxing also entails good balance and agility, especially in reacting to the opponents' punches. The greatest difference in drill for boxers today is the addition of strength training to increase the boxer's punching power. This is achieved by focusing the strength program on higher weights with fewer repetitions. In addition, plyometrics and resistance exercises are excellent for building muscle strength and endurance (Moran & McGlynn, 1997).

Key	Exercises	Strength	Muscular Endurance	Aerobic	Anaerobic	Warm-up/ Cool-down	Flexibility	Rehabilitation	Agility and Balance
T	Treadmill			☆	☆	☆			
RM	Rowing Machine			○	○				
XC	X-C Ski Machine			○	○				
SM	StairMaster			○		☆			
VC	Versa Climber		☆	○	☆	○			
B	Bicycling			○	○	☆		○	
S	Swimming			○			○		
AJ	Aqua Jogging			○				☆	
A	Aerobics			○			○		○
LS	Lateral Sports				○				○
WT	Weight Training	☆	☆					☆	
P	Plyometrics	○	○					○	
AE	Arm Ergometer	○	☆		○				
RB	Roller Blading			○					○
RJ	Rope Jumping			☆	○	☆			○
AG	Agility Exercises				○				○
F	Flexibility Exercises					○	○		
R	Running			☆	☆	☆			

○ = Recommended ☆ = Highly Recommended

Figure 1 – Cross training matrix suitable for boxers (Moran & McGlynn, 1997)

2 Goal, tasks and methodology of work

2.1 Goal of the work

Based on the results of the studies and findings gained from literature, to prepare cross-training program using athletic drills for boxers, improving their boxing skills.

2.2 Tasks of the work

- To create search engine for collection of studies from various electronic information sources
- To convert literary research and gather studies that focus on improving boxer skills through cross-training
- To propose three training programs using athletic skills through cross training for top-level boxers
- To design the final bachelor thesis

2.3 Methodics of the work (design)

In this work, the method of systematic review was used. In the discussion of the systematic review, the different options of a given clinical problem are compared, but its main aim is to find connections within the resulting set of scientific knowledge. It is an assessment of the quality, heterogeneity and practical applicability of the results of individual studies. The aim of this final work was to collect studies that examined the use of cross training and athletic skills for the top boxing, then analyze them and describe their results at work. To collect relevant information, a search key was created at the beginning of the work solution to search for studies and scientific articles on multiple electronic databases. This search key makes it easy and quicker to search in a large number of studies that are contained in various electronic databases. When drawing up a motion program, it was using the observation method in addition to the above-mentioned sources and my own experience gained over the years.

3 Descriptive-analytical part of the thesis

3.1 Circuit core and stability training

The circuit core work out is key in boxing, because the core transfers the forces and the motions from the lower to upper body. The core needs to be strong and stable before any power movement. As the most strong is the core is the powerfully the movement (kinematic chain). If we want to have a strong punch, we need to have first strong core. The muscles from mid-thigh provides the motion to your neck. This force that is providing transfers to all body during the punch. Stability is very important in boxing too, because keep the body stable, in another case there is a big possibility for injuries. As we already know, all movements are initiated from the center of the body, located here center of gravity and is coming the all power from this place. A properly activated body nucleus brings us effective coordination of the muscles of the cross, lumbar and pelvis. These facts are for the box extremely important. Boxer needs to be stable in combat and at the same time produce dynamic force in strikes that originate from rotation of the entire lumbo-pelvic-hip LPH complex. It is therefore important to strengthen the deep muscles and not the surface ones. Surface strengthening, for example, to overloading postural muscles, what leads to the fact that the fighter can not applied exercise the maximum is strongly restricted and especially threatening to muscular dysbalance, which can lead to health problems with motion apparatuses and injuries. Conversely, core training is focused on deepening the depth muscles. It also increases performance and performance stability and mobility also works as a compensatory exercise because thanks we prevent them preventively from injuries in sports performance and we renew correctly holding the body. Strengthening the deeply stored muscles increases stability and ability to perform moves in unstable positions and overall it is boxer or any other athlete capable of doing more. This is what we see benefit and the importance of correctly applied core training for the box.

Exercise time: 45 seconds

Rest between exercises: 10 seconds – moving between stations

Series: 3-4x

Rest between series: 2-3 minutes break

Requisite: bosu, aquahit, medicinball, fitball, expander, hanging ropes, mini disc balance
At the beginning of the training warming up 15 minutes, at the end of the training 10 minutes cool down - slowly running, stretching

1. Squats on bosu with aquahit above the head

- stand crooked on bosu, a water bag in tensed arms above the head – squatting and returning to the starting position
- stimulation of lower limb muscles, gluteus muscles, postural stability and strengthening of the upper limb muscles

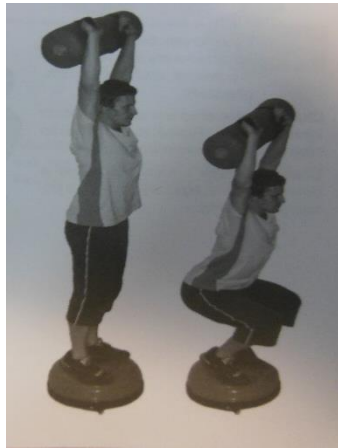


Figure 2 – Squats on bosu with water bag (Jebavý & Zumr, 2009)

2. Hyperextension on the bosu

- the belly on the bosu, the toes touching the ground, the hands on the neck, the head on the ground – to make extension with the chest, the legs away from the pad
- stimulation of the back muscles

