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The effectiveness of the long slow distance training method on improving vo_2max in basketball athletes

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Abstract

Basketball is a high-intensity sport that demands superior aerobic capacity to sustain performance throughout the match. One key physiological indicator of endurance is VO_2Max, which plays a crucial role in determining an athlete's ability to recover and maintain performance. This study aims to examine the effectiveness of the Long Slow Distance (LSD) training method in enhancing the VO_2Max of male basketball athletes at Jakarta State University (UNJ). The research employed a pre-test and post-test experimental design with a single group. The LSD training intervention was conducted over a period of six weeks, with a frequency of three sessions per week, totaling 18 sessions. A total of 17 male basketball athletes were selected using total sampling from a population of 20 athletes. The Beep Test was selected as the primary VO_2Max assessment tool due to its practical application in field settings. Data analysis was conducted using SPSS software, applying tests for normality, homogeneity, and paired sample t-tests with a significance threshold of $p \leq 0.05$. The paired sample t-test revealed a statistically significant improvement in VO_2Max ($t(16) = 13.40$, $p < 0.001$, Cohen's $d = 1.83$), indicating a large effect size and meaningful physiological adaptation. Similarly, the Beep Test scores improved significantly ($t(16) = 10.11$, $p < 0.001$, Cohen's $d = 1.53$), reflecting a substantial increase in aerobic endurance. These findings confirm that LSD training effectively improves aerobic capacity and serves as a suitable endurance strategy, particularly during the general preparatory phