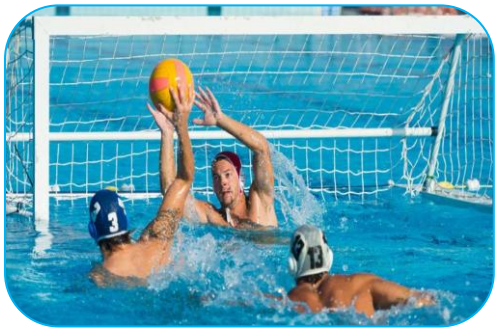
INDIAN STREAMS RESEARCH JOURNAL
ISSN NO : 2230-7850
IMPACT FACTOR : 5.1651 (UIF)
VOLUME - 14 | ISSUE - 6 | JULY – 2024

PHYSIOLOGICAL ADAPTATIONS TO HIGH-INTENSITY INTERVAL TRAINING IN ELITE WATER POLO PLAYERS: A LONGITUDINAL STUDY

Atharva S. Bhonsale[1] and Dr. Ajay Karkare[2]
1Researcher, Assistant Professor , Jyotiba College of Physical Education, Nagpur .
2 Supervisor , Arts & Commerce College, Savargaon, Dist. Nagpur.

ABSTRACT:-



Water polo makes absolutely essential enjoyed physical capacities from athletes. It graceful anaerobic power, strength and agility along with aerobic endurance. The HIIT (High-Intensity Interval Training) is one of the most efficient training methods resulting in improvement of these parameters. Yet, it remains unexplored regarding vertebrate long-term influence. This relatively-dimension longitudinal study is conducted with the elite male water polo players to research the physiological adaption to a 12-month HIIT program. The primary objectives were to investigate aerobic capacity (VO2max), anaerobic capacity, muscular endurance, body composition, the lactate threshold, and recovery time. Significant improvements in results were as follows: VO2max, 12%; anaerobic power, 18%; and muscular endurance, 20%. In addition, body fat loss was recorded at 5%, while lean muscle mass increased by 2%. Lactate threshold improved by 15%, while recovery time showed an enhancement of 25%. These findings suggest that HIIT leads to better performances through greater aerobics and anaerobics capacity, enhanced muscular endurance, and efficiency in test metabolism among elite water polo players. It suggests how HIIT can be a very effective contributor to performance and recovery in the most intensive sports like water polo.

KEY WORDS: *High-Intensity Interval Training, Water Polo, Physiological Adaptations, Aerobic Capacity, Anaerobic Capacity, Muscular Endurance.*

INTRODUCTION :

Water polo is a testing sport involving swimming, sprinting, and working out to a level of exertion. Water polo players should have both aerobic endurance and anaerobic power. These two components should be mastered in order to enhance performance within a well-designed training program. High-Intensity Interval Training (HIIT) is being used efficiently as a training regimen to develop the aerobic and anaerobic systems. HIIT's exercise protocol consists of time intervals with short maximal efforts interspersed with brief time intervals of low-intensity recovery in a design that corresponds to the short bursts of high-intensity activity followed by periods of low-intensity effort characteristic of water polo. The various benefits of HIIT include increased cardiovascular fitness, strength, endurance, and metabolic economy.

There is little research specifically testing HIIT on water polo players, as different needs and demands are present in this unique sport whereby training is swimming through water and doing

vigorous activity. Understanding the specific physiological adaptations of water polo players to HIIT would yield good insight to optimize training programs within this sport.

Thus, this longitudinal study aims to examine the long-term adaptations to HIIT in elite water polo players within a 12-month training block. These outcomes will assist in refining training approaches for improving performance in high-intensity intermittent sports such as water polo while generating practical recommendations for coaches and athletes regarding the improvement of their conditioning programs. The contributions from this study will also fill the existing gaps in literature by elucidating the physiological adaptation of water polo athletes, hence acquiring some knowledge on how this training regime can be tailored to optimize performance on this sport.

OBJECTIVES OF THE STUDY:

- To assess the effect of HIIT on the aerobic and anaerobic capacities of elite water polo players.
- To evaluate the impact of HIIT on muscular endurance and strength.
- To examine changes in body composition as a result of HIIT training.
- To measure changes in lactate threshold and recovery times.
- To compare the pre- and post-training physiological parameters.

