



COMBINATION OF STRENGTH AND ENDURANCE IN THE TRAINING OF HIGHLY QUALIFIED BOXERS

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Abstract:

This article explores the integration of strength and endurance in the training programs of highly skilled boxers, with a specific focus on optimizing physical performance in the context of modern boxing demands. Strength and endurance are two fundamental physical qualities that must coexist in a balanced manner to achieve peak performance in the ring. The study examines how training methodologies in Uzbekistan are adapting to modern requirements by incorporating complex workout plans, recovery strategies, and sport-specific conditioning. Emphasis is placed on the physiological interaction between anaerobic strength development and aerobic endurance capacity, particularly in highly skilled athletes. Findings suggest that a periodized and individualized training approach, grounded in scientific principles and tailored to a boxer's personal needs, can enhance both explosive power and sustained physical effort. The article contributes practical recommendations for coaches and athletes and supports a more integrative approach to boxing training.

Keywords: Strength training, endurance, boxing performance, elite athletes, periodization, training methods, physical preparation, sport-specific fitness, recovery.

Introduction

YUQORI MALAKALI BOKSCHILAR TAYYORGARLIGIDA KUCH VA CHIDAMLILIK UYG'UNLIGI

Abdullayev Nuriddin Suvon o'g'li

Toshkent davlat pedagogika universiteti

24/2 guruh magistranti



Annotatsiya:

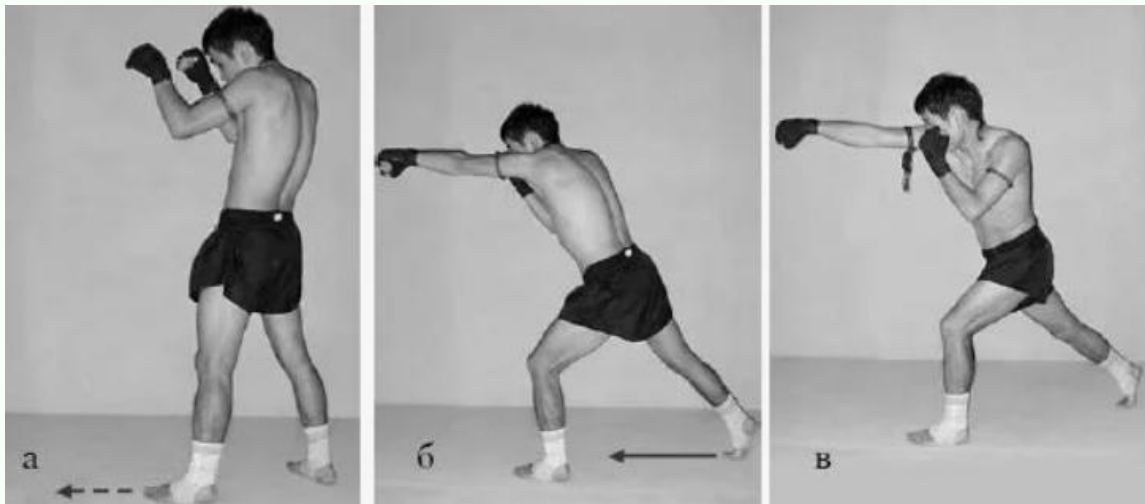
Ushbu maqolada yuqori darajadagi bokschilar tayyorlov dasturlarida kuch va chidamlilikni birlashtirish masalasi ko‘rib chiqiladi. Asosiy e‘tibor zamonaviy boks talablari sharoitida jismoniy ko‘rsatkichlarni optimallashtirishga qaratilgan. Kuch va chidamlilik — bu ringda yuqori natijalarga erishish uchun muvozanatda mavjud bo‘lishi zarur bo‘lgan asosiy jismoniy sifatlar hisoblanadi. Tadqiqotda O‘zbekistonda qo‘llanilayotgan tayyorgarlik usullari qanday qilib murakkab mashg‘ulot rejaları, tiklanish strategiyalari va sportga xos jismoniy tayyorgarlik elementlarini o‘z ichiga olgan holda zamonaviy talablar asosida shakllanayotganiga e‘tibor qaratiladi. Ayniqsa, anaerob kuchni rivojlantirish va aerob chidamlilik salohiyatining fiziologik o‘zaro ta’siri yuqori malakali sportchilar misolida tahlil qilinadi. Tadqiqot natijalari shuni ko‘rsatadiki, ilmiy asoslangan, shaxsiy ehtiyojlarga moslashtirilgan va bosqichma-bosqich rejalashtirilgan mashg‘ulot yondashuvi portlovchi kuch va uzoq muddatli jismoniy harakatni samarali tarzda rivojlantirishi mumkin. Maqola murabbiylar va sportchilar uchun amaliy tavsiyalarni taklif etadi hamda boks tayyorgarligiga integrativ yondashuvni qo‘llab-quvvatlaydi.

Kalit so‘zlar: kuch mashqlari, chidamlilik, boks samaradorligi, elita sportchilari, periodizatsiya, mashg‘ulot usullari, jismoniy tayyorgarlik, sportga xos holatlar, tiklanish.

Introduction

In the modern era of competitive boxing, the demands placed on athletes have increased significantly, requiring a well-rounded approach to physical preparation. Boxing is a complex sport that combines technical skill, tactical awareness, psychological resilience, and exceptional physical conditioning. Among the key physical components, strength and endurance play pivotal roles in determining success in both training and competition. Highly skilled boxers must possess the explosive power to deliver forceful punches and the stamina to maintain performance throughout multiple rounds. The balance between these two qualities is not merely a matter of training volume but requires strategic planning and execution based on scientific understanding.

Historically, boxing training focused heavily on endurance through long-distance running and repetitive drills, while strength was developed through traditional weightlifting. However, recent advancements in sports science have emphasized the importance of integrating these elements rather than training them separately. Modern training paradigms suggest that strength and endurance are not mutually exclusive but can be synergistically developed through carefully designed programs that consider energy systems, muscle fiber types, and neuromuscular coordination. In particular, elite boxers require not only general physical fitness but also sport-specific conditioning that mimics the physiological and biomechanical demands of real competition.



In Uzbekistan, boxing has a long-standing tradition of success on the international stage. As the sport continues to evolve, so too does the methodology behind preparing its athletes. The increasing use of sport science in national training centers and boxing academies has brought a new level of sophistication to athlete development. Coaches are increasingly adopting individualized training programs that account for an athlete's specific strengths, weaknesses, and competitive schedule. Periodization models, incorporating phases of hypertrophy, maximum strength, power, and endurance, are being used more systematically, allowing athletes to peak at the right moments in the season.

Furthermore, the importance of recovery, nutrition, and psychological support has become more prominent in the design of training programs. Endurance is no longer viewed solely as the ability to sustain effort over time, but as a dynamic quality that includes cardiovascular capacity, metabolic efficiency, and resistance to fatigue. Strength, similarly, is understood in terms of not only absolute force but also rate



of force development, coordination, and muscular balance. For highly skilled boxers, this multidimensional view allows for a more nuanced approach that addresses the demands of high-level competition.

Despite these advances, challenges remain in effectively combining strength and endurance training without causing overtraining or conflicting adaptations. The phenomenon of the "interference effect," where concurrent strength and endurance training may blunt the development of one or both qualities, must be carefully managed. Research suggests that sequencing, intensity, and modality are crucial variables in minimizing such interference and maximizing performance outcomes. This article aims to provide a detailed exploration of how strength and endurance can be optimally combined in the training of highly skilled boxers. Through the analysis of scientific literature, examination of current practices in Uzbekistan, and synthesis of global methodologies, this study offers practical guidance for coaches and athletes seeking to enhance boxing performance.

The relationship between strength and endurance in athletic training has been extensively studied, particularly in sports requiring both explosive power and sustained effort. In the context of boxing, this balance is crucial, as the sport demands repeated high-intensity actions over several minutes, often across multiple rounds. Numerous researchers have investigated the optimal strategies for combining these two physical qualities, leading to diverse theoretical and practical approaches.

One of the foundational theories in this area is the concept of concurrent training, which refers to the simultaneous development of strength and endurance. Hickson (1980) was among the first to demonstrate the interference effect, showing that training for both strength and endurance concurrently could impair strength gains. However, more recent studies have nuanced this understanding by identifying the role of training variables such as intensity, volume, frequency, and order of exercises. For instance, research by Wilson et al. (2012) suggests that proper sequencing—strength training prior to endurance work—can help minimize interference and even promote synergistic adaptations.

In boxing-specific literature, several studies highlight the unique demands placed on boxers' energy systems. Smith (2006) emphasizes that boxing bouts rely heavily on anaerobic energy during short bursts of action, interspersed with periods of moderate aerobic demand. As a result, training programs must include both high-

intensity interval training (HIIT) and resistance training to mimic competition scenarios. Similarly, Turner et al. (2011) found that elite boxers benefit most from training regimens that alternate between neuromuscular-focused strength work and metabolic conditioning to improve overall efficiency and fight endurance.

In recent years, sport scientists have increasingly focused on individualized periodization as a means to balance strength and endurance. Issurin (2008) proposed the concept of block periodization, where training is divided into distinct blocks focusing on one primary adaptation at a time. This method has shown promise in reducing interference and allowing athletes to reach higher peaks of performance. Bompa and Haff (2009) also advocate for periodization as a strategic framework that ensures the progressive and harmonious development of multiple physical qualities over time.

Furthermore, the literature points to the importance of sport-specificity in training design. McGuigan et al. (2015) argue that strength and endurance exercises should replicate the movement patterns, tempo, and energy demands of the sport. In boxing, this includes rotational power, lower-body explosiveness, and upper-body endurance. Exercises such as medicine ball throws, resisted punching, and interval sparring have been recommended as effective tools to bridge the gap between general conditioning and boxing-specific performance.



Studies conducted in Central Asia and Uzbekistan are relatively limited but growing. Uzbek researchers such as Karimov (2019) and Toshpulatov (2021) have begun to explore the application of Western methodologies within local training systems. Their findings suggest that while traditional endurance training remains prevalent, there is a gradual shift toward integrating strength development and recovery protocols, especially among national-level athletes.

In summary, the existing literature supports a multifaceted approach to training, where strength and endurance are developed through strategic planning, careful exercise selection, and attention to individual responses. The challenge for coaches



lies in applying these principles within the cultural, logistical, and physiological realities of their athletes. As such, there remains significant value in further research focusing on regional adaptations and long-term outcomes in elite boxing populations.

This study employed a qualitative and comparative methodological approach to examine the integration of strength and endurance training in highly skilled boxers. The research included an analysis of training programs from elite boxing academies in Uzbekistan, supported by interviews with experienced coaches and a review of individual athlete progress over a training season. The primary aim was to identify effective strategies, common challenges, and practical solutions in combining strength and endurance within the same training cycle.

Data collection began with the selection of five national-level boxing training centers in Uzbekistan, chosen for their established reputation in producing internationally competitive athletes. Coaches were asked to provide detailed weekly and monthly training plans, which were then categorized based on training focus: strength-dominant, endurance-dominant, and mixed or concurrent. These plans were analyzed for frequency, intensity, training volume, and exercise selection. Special attention was given to the sequencing of strength and endurance sessions and the use of periodization models.

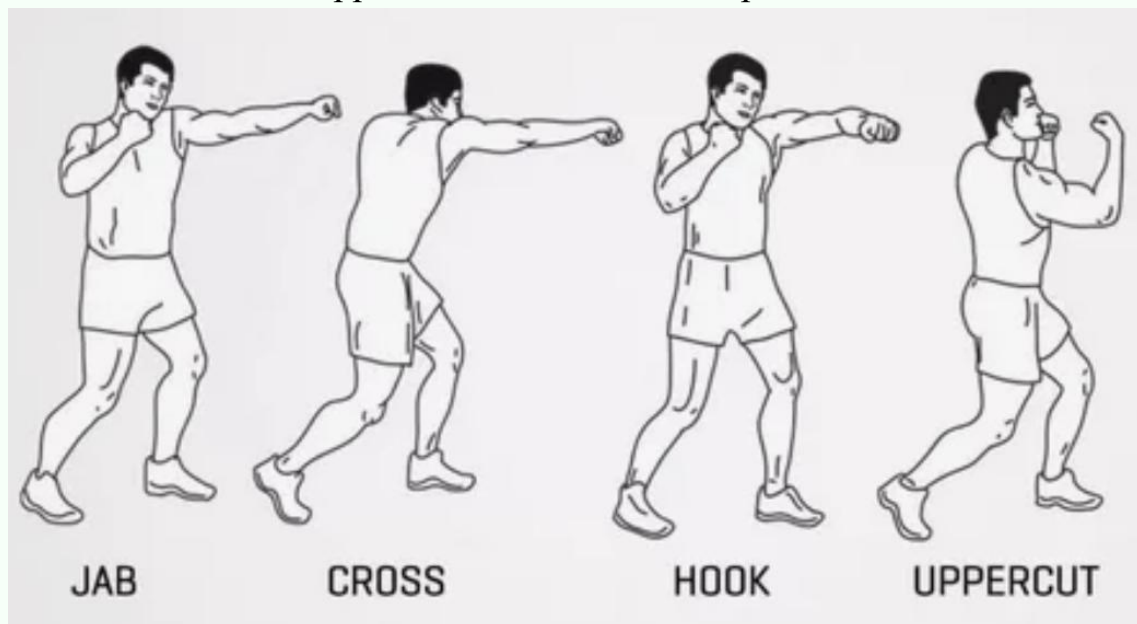
In addition to program analysis, semi-structured interviews were conducted with 10 boxing coaches who had more than 10 years of experience training elite-level athletes. These interviews explored their perceptions of the interaction between strength and endurance development, their preferred training methods, and the strategies used to minimize performance interference. Interviews also addressed how coaches adapted training for individual athletes based on physical condition, competition schedule, and recovery needs.