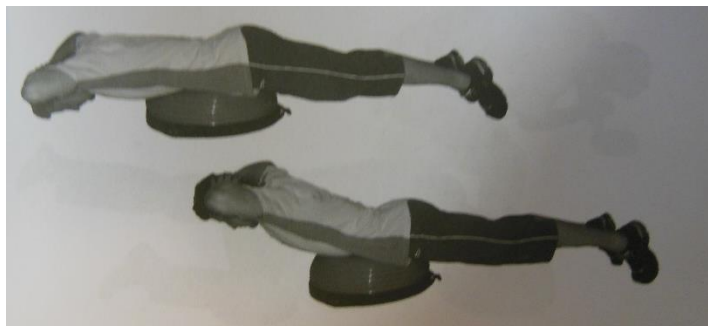


Figure 3 – Hyperextension on bosu (Jebavý & Zumr, 2009)

3. Push-ups on medicinbal and on bosu

- press up, the toes on bosu, hands leaning on medicinbal – doing push-ups, activating the buttock, during the exercise there should not be bending in the chest and lumbar spine
- stimulation of the muscles of the arms, especially the triginal muscle of the shoulder, shoulder waist, blade fixators, lower limbs and total strengthening

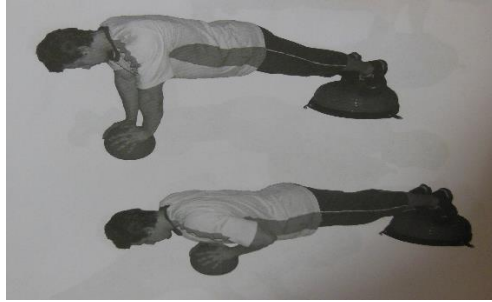


Figure 4 - Push-ups on medicinbal and on bosu (Jebavý & Zumr, 2009)

4. Strengthening the abdomen on the fitball

- press up, the toes leaning on big ball – by swinging the big ball, the loop is dropped and back
- stimulation of the abdominal muscles, arm muscles and general strengthening

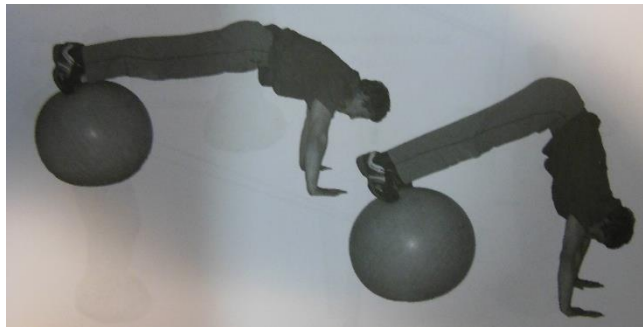


Figure 5 – Strengthening the abs on the fitball (Jebavý & Zumr, 2009)

5. Reverse lunges with aquhit on the back

- standing a water bag on the back – reverse lunges, torso upright
- stimulation of lower limb muscles and total strengthening

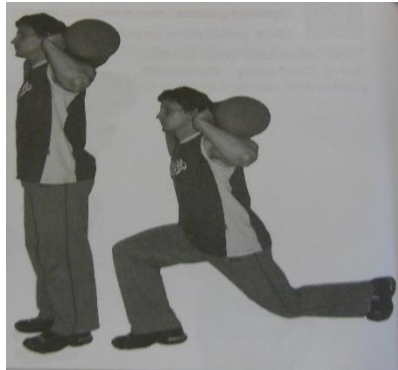


Figure 6 - Reverse lunges with water bag (Jebavý & Zumr, 2009)

6. Tightening of the expander on the bosu

- narrow stand on bosu facing the firm support, forearm, holding the expander in the hands – pulling the arms against the expander puller, straightens the arms to the body, the elbows along the rear torso
- stimulation of the back muscles, especially blade fixators and broad back muscles

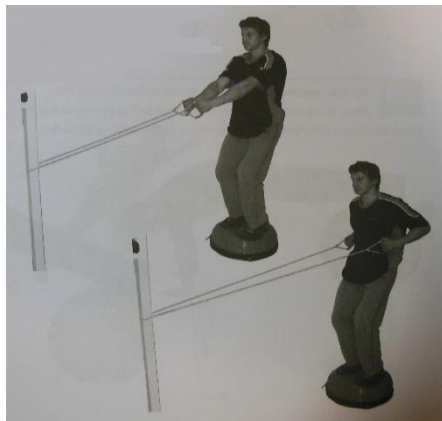


Figure 7 – Tightening expander on the bosu (Jebavý & Zumr, 2009)

7. Triceps with expander on fitball and bosu

- laying on fitball, the big ball is supported on the bosu, the feet on the pad, the expander we hold under the bosu behind the head – we perform triceps in the front
- stimulation of arm muscles and shoulder waist

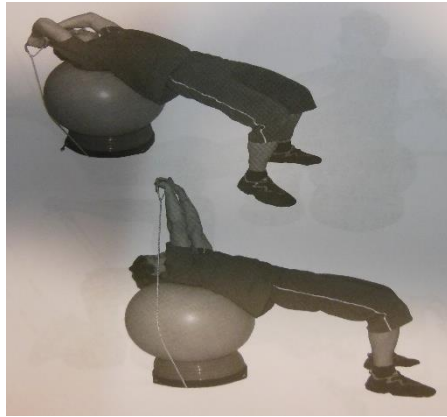


Figure 8 – Triceps with expander on fitball and bosu (Jebavý & Zumr, 2009)