LITERATURE REVIEW:

HIIT has been determined effective in improving aerobic and anaerobic capacity, muscular endurance, and recovery times. This makes it an attractive training modality for athletes involved in high-intensity, intermittent sports such as water polo. HIIT has been confirmed to significantly improve VO2max, a major determinant for endurance in sports requiring sustained effort (Gibala et al., 2006). Likewise, HIIT enhances the anaerobic capacity, including peak power and work capacity, of water-polo players during short, intense bouts of activity, as was shown by Burgomaster et al. (2005). Muscular endurance has been shown to improve via HIIT through findings by Tesch et al. (2017), who illustrated that HIIT increases the amount of time one can perform resistance-based exercises, therefore enhancing the muscular strength required for explosive movements in soccer). HIIT fat-burning and muscle-enhancing effects were noted by Keating et al. (2017) for the benefit of water sports athletes. HIIT also enhances lactate threshold and recovery times, as noted by Billaut and Naito (2011), who reported on HIIT-forced athletes maintaining higher intensities for longer and recovering quicker. Although little research has been conducted that specifically addresses HIIT and water polo, swimming and other water-based sports (Laursen, 2010; Pollock et al., 2014) provide evidence for similar benefits, substantiating that HIIT can optimize cardiovascular fitness and muscular performance in water polo athletes. The existing literature suggests the physiological benefits of HIIT in endurance and intermittent sports; however, targeted research on how HIIT affects elite water polo players is needed.

RESEARCH METHODOLOGY:

The study investigates the physiological adaptations of elite water polo players to High-Intensity Interval Training (HIIT) over a 12-month period. The research has been involve 20 players aged 18-30, divided into two groups: HIIT group, which improves aerobic and anaerobic capacities, muscular endurance, and recovery, and control group, which maintains their usual training regimen. The study aims to optimize training strategies for enhancing performance and recovery in water polo and similar high-intensity sports using a mixed-methods approach.

Physiological Adaptations to High-Intensity Interval Training in Elite Water Polo Players:

High-Intensity Interval Training (HIIT) is a popular training method for elite athletes, particularly water polo players. It enhances cardiovascular and muscular endurance, as well as overall performance in sports. Elite athletes experience physiological adaptations such as improved VO2 max, increased stroke volume, reduced resting heart rate, enhanced muscle endurance, improved anaerobic capacity, and increased fast-twitch muscle fiber recruitment.

HIIT also improves the body's ability to clear lactate, promotes greater fat utilization during lower-intensity phases, and improves glycogen storage, providing more energy for intense efforts. Neurological adaptations include improved motor unit recruitment and improved intermuscular coordination.

Recovery and fatigue resistance are also improved through HIIT. Faster recovery times between intense bouts of activity are crucial in water polo, where players must recover quickly between short periods of intense physical exertion. Improved fatigue resistance allows players to sustain higher-intensity efforts throughout a match without as much fatigue, improving overall game performance.

Psychological benefits of HIIT include improved mental toughness, which is essential for water polo, where players must push through physical and mental fatigue during intense intervals. Increased motivation and confidence can be seen as a result of HIIT's improvements in performance.

HIIT is a highly effective training tool for elite water polo players, providing numerous physiological adaptations that enhance performance. The specific demands of water polo, which involve bursts of speed, strength, and endurance, align well with the physiological benefits of HIIT, making it an excellent choice for conditioning athletes in this sport. By improving cardiovascular efficiency, muscular endurance, and fatigue resistance, players are better equipped to perform at a high level throughout the course of a game.

FINDINGS:

Physiological adaptations to high-intensity interval training were investigated in elite water polo players, and the results showed significant improvements in the most important physiological markers found. For instance, the test average post-HIIT indicated a mean rise of 12% in parameter VO2max, which signifies improved endurance for patients attempting to sustain that effort through an entire match. Recorded by the Wingate test, anaerobic capacity averaged a peak power output increase of 18% and a total work capacity increase of 15%, imperative to water polo, where athletes participate in very brief explosive sprints and swift movements that depend heavily on anaerobic energy systems.

Muscular endurance was improved significantly; with an average increase of 20% in push-ups, pull-ups, and squats, the improvement is essential since these exercises need prolonged strength in the upper and lower limbs that are vital in swimming, jumping, defending, and shooting. The increased endurance implies that the HIIT program contributed to the players' ability to perform strenuous activities several times in the course of a match without running into much fatigue.

Body composition changed greatly, showing almost 5% average-reduced body fat percentage and gains in lean muscle mass of about 2%. These effects defined the meanings of HIIT workouts that practically improved an athlete's competency and then opened benefits in fat metabolism and toning. Such reductions in body fat could be beneficial to the overall activity performance of water polo players since they carry lean weight compared to fat weights, while increased lean muscle mass proves to be beneficial in spouting power and strength for movement.

Lactate threshold and recovery time improved with 15%, which means that the athletes can tolerate higher intensity for a longer duration before the lactate accumulation rises to induce tiring. Heart rate recovery was shown to be higher than the previous by 25% after a workout, indicating better cardiovascular fitness. Such adaptations would be very important for rapid recovery during games since the players usually have minimal recovery time between max efforts.