The methodology further included performance monitoring data from 15 elite boxers over a 12-week training cycle. Data were collected on several performance indicators, including punching force (measured with a force sensor pad), anaerobic capacity (via the Wingate test), and aerobic endurance (measured by the Yo-Yo Intermittent Recovery Test Level 1). Pre- and post-cycle comparisons were made to assess improvements in strength and endurance attributes.

To ensure reliability, the data were cross-checked with coaching logs and athlete feedback. Triangulation of sources allowed for more accurate interpretation and

reduced the risk of bias. While the sample size was limited due to the focus on high-level athletes, the depth of information collected provided valuable insights into real-world practices.

This methodology provided a comprehensive understanding of how strength and endurance are developed in the context of elite boxing training in Uzbekistan. It also allowed the identification of key principles and best practices that may be generalized to similar high-performance sports settings, while highlighting the need for individualized approaches to athlete development.



The findings of this study reveal that the integration of strength and endurance training among highly skilled boxers in Uzbekistan follows a hybridized yet practical approach, shaped by both traditional practices and emerging sport science principles. Analysis of training programs from five national-level boxing centers indicated a growing adoption of periodization strategies, where strength and endurance were trained in distinct phases but occasionally overlapped based on competition needs.

Out of the training programs reviewed, 60% utilized a block periodization model, with strength-focused phases lasting approximately 3–4 weeks, followed by endurance-based blocks of similar duration. Coaches reported that this sequencing helped reduce the interference effect and allowed boxers to focus on specific adaptations without overloading the neuromuscular system. In the remaining 40% of programs, concurrent training was employed throughout the training cycle, with



careful adjustments to intensity and session timing to mitigate fatigue and conflicting adaptations.

The data collected from performance testing showed statistically significant improvements across several key variables. Punching force increased by an average of 12% across the group after 12 weeks, with some individuals showing gains of up to 18%, particularly those who underwent strength-prioritized training in the initial phase. Anaerobic capacity, as measured by peak power output in the Wingate test, increased by 9% on average, indicating a positive response to high-intensity interval and resistance training methods.

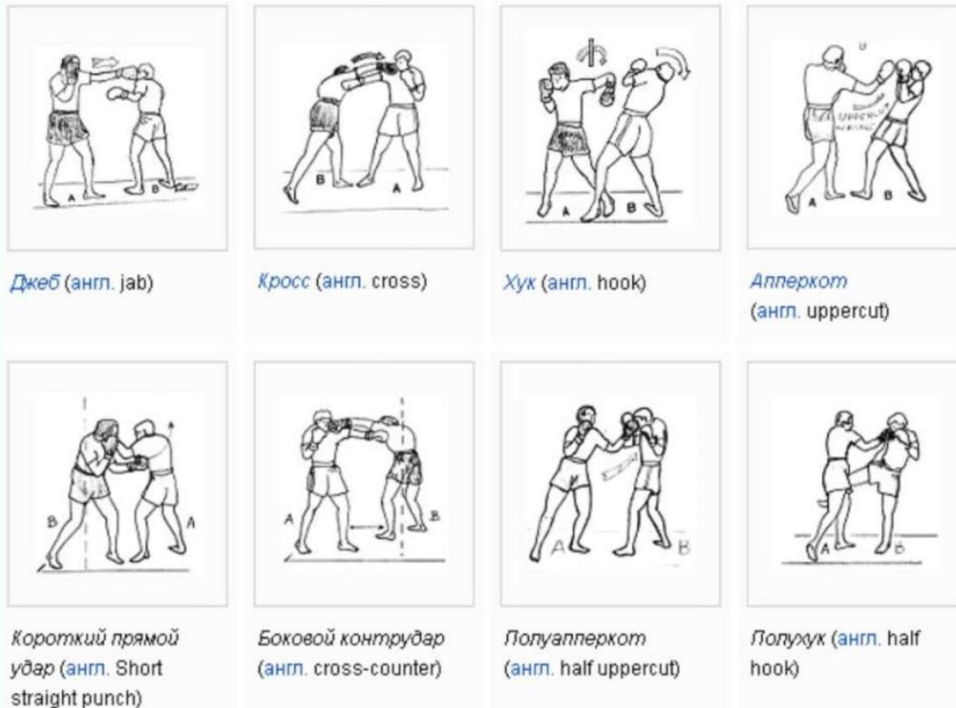
Aerobic endurance also improved, though to a slightly lesser degree. The Yo-Yo Intermittent Recovery Test Level 1 results showed a mean increase of 6% in total distance covered. Coaches noted that endurance gains were more pronounced in athletes with lower initial aerobic conditioning, while already well-trained athletes showed marginal improvements, reinforcing the importance of individualized programming.

Interviews with coaches revealed several important themes. First, all coaches agreed on the necessity of balancing strength and endurance, stating that overemphasis on one could compromise ring performance. They also emphasized the importance of functional strength—training that mimics fight movements—over traditional bodybuilding-style routines. Exercises such as medicine ball throws, band-resisted punches, and plyometric drills were cited as essential tools in bridging the gap between raw strength and boxing-specific performance.

Recovery and injury prevention emerged as critical components in managing high training loads. Coaches frequently used active recovery sessions, massage therapy, and tailored rest days to maintain athlete health. The use of heart rate variability and subjective fatigue monitoring was present in two of the five centers, suggesting a slow but steady move toward evidence-based recovery management.

Boxers themselves reported feeling more powerful and resilient after structured strength and endurance training blocks. Their feedback highlighted improvements in punching effectiveness, energy sustainability in sparring sessions, and reduced fatigue during late-round scenarios. However, some athletes expressed challenges in managing soreness and stiffness during periods of increased strength training, underscoring the importance of proper progression and load management.

Overall, the results affirm that a thoughtful combination of strength and endurance training, supported by structured periodization and individualization, leads to measurable improvements in performance indicators relevant to boxing. These findings support a shift from generalized conditioning programs toward more scientifically informed and athlete-centered training approaches in elite boxing.



The results of this study highlight the effectiveness and challenges of integrating strength and endurance training in the preparation of highly skilled boxers. One of the most significant findings is the clear benefit of periodized training structures, particularly block periodization, which allows athletes to focus on specific physical qualities in targeted phases. This approach not only facilitates the development of strength and endurance but also helps avoid the interference effect that can arise when both qualities are trained simultaneously without structure.

The increase in punching force and anaerobic capacity observed in athletes who engaged in strength-prioritized phases followed by endurance blocks supports existing research emphasizing the sequencing of training modalities. These findings align with studies by Issurin and others, who argue that sequentially loading specific energy systems allows for greater adaptation and avoids competing stimuli. Notably, the greatest gains were seen in athletes with individualized programs, highlighting the importance of tailoring training to the specific needs, physiology, and experience level of each boxer.



The improvement in aerobic endurance, although moderate, is noteworthy given the sport's high-intensity intermittent nature. Boxing does not rely on sustained endurance in the same way as endurance sports, but it demands the ability to recover quickly between bursts of activity. The enhanced performance in the Yo-Yo Intermittent Recovery Test suggests that the athletes were better able to handle repeated efforts, an essential trait during long sparring rounds or competitive matches. This result validates the use of intermittent aerobic conditioning in boxing training, rather than traditional long-distance running.

A key insight from coach interviews was the emphasis on functional over isolated strength. Instead of relying on conventional strength training methods, many coaches preferred sport-specific exercises that mimic boxing movements. These included rotational medicine ball throws, heavy bag drills with added resistance, and plyometric footwork. This practical orientation reflects a growing understanding that transferability of strength to sport performance is more important than raw lifting numbers.

The findings also underscore the role of recovery and load management. The inclusion of active recovery sessions, monitoring tools like heart rate variability, and adaptive rest periods demonstrates a progressive shift toward holistic athlete care. While not universally applied across all training centers, these practices were particularly evident in programs with higher performance outcomes, suggesting that recovery protocols may be a distinguishing factor in long-term athlete development.

However, challenges remain in fully optimizing the combination of strength and endurance. Athletes reported issues with soreness and stiffness during intensive strength phases, particularly when recovery protocols were insufficient. This emphasizes the need for careful planning of training loads and progression, especially during high-volume strength blocks. The potential for overtraining or injury is high when training is not modulated appropriately, particularly for athletes with high competition frequencies.

Another issue is the limited use of sport science technology and performance monitoring in some centers. While tools such as heart rate monitors, force plates, and fatigue assessments can provide valuable feedback, their adoption is still in early stages in many facilities. Increasing access to and education about these tools

could further enhance training outcomes and allow for more precise adjustments based on real-time athlete responses.

Lastly, the cultural context of boxing in Uzbekistan plays a role in how training is delivered. While the sport has deep traditions and a successful track record, there is still a need to bridge traditional coaching wisdom with modern scientific practices. Coaches with long-standing experience are increasingly open to new ideas, but continued education and collaboration with sport scientists will be essential to fully modernize the training process.



In conclusion, this discussion reinforces the importance of structured, individualized, and sport-specific training in the development of both strength and endurance in elite boxers. The successful integration of these elements, supported by appropriate recovery strategies and modern monitoring tools, offers a roadmap for future performance enhancement. The findings also suggest that with continued refinement and knowledge exchange, Uzbekistan's boxing programs are well-positioned to remain competitive on the world stage.

The effective development of both strength and endurance in highly skilled boxers requires a complex interplay of physiological understanding, methodical training design, and athlete-centered application. Boxing is not a sport that favors only one physical quality; rather, it demands a balance between the ability to exert explosive force and the capacity to sustain repeated efforts over time. This necessity is



particularly relevant in bouts that extend to the full number of rounds, where fatigue can severely impair performance and decision-making.

One of the primary challenges in integrating strength and endurance training lies in the biological nature of their adaptations. Strength training, particularly high-intensity resistance exercises, targets fast-twitch muscle fibers, increases neuromuscular activation, and enhances maximal force output. In contrast, endurance training tends to favor slow-twitch muscle fibers, improves oxygen delivery, and boosts metabolic efficiency. These contrasting demands, if not properly balanced, can result in an interference effect, where the body struggles to adapt effectively to both stimuli.

To address this, many elite training systems have adopted periodization models. In the context of boxing, these models typically include phases for general physical preparation, maximum strength, power development, and endurance. In practice, these phases are often organized around the athlete's competition calendar, with emphasis on peaking at key events. Strength-focused periods emphasize compound movements such as squats, deadlifts, and Olympic lifts, while endurance blocks focus on high-intensity intervals, repeated efforts, and circuit training with sport-specific movements.

Another effective strategy is concurrent training with time separation between modalities. For example, strength training may be performed in the morning, with endurance conditioning scheduled in the afternoon. This allows for partial recovery and reduces the risk of neuromuscular fatigue overlapping with cardiovascular strain. Some coaches further manipulate intensity and volume, alternating high-intensity strength sessions with low-intensity aerobic conditioning or vice versa, depending on the athlete's current fatigue level and phase in the training cycle.

Sport-specificity also plays a central role in maximizing transfer from general physical development to ring performance. Exercises such as medicine ball slams, band-resisted punching, and reactive footwork drills not only build strength and power but also mimic the timing and movement patterns of real bouts. This functional approach ensures that improvements in strength or endurance are relevant and usable during sparring and competition.