8. Sit-ups on bosu

- sitting on the bosu with a slight incline of the hull back – slowly lift to the sit and back
- stimulation of the abdominal muscles



Figure 9 – Sits-ups on bosu (Jebavý & Zumr, 2009)

9. Diagonal lunges with aquahit

- standing, the water bag in the folded arms behind the head on the shoulders
- stepping right (left) across the axis of the other leg, step back and the left (right) leg diagonal reverse
- stimulation of lower limb muscles and total strengthening

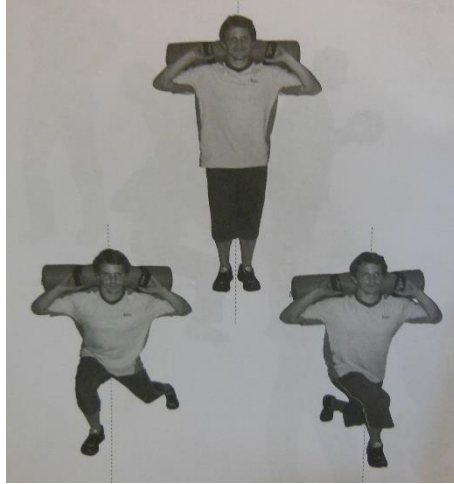


Figure 10 – Diagonal lunges with water bag (Jebavý & Zumr, 2009)

10. Pull-ups on fitball

- hanging position on the fixed loading platform, the calf resting on a large ball – repeatedly pull-ups to the loading line, the trunk and legs are almost in one plane, in the upper position don't leave the pelvis down
- overall reinforcement with an emphasis on the stimulation of the muscles of the arms and shoulder



Figure 11 – Pull-ups on fitball (Jebavý & Zumr, 2009)

11. Push-ups on fitball and hanging ropes

- press-up, shins leaning on the big ball, arms hanging on hanging ropes – do the push-ups, activate buckle muscles, don't bend in the chest and lumbar spine during the exercise
- stimulation of the musculature of the arms, especially the trigeminal muscle of the shoulder, the shoulder arm, the blade fixators and the overall strengthening of the lower limb muscles

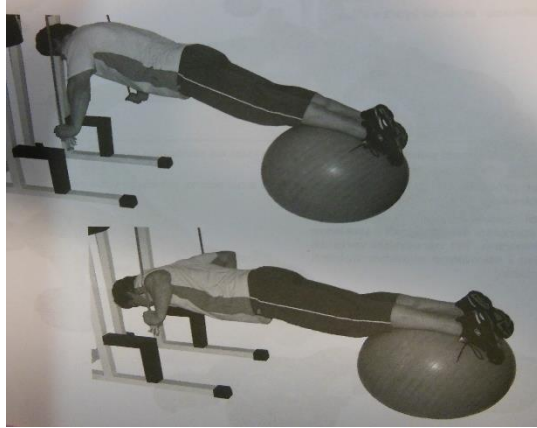


Figure 12 – Push-ups on fitball (Jebavý & Zumr, 2009)

12. Rotation of the trunk with aquahit

- sitting on the mini disc balance, the feet on the ground, the water bag lying beside the body in tight arms – repeatedly rotate of the trunk with laying the water bag on the ground
- stimulation of abdominal muscles and upper limbs, total strengthening

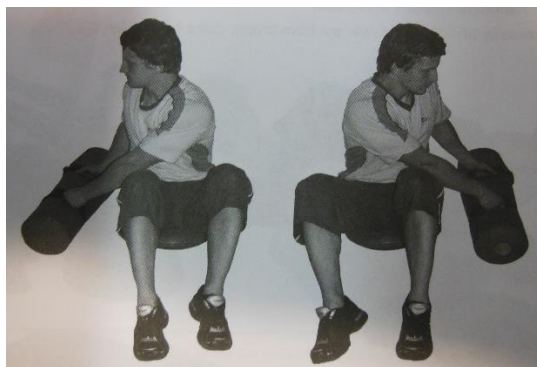


Figure 13 – Rotation of the trunk with water bag (Jebavý & Zumr, 2009)

3.2 Strength training

Exercises:

- 1) Clean – 8-10 repetitions, 70 -80% 1RM, 3 sets, rest between sets 2-3 minutes
- 2) Squat - 8-10 repetitions, 70 -80% 1RM, 3 sets, rest between sets 2-3 minutes
- 3) Romanian deadlift 8-10 repetitions, 70 -80% 1RM, 3 sets, rest between sets 2-3 minutes
- 4) Depth jumps – 15 repetitions, 3 sets, 1 minute rest between sets
- 5) Single leg jumps -15 repetitions, 3 sets, 1 minute rest between sets for each leg
- 6) Floor press 8-10 repetitions, 70 -80% 1RM, 3 sets, rest between sets 2-3 minutes
- 7) Suspension row -12-15 repetitions, 3 sets, 1 minute rest between sets
- 8) Shoulder press - 8-10 repetitions, 70 -80% 1RM, 3 sets, rest between sets 2-3 minutes
- 9) Dumbbell row- 8-10 repetitions, 70 -80% 1RM, 3 sets, rest between sets 2-3 minutes for each arm
- 10) Bench press 8-10 repetitions, 70 -80% 1RM, 3 sets, rest between sets 2-3 minutes
- 11) Dumbbell punches – 10-15 repetitions, 2kg weight for each hand, 3 sets, 1 minute rest