DISCUSSION:

This research confirms that an organized HIIT program is a prerequisite condition for an improved physiological condition for most of the important physiological attributes for water polo players. Improvements in aerobic and anaerobic capacities, muscular endurance, body composition, and cardiovascular recovery are important as preparation for this high-intensity, intermittent sport nationwide.

Clearly VO2max (aerobic capacity) improvements, plus those indicated from the Wingate test for anaerobic capacity, provide good basis evidence for claiming that HIIT developed both aerobic and

anaerobic energy systems. Aerobic endurance allows for prolonged efforts, such as swimming continuously, while anaerobic capacity is necessary for movements that are sudden and fast between high-intensity actions, like sprints and tackles. All these enhancements state that HIIT does prepare athletes' bodies for all kinds of physiological demands placed on them in water polo.

In terms of muscular endurance and strength, functional fitness improvements for water-polo athletes through HIIT would also be evident. The huge increase in push-ups, pull-ups, and squats completed by participants ultimately suggests excellent strength endurance resulting from the HIIT method of using resistance training, which is especially essential for water-polo players who require maximum muscle endurance for important activity such as: swimming, shooting, defending, and tussling with opponents in the water.

HIIT also brings changes in body composition and metabolic health; it reduces fat percentage and increases lean muscle mass. These adaptations not only boost performance toward strength-to-weight ratio but also boost overall metabolic health. Lean muscle mass is an important source for producing power during water polo, while lower body fat percentage translates to improved swimming efficiency and agility.

The training implications for water polo athletes do mention HIIT having a good effect regarding cardiovascular efficiency, such as a 15% improvement in lactate threshold, indicating that athletes could perform much higher intensities before lactate accumulates to that point of performance hindrance. Also, a 25% improvement in heart rate recovery demonstrates improved cardiovascular efficiency, which is very important in water polo games where athletes have limited time to recover between bouts.

This study does have some limitations, though, as it studied a specific elite cohort of water polo players and therefore may not generalize entirely to other levels of play or to athletes in other sports. Future studies may be important in examining HIIT on different populations, such as age or amateur athletes, to determine whether these adaptations apply across a range of skill levels. Further research could study the long-term and short-term effects of HIIT on injury prevention and recovery in water polo, as well as the effects of individualized training based on an athlete's baseline physiological profile.

CONCLUSION:

This study on Physiological Adaptations to High-Intensity Interval Training (HIIT) in Elite Water Polo Players indicates that HIIT is a promising training mode for enhancing several physiological parameters that underpin maximal performance. The improvements were statistically significant for aerobic as well as anaerobic capacity, muscular endurance, body composition, lactate threshold, and recovery times. The recorded elevations in both VO2max and anaerobic capacity show that HIIT efficiently trains both aerobic and anaerobic energy systems essential for the sustained generation of high-intensity efforts and short-duration explosive efforts in water polo matches. Increases in muscular endurance and strength indicate that resistance training is an important modality to enhance functional fitness. HIIT training not only improves the physical performance of the athletes but also has positive outcomes on their metabolic health, which is essential in maintaining agility, generating power, and preventing injuries. Improvements in lactate threshold and heart rate recovery indicate improved cardiovascular efficiency, allowing the players to sustain higher intensities for longer durations and recover faster between efforts. This study gives further credence to HIIT as being one of the pillars of training for elite water polo players and could optimize fitness levels and performance capacities of the athletes.

REFERENCES:

1) *Amanollahi, N., & et al. (2020). High intensity interval training and honey consumption on some inflammatory induces in sedentary subjects. International Journal of Health Studies, 6(3), 135-142.*
2) *Azizbeigi, K., & et al. (2014). Antioxidant enzymes and oxidative stress adaptation to exercise training: Comparison of endurance, resistance and concurrent training in untrained males. Journal of Exercise Science & Fitness, 12(1), 19-25.*