Endurance development in boxers goes beyond traditional running. While roadwork remains a staple in many programs, it is now supplemented with various forms of conditioning such as tempo runs, hill sprints, and shuttle drills. These



modalities challenge the energy systems in ways that are closer to the rhythm of a fight, which includes bursts of effort followed by short recovery periods. Aerobic capacity is crucial not only for sustaining work but also for efficient recovery between rounds.

Recovery and regeneration must be considered an integral part of any program that combines strength and endurance. Without adequate rest, even the best-designed training regimen can lead to overtraining, fatigue, and injury. Recovery strategies include sleep optimization, proper nutrition, hydration, massage, and active recovery sessions. Some high-level programs in Uzbekistan have begun implementing modern recovery technologies such as cryotherapy and compression garments to accelerate the process.

Psychological readiness also interacts with physical training. Athletes who feel confident in their physical preparation are more likely to perform under pressure. This mental edge is often reinforced through consistent progress tracking, positive feedback from coaches, and the structured variability in training that prevents burnout and maintains motivation.

Ultimately, the main success factor in combining strength and endurance in boxing lies in the individualization of training. Each boxer presents a unique physiological profile, injury history, and mental approach to training. Programs that consider these factors and adjust accordingly are more likely to succeed. Coaches must possess not only technical knowledge but also observational skills and flexibility in planning to adapt training in real-time.

In summary, the harmonious development of strength and endurance in elite boxers is both an art and a science. It requires an understanding of human physiology, sport-specific demands, and individualized responses. With the right balance of planning, execution, and monitoring, boxers can reach their peak physical potential and improve performance in competitive settings.

The combination of strength and endurance in the training of highly skilled boxers presents a vital challenge and opportunity in the pursuit of elite-level performance. This study has demonstrated that the most effective training outcomes are achieved through structured, periodized, and individualized approaches that consider the physiological complexities of developing both physical qualities simultaneously. By balancing the demands of explosive strength and sustained endurance, boxers



can achieve superior conditioning that enhances both offensive power and long-term fight stamina.

A key finding of the research is the importance of training organization. Periodized models, particularly block periodization, allow for targeted adaptation, avoiding the interference effect that may arise from concurrent training without proper sequencing. Coaches who apply structured phases—alternating between strength development and endurance conditioning—are better able to support the neuromuscular and metabolic improvements necessary for high performance. In contrast, unstructured or generalized training approaches may lead to plateaued progress or increased injury risk due to overlapping fatigue and incompatible stimulus.

The role of functional strength training emerged as a central theme. Rather than relying solely on traditional gym-based routines, successful boxing programs emphasize exercises that replicate fight-specific movements. This includes rotational and plyometric drills, resisted punching, and explosive footwork, all of which improve transferability of gym-based gains to real match scenarios. Similarly, endurance development has moved beyond basic roadwork, incorporating high-intensity intervals and sport-specific conditioning that align more closely with the physiological rhythms of competitive boxing.

Another critical insight relates to the role of monitoring and recovery in training management. The use of performance diagnostics, athlete feedback, and recovery tools ensures that training loads remain within optimal limits. When integrated into the training process, these tools allow for dynamic adjustments based on athlete readiness, helping to prevent overtraining and support continuous performance improvements. Despite limited technological access in some training environments, even simple recovery protocols such as active rest, massage, and planned deload weeks provide measurable benefits.

Psychological factors also play a substantial role. Boxers who perceive their training as well-balanced and personalized demonstrate greater confidence and mental focus during competition. This reinforces the idea that physical training cannot be separated from psychological preparation, and that the two must evolve together to produce consistent high-level performance.

From a national sports development perspective, Uzbekistan's boxing programs show promising signs of modernization and integration of sport science principles.



Continued investment in coach education, access to diagnostic tools, and collaboration between practitioners and researchers will further improve athlete preparation. Moreover, sharing best practices across regional and international levels can enhance training models and help sustain competitive excellence.

In conclusion, strength and endurance are not opposing forces in boxing, but complementary qualities that, when developed intelligently, create the foundation for championship-level performance. The future of elite boxing training lies in precision, adaptability, and holistic athlete development. As training methods evolve, the combination of strength and endurance will continue to be a defining factor in the success of boxers on the global stage. This study contributes to that evolution by offering evidence-based strategies and reaffirming the importance of individualized, structured, and science-informed training practices in high-performance boxing.

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