1. Clean

- assume a shoulder-width posture, with knees inside the arms. Now while keeping the back flat, bend at the knees and hips so that you can grab the bar with the arms fully extended and a pronated grip that is slightly wider than shoulder width. Point the elbows out to sides. The bar should be close to the shins. Position the shoulders over or slightly ahead of the bar. Establish a flat back posture. This will be your starting position. Begin to pull the bar by extending the knees. Move your hips forward and raise the shoulders at the same rate while keeping the angle of the back constant; continue to lift the bar straight up while keeping it close to your body. As the bar passes the knee, extend at the ankles, knees, and hips forcefully, similar to a jumping motion. As you do so, continue to guide the bar with your hands, shrugging your shoulders and using the momentum from your movement to pull the bar as high as possible. The bar should travel close to your body, and you should keep your elbows out. At maximum

elevation, your feet should clear the floor and you should start to pull yourself under the bar. The mechanics of this could change slightly, depending on the weight used. You should descend into a squatting position as you pull yourself under the bar. As the bar hits terminal height, rotate your elbows around and under the bar. Rack the bar across the front of the shoulders while keeping the torso erect and flexing the hips and knees to absorb the weight of the bar. Stand to full height, holding the bar in the clean position. Without moving your feet, press the bar overhead as you exhale. Lower the bar under control.

- to perform “explosive” movements, activating several muscles & joints in the process. This has a large transfer to any sport that involves running, jumping, throwing or striking movements. Rapid kinetic chain sequencing, which is important for any sport, for instance the punch in boxing with force from the generated from floor to the hips, through the core then into the upper body for a knockout punch. Promotes effective mass as muscles activate during hip extension, relax during flight of the bar before contracting again during the catch. Develops the ability to absorb force. Activates and develops function of type II muscle fibers, these are needed to produce force quickly. Regression and development exercises improve posture, mobility and reduce risk of injury. You need to develop movement patterns and foundational strength before attempting these exercises to make sure you’re performing exercises correctly and safely.



Figure 14 – Technique of the clean (Liggett et al., 2014)

2. Squat

- Setup. Face the bar. Grab it tight with a medium grip. Put it on your upper-back by dipping under the bar. Raise your chest. Move your feet under the bar. Unrack it by straightening your legs. Step back with straight legs. Lock your hips and knees. Take a big breath, hold it and Squat down. Push your knees out while moving your hips back. Keep your lower back neutral. Squat down until your hips are below your knees. Thighs parallel to the floor isn't low enough. You must break parallel. Break parallel then Squat back up. Keep your knees out and chest up. Lock your hips and knees at the top. Breathe.
- Strengthens the lower body and core. This has a large transfer to any sport that involves running, jumping, throwing or striking movements. Promotes a forceful hip extension, which important transferring force generated from floor to the hips and through to the core. Develops core strength, this is important for rotational velocity and effective mass during a punch. Can increase lean mass of the core, this is the most influential contributor to punching force. A large eccentric component to the lift will strengthen hamstrings and glutes, this develops an effective stretch shortening cycle whilst reducing the likelihood of injury. Studies show that the squat improves jump height. From our own research, we know that the higher you jump is related to a harder punch, this is why the squat is prioritised in our strength programs. Boxers count on their legs to keep them upright and moving quickly during a fight. To build lower-body power, boxers can work with the squat, an exercise that hits the muscles in the hips, back and front of the thighs.



Figure 15 – Squat (Haley, 2012)

3. Romanian deadlift

- hold a bar at hip level with a pronated (palms facing down) grip. Your shoulders should be back, your back arched, and your knees slightly bent. This will be your starting position. Lower the bar by moving your butt back as far as you can. Keep the bar close to your body, your head looking forward, and your shoulders back. Done correctly, you should reach the maximum range of your hamstring flexibility just below the knee. Any further movement will be compensation and should be avoided for this movement. At the bottom of your range of motion, return the starting position by driving the hips forward to stand up tall.
- Develops the posterior chain, this is important to improve function of glutes and hamstrings, as well as strengthening the lower back and core. This is important for athletes as the posterior chain is not strengthened through traditional boxing methods, therefore the Romanian deadlift can also reduce the likelihood of injury. Movement assessments show that boxers are quad-dominant athletes and find it difficult to hinge at the hips, this means that the glutes can become underactive. The Romanian deadlift is a great tool to learn the hip-hinge pattern. Promotes a forceful hip extension, which important transferring force generated from floor to the hips and through to the core. Develops core strength, this is important for rotational velocity and effective mass. A large eccentric component to the lift will strengthen hamstrings and glutes, this develops an effective stretch shortening cycle whilst reducing the likelihood of injury.



Figure 16 – Technique of romanian deadlift (Gonzales, 2016)

4. Depth jumps

- Stand on a box, bench or sturdy chair approximately 30-40 cm high. Step off the bench (don't jump off) and as soon as you land explode vertically, as high as you can. Try to minimize ground contact time (don't sink down into a deep squat before jumping up).
- Depth jumps are a plyometric movement that develop explosive power through the legs. Plyometrics essentially enhance muscular speed by making muscles more explosive, through stretch-shortening-cycle improvement, which is brought about through an increase in the speed of force of the muscles as their elastic properties are utilized. It is preferable in many instances for depth jumps to be performed without weights, due to the impact they have on the joints. Given much of the power of any punch, not to mention footwork (which plays an important role in landing these punches), requires explosive power through the legs, it is pertinent to focus on leg exercises emphasizing power - plyometrics are among the best at doing this.



Figure 17 – Depth jumps technique (Kochhar, 2015)

5. Single leg jumps

- Bend knee slightly while standing on one leg. Staying on the same foot try to gain as much height and distance as possible with each hop. Keep ground contact time as short as possible.
- Another plyometric movement, single leg hops, will assist with the development of both leg power and balance. Balance in boxing is crucial, as one cannot properly execute a perfectly timed punch if the body is not stable. Often, when one is hit, and consequently thrown off balance, their ability to recover sufficiently before their opponent is on them suffers. With single-leg hops, the ability to throw punches from this vulnerable position will be improved as the body becomes adept at stabilizing in a split second.
- Complete three sets of 15 repetitions, with 1 minute rest between sets, and repeat with opposite leg.

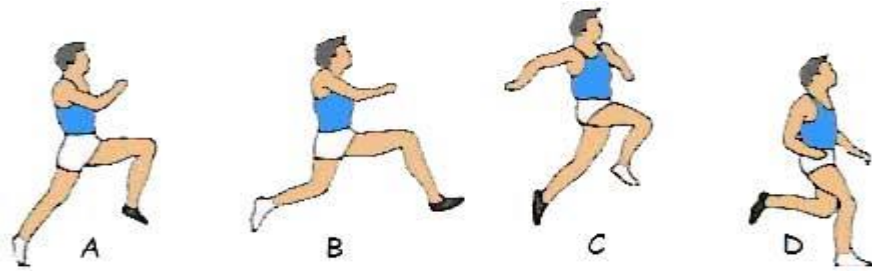


Figure 18 – Technique of single leg jumps (Mackenzie, 2007)

6. Floor press

- Lie on your back and position yourself under the bar. Too far in front of the bar and you'll drop the barbell on your forehead trying to unrack it. Too far behind and you'll be grinding reps into the squat rack. Grab the barbell with a shoulder-width grip or slightly narrower and push yourself into the ground to set the scapulae and provide stability. Bending the knees lead to addition spinal stress due to low back arching and it also invites driving with the leg. Fully extend both legs and drive your heels into the ground, increasing stability without leg drive. Since your shoulders are locked in, you'll need a lift off. Unracking without a lift off forces the

shoulders into abduction and protraction, completely defeating the purpose of getting tight in the first place. Row the Bar. There aren't any points for crashing your elbows into the ground on a floor press. Instead, actively row the bar to the lower chest during the eccentric portion of the lift. By rowing the bar you'll activate the lats, thereby providing stability to the upper body and greater strength in the press. Tuck the elbows. Keep the elbows tucked at 45 degrees for safe and powerful pressing. Flaring the elbows wide creates loads of stress on the joints and creates an unstable pushing position. Conversely, narrow grips are extremely awkward, stressful, and not conducive to big strength gains. Keep the wrist and elbow joints stacked underneath the bar for best results. Pause and Press. Lower the bar under control until the upper arm touches the ground, stay tight and explosively extend the tucked elbows while maintaining alignment of the wrist, elbow, and bar. Finish with the bar exactly where you began the press.

- Develops upper body strength, particularly the chest, triceps and shoulders. Demanding on core strength. Neutral grip and partial range makes the floor press a shoulder friendly exercise. This is useful as poor shoulder mobility is common in boxing. Partial range also increases the demand on the tricep muscles to assist in full extension of the arm. This can increase our strength at the end range of punches, as well as reducing likelihood of elbow and shoulder injuries. Easy to set up and the technique is quickly learnt – meaning boxers can show decent progress in a short amount of time.

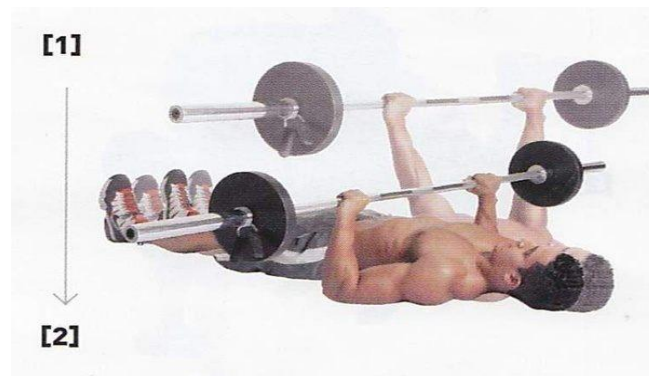


Figure 19 – Floor press technique (Lemke, 2015)

7. Suspension Row

- Suspend your straps at around chest height. Take a handle in each hand and lean back. Keep your body erect and your head and chest up. Your arms should be fully extended. This will be your starting position. Begin by flexing the elbow to initiate the movement. Protract your shoulder blades as you do so. At the completion of the motion pause, and then return to the starting position.
- Develops upper body strength, particularly the lats, biceps and shoulders. Demanding on core and posterior chain strength. Requires effective scapula retraction, this promotes use of the rotator cuff and posterior shoulder muscles. Therefore, improving the function and reducing the likelihood of injury for the shoulder. Requires balance and co-ordination, whilst being beneficial to posture and shoulder mobility. Easy to set up and the technique is quickly learnt – meaning boxers can show decent progress in a short amount of time. Boxers need well-conditioned bodies to hit hard and stay on their feet through rounds of pounding. Working out with a dumbbell in each hand allows boxers to build strength endurance on both sides of the body. Dumbbell training will boost a boxer's overall strength and stamina for sparring, pounding the heavy bag and going rounds with an opponent. With a boxing dumbbell workout you will develop the muscles in your arms, torso and lower body that you need in the ring.



Figure 20 – Suspension row technique (Roizen, 2015)

8. Shoulder press

- While holding a dumbbell in each hand, sit on a military press bench or utility bench that has back support. Place the dumbbells upright on top of your thighs. Now raise the dumbbells to shoulder height one at a time using your thighs to help propel them up into position. Make sure to rotate your wrists so that the palms of your hands are facing forward. This is your starting position. Now, exhale and push the dumbbells upward until they touch at the top. Then, after a brief pause at the top contracted position, slowly lower the weights back down to the starting position while inhaling.
- Keeping your guard up for three-minute rounds can tax a boxer's shoulders. A dumbbell shoulder press will develop both power and endurance in the deltoids. For this move, use weights heavy enough to produce fatigue after eight reps. Start by standing with your feet shoulder-width apart. Hold the weights above your shoulders with palms facing forward. Push the weights up until your arms are straight above your head. Pause and return to the starting position. Perform three sets of six to eight reps.



Figure 21 – Dumbbell shoulder press technique (Michelfelder, 2017)

9. Dumbbell row

- Choose a flat bench and place a dumbbell on each side of it. Place the right leg on top of the end of the bench, bend your torso forward from the waist until your upper body is parallel to the floor, and place your right hand on the other end of the bench for support. Use the left hand to pick up the dumbbell on the floor and hold the weight while keeping your lower back straight. The palm of the hand should be facing your torso. This will be your starting position. Pull the resistance straight up to the side of your chest, keeping your upper arm close to your side and keeping the torso stationary. Breathe out as you perform this step. Tip: Concentrate on squeezing the back muscles once you reach the full contracted position. Also, make sure that the force is performed with the back muscles and not the arms. Finally, the upper torso should remain stationary and only the arms should move. The forearms should do no other work except for holding the dumbbell; therefore do not try to pull the dumbbell up using the forearms. Lower the resistance straight down to the starting position. Breathe in as you perform this step. Repeat the movement for the specified amount of repetitions. Switch sides and repeat again with the other arm
- Boxers engage their back muscles to power certain punches like the cross. To develop the back muscles, work with an alternating dumbbell row. Hold a dumbbell in each hand and hinge forward at the waist. Keep your back straight but bend your knees slightly. Allow the dumbbells to hang down from your shoulders. Pull one weight up at a time toward your armpit. Lower it back down and repeat on the other side for one rep. Perform three sets of 15 reps with a weight heavy enough to fatigue your shoulders on the last rep.



Figure 22 – Dumbbell row technique (Krunoslav, 2012)

10. Bench press

- Lie on the flat bench with your eyes under the bar. Lift your chest and squeeze your shoulder-blades. Feet flat on the floor. Grab the bar. Put your pinky on the ring marks of your bar. Hold the bar in the base of your palm with a full grip and straight wrists. Take a big breath and unrack the bar by straightening your arms. Move the bar over your shoulders with your elbows locked. Lower it to your mid-chest while tucking your elbows 75°. Keep your forearms vertical. Hold your breath at the bottom. Press the bar from your mid-chest to above your shoulders. Keep your butt on the bench. Lock your elbows at the top. Breathe.
- The bench press is an essential exercise for developing upper-body strength, particularly through the chest. Lie on a bench or on the floor with a dumbbell in each hand. Your upper arms should be at a right angle to your sides with your forearms perpendicular to the floor. Press the weight up until your arms are straight and the dumbbells nearly touch, then lower them back down. Work with weights that are heavy enough to fatigue your chest after eight reps and continue for three sets.



Figure 23 – Bench press technique (Michelfelder, 2017)

11. Dumbbell punches

- grasp a lighter dumbbell with each of your hands. The feet are placed shoulder width apart, you can relocate one foot for a more stable standing. The legs are slightly bent. Arrange the upper arms next to the torso and bend the elbow joints to 90 degrees and hold them parallel to the ground. The palms of the hands point to each other in front of the body. Guide one dumbbell forwards and in shoulder-height. Turn the palm of the hand down, the other arm does not move now. Bring the stretched arm back again. A wink of an eye before the first arm is in its starting position the other arm begins to move forward. You can let your upper body follow the motion by turning it is with each move.
- Bicep power adds knockout potential to the upper cut and the triceps add snap to the jab. You can train your arm muscles using motions that resemble punches. To perform dumbbell upper cuts, hold a weight in each hand in a boxing stance -- feet hips-width apart, left foot a step in front of your right -- with your hands up to protect your face. Slowly make an upper-cut motion, alternating right and left while directing your punches out at a 45-degree angle. Don't punch higher than your face. Perform foot sets of 10 to 15 reps with a weight light enough to punch fluidly with but heavy enough to feel fatigue on the last rep. Alternate the lead leg in your stance between sets. Work your triceps by throwing straight punches from the front stance, using the same amount of weight and numbers of sets and reps.



Figure 24 – Dumbbell punches technique (Spotebi, 2017)

3.3 Endurance circuit training on the track and field

Exercise time: 1 minute

Rest between exercises: 10 seconds – moving between stations

Series: 3-4x

Rest between series: 3 minutes break

1. Running upstairs– 40 seconds up, 20 seconds down

- Running is a high-intensity form of cardiovascular exercise that elevates your heart rate and works large groups of muscles. Running upstairs can add intensity to your workout, burn additional calories and increase the strength of large groups of muscles.
- Running on an upward incline engages the glutes - the muscles of your hips and butt. This running also strengthen your calves, ankles and thighs. Over time, this can lead to greater muscle tone and fat loss in your lower body. The muscle strengthening associated with running upstairs can also decrease the pain that commonly occurs with muscle disuse. Running upstairs is a challenging task that requires you to competently navigate each step. This can improve agility and balance - two skills that are not only important for everyday life, but can also help you excel at sports and other physical fitness tasks. Running upstairs can also help you improve your speed.



Figure 25 – Running upstairs (Freepik, 2017)

2. Rope-skipping

- Side to side rope skipping - starting off in the Two Feet Basic Jump position, begin performing the same jump as normal. As you're jumping, using both feet, start jumping from side to side. You can start by doing short side jumps first then progress onto longer side jumps.
- Jumping rope helps fighters develop their footwork for ring movement. The key to throwing a heavy punch is having a solid base underneath your torso. Moving your feet in the proper manner allows you to throw crisp and clean punches that cause damage, and helps you avoid punches. Jumping rope at a fast pace gives you confidence that you can move your feet quickly in the ring. This is key as it increases your ability to time movements and throw punches while you are balanced. If you throw punches while your feet are not placed correctly, they lack force and power. Throwing punches with expert timing allows you to hit your opponent with force. Timing is more important than lifting weights when it comes to power punching. Jumping rope is a key exercise for building speed, quickness, footwork, endurance and confidence.

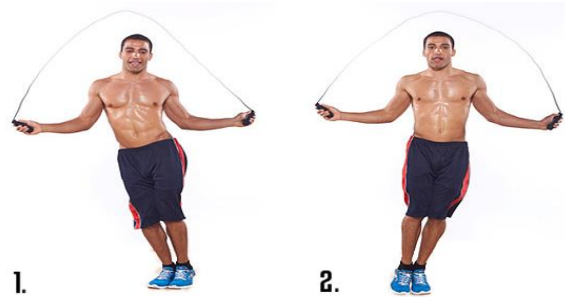


Figure 26 – Side to side rope skipping technique (SevenFitness, 2016)

3. Ladder drills – Rapid side steps

- Rapid side steps. Take a step to left foot out to the side then bring the right foot to meet left. Stay on for toes and stay tall. Make sure you do the exercise in both directions.
- Boxing agility drills are designed to help improve your speed and quickness while in the ring. Although many boxers develop their speed and agility to improve their punch accuracy and effectiveness, many boxing agility drills will also help you improve your defense skills.



Figure 27 – Rapid side steps using the ladder (Fit&Me, 2017)

4. 10-20-30 meters shuttle run

- Firstly, place a marker at 10 metres (m), 20m, and 30m. Run to the 10m mark first, touching the floor and running back to the start line. Then run to the 20m line and back. Finally run to the 30m line and back. Start the routine again and repeat.
- They help develop your acceleration, speed and your anaerobic fitness.

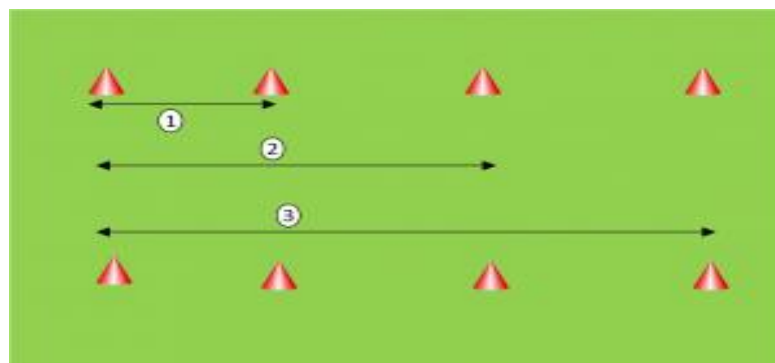


Figure 28 – Shuttle run (Erdmann, 2017)

5. Burpees

- The classic burpee is a four-point move. From a standing position, drop into a squat with your hands on the ground just in front of your feet. Then kick your feet back behind you, keeping your arms extended so you are in a raised plank position. At this stage, the more adventurous can throw a press-up into the mix, which really ramps up the difficulty. In the basic burpee, you remain in the raised plank and jump your feet back towards your hands. Then round off the manoeuvre by leaping into the air with your arms straight above you. Then do it all again.
- Doing burpees is a full-body workout in every sense. They build strength and endurance, raise your heart rate and burn bundles of calories, while also testing your balance and co-ordination.

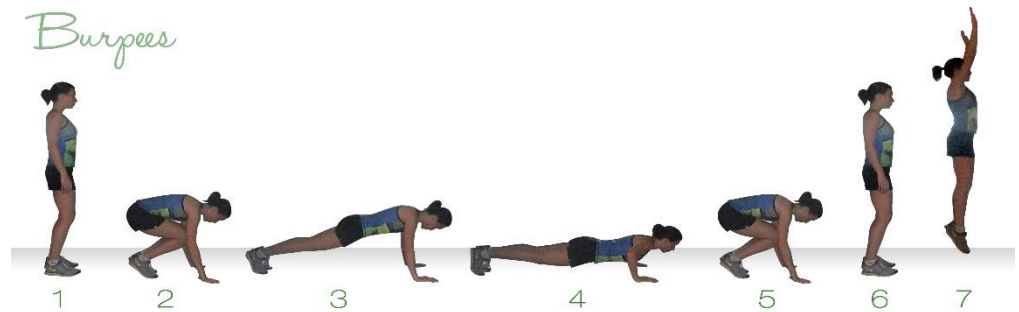


Figure 29 – Burpees technique (Udodiri, 2017)

6. Slalom

- Set up 5-6 markers or agility poles at various distances and directions. Starting at the first marker or agility pole, run around each markers or agility pole in order to the final marker.
- The nature of boxing as a fast paced, high impact sport means that regular interval training will help develop your body to engage in bursts of speed and strength. High intensity sprints are categorised as an anaerobic activity just like boxing and if done correctly, they are the most beneficial type of running for a boxer. Sprinting intervals will force your body to use energy sources inside your muscles as your body's demand for oxygen exceeds the amount of oxygen available.

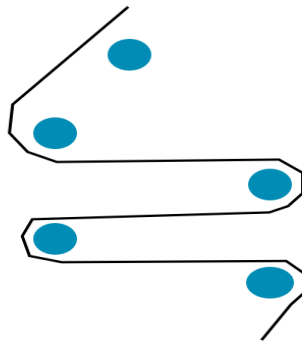


Figure 30- Slalom agility dril (ProTrainingPrograms, 2017)

7. Frog jumps

- Sit back with your feet in a wide stance and with the toes turned out at an angle. Jump forward and up, land on your toes and squat. Jump back and return to the starting position. Repeat this back and forth movement until the set is complete.
- The frog jumps is a plyometric exercise and the goal of this kind of training is to gain muscles mass and get fast, firm and powerful muscles. Plyometric exercises get your heart rate up and help you build cardio fitness and muscle endurance.



Figure 31 – Frog jumps technique (Kristen, 2012)

8. Boomerang runs

- On the edge of the 15 meter box, put three blue cones in a line, 4 meters apart. Place another four in a line left of the central cone, one yard apart, each cone a different colour. Do the same on the right, using the same colours. From the nearest blue cone to the furthest via the smallest angle the red cone. Use your outside foot to change direction. Run back, then run via the other red cone. Run back. Do this for each cone until you reach the widest angle.
- Having great change-of-direction speed (agility with quickness) allows the athlete to beat her or his opponent "to the stop" or recover from mistakes in positioning. Boomerang runs are excellent for practising change of direction at all angles, developing agility while improving acceleration and deceleration. On the edge of the 18-yard box, put three blue cones in a line, five yards apart. Place another four in a line left of the central cone, one yard apart, each cone a different color. Do the same on the right, using the same colors.

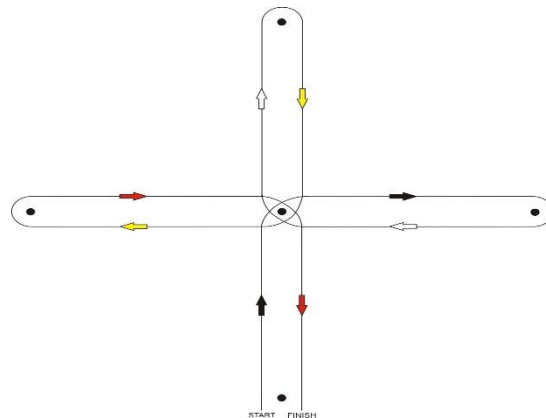


Figure 32 – Boomerang run (Sekedar, 2011)

9. Ladder drills – Step in – step out

- Start side on to the ladder, facing the ladder. Step your outside foot into the ladder, then bring your inside foot in. Now move down your ladder by bringing your outside foot out, followed by your inside foot, in a ‘one-two-three-four’ motion.
- Ladder drills is an excellent training method to improve the quickness of your feet. A ladder for exercise purposes is a lightweight equipment placed on the floor to guide you through the movement of your feet. Your footwork is just as important as your hands in boxing. It’s absolutely crucial that you perform exercises that improve footwork in boxing to better your agility, balance and positioning. In an actual fight, you need to be able to dart in and out of range quickly and safely. It makes all the difference on whether you’re going dictate the pace of the fight, or your opponent will.



Figure 33 – Ladder drill step in step out (Garage Gym Ideas, 2017)

4 Conclusion

Boxing is one of the most physically challenging sports in the world. By nature, boxing is an explosive, highly individualized, anaerobic sport. Namely, the estimate is that boxing is 70-80% anaerobic and 20-30% aerobic. A series of powerful and explosive bumps represents an anaerobic component, while circling the ring during the match is part of the aerobic component. Fitness training for athletes is a long-term issue where we must mainly take care of our health. The components of conditioning are speed, strength, endurance, coordination and dexterity. Besides the development of our body, we should try also for balanced eating, regeneration and mental well-being, because it all moves athletes to a higher level of performance and also contributes to a better health and life of the individual. At present, the process of developing physical fitness and performance becomes art, whose task is to prepare an athlete's body to match the demands of top sport without any health damage. The ideal blow consists of hand, leg and body synchronization. The better coordination of the leg extension, the rotation of the body and the extension of the hand, the beat is more effective. That is why exercises aimed at strengthening the entire chain are of crucial importance. Contractions during the boxing movement range from 50 to 250 milliseconds, which speaks of a large role of speed and explosive power. However, the component of maximum strength is also important. The goal is to develop a high level of strength and imply it in the shortest possible time. When designing a power and strength program you should know that boxing training is very large, so the choice of exercise and volume should be followed by sport. The exercises I use with boxers are all basic by their structure, synergize large muscle groups and give a great metabolic and endogenous stimulus.

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