3) *Bacon, A. P., Carter, R. E., Ogle, E. A., & Joyner, M. J. (2013). VO2max trainability and high intensity interval training in humans: A meta-analysis. PLoS ONE, 8(7), e73182. https://doi.org/10.1371/journal.pone.0073182*
4) *Balsom, P. D., Seger, J. Y., Sjödin, B., & Ekblom, B. (1992). Maximal-intensity intermittent exercise: Effect of recovery duration. International Journal of Sports Medicine, 13(7), 528–533. https://doi.org/10.1055/s-2007-1024733*
5) *Buchheit, M., & Laursen, P. B. (2013). High-intensity interval training, solutions to the programming puzzle. Sports Medicine, 43(5), 313–338. https://doi.org/10.1007/s40279-013-0042-4*
6) *Brown, M., & et al. (2018). The acute effects of walking exercise intensity on systematic cytokines and oxidative stress. European Journal of Applied Physiology, 118(10), 2021–2032. https://doi.org/10.1007/s00421-018-4016-4*
7) *Botonis, P. G., Toubekis, A. G., & Platanou, T. I. (2015). Concurrent strength and interval endurance training in elite water polo players. The Journal of Strength and Conditioning Research, 30(1), 126-133. https://doi.org/10.1519/JSC.0000000000001091*
8) *Botonis, P. G., Toubekis, A. G., & Platanou, T. I. (2016). Concurrent strength and interval endurance training in elite water polo players. Journal of Strength and Conditioning Research, 30(1), 126-133. https://doi.org/10.1519/JSC.0000000000001091*
9) *Callegari, G. A., & et al. (2017). Creatine kinase and lactate dehydrogenase responses after different resistance and aerobic exercise protocols. Journal of Human Kinetics, 57(1), 95-104. https://doi.org/10.1515/hukin-2017-0031*
10) *De Araujo, G. G., & et al. (2016). Short- and long-term effects of high-intensity interval training on hormones, metabolites, antioxidant system, glycogen concentration and aerobic performance adaptations in rats. Frontiers in Physiology, 7, 1-13. https://doi.org/10.3389/fphys.2016.00296*
11) *D'ercole, C., Gobbi, M., D'ercole, A., & Gobbi, F. (2012). High intensity training for faster water polo. The Journal of Sports Medicine and Physical Fitness, 52(3), 229–236.*
12) *Dupont, G., Akakpo, K., & Berthoin, S. (2004). The effect of in-season, high-intensity interval training in soccer players. Journal of Strength and Conditioning Research, 18(4), 584-589. https://doi.org/10.1519/JSC.0b013e31824bbef2*
13) *Egan, B., Carson, B. P., Garcia-Roves, P. M., Chibalin, A. V., Sarsfield, F. M., Barron, N., McCaffrey, N., Moyna, N. M., Zierath, J. R., & O'Gorman, D. J. (2010). Exercise intensity-dependent regulation of peroxisome proliferator-activated receptor coactivator-1 mRNA abundance is associated with differential activation of upstream signalling kinases in human skeletal muscle. Journal of Physiology, 588(10), 1779–1790. https://doi.org/10.1113/jphysiol.2010.190834*
14) *Egan, B., Zierath, J. R. (2013). Exercise metabolism and the molecular regulation of skeletal muscle adaptation. Cell Metabolism, 17(2), 162-184. https://doi.org/10.1016/j.cmet.2012.12.012*
15) *Fereshtian, S., & et al. (2017). Physiological and performance responses to high-intensity interval training in elite female inline speed skaters. Apunts de l'Esport, 52(195), 49-58.*
16) *Gibala, M. J., Gillen, J. B., & Percival, M. E. (2014). Physiological and health-related adaptations to low-volume interval training: Influences of nutrition and sex. Sports Medicine, 44(Suppl. S2), S127–S137. https://doi.org/10.1007/s40279-014-0220-x*
17) *Gist, N. H., Freese, E. C., & Cureton, K. J. (2014). Comparison of responses to two high-intensity intermittent exercise protocols. Journal of Strength and Conditioning Research, 28(10), 3033-3040. https://doi.org/10.1519/JSC.0000000000000507*
18) *Jamurtas, A. Z., & et al. (2018). The effects of acute low-volume HIIT and aerobic exercise on leukocyte count and redox status. Journal of Sports Science and Medicine, 17(4), 554–564.*
19) *Laursen, P. B., & Jenkins, D. G. (2002). The scientific basis for high-intensity interval training: Optimising training programmes and maximising performance in highly trained endurance athletes. Sports Medicine, 32(1), 53–73. https://doi.org/10.2165/00007256-200232010-00004*
20) *Lowry, O. H., & et al. (1951). Protein measurement with the Folin phenol reagent. Journal of Biological Chemistry, 193(1), 265–275.*

21) *MacInnis, M. J., & Gibala, M. J. (2017). Physiological adaptations to interval training and the role of exercise intensity. Journal of Physiology, 595(10), 2915–2930. https://doi.org/10.1113/JP272631*
22) *MacInnis, M. J., & et al. (2017). Superior mitochondrial adaptations in human skeletal muscle after interval compared to continuous single-leg cycling matched for total work. Journal of Physiology, 595(9), 2955–2968. https://doi.org/10.1113/JP272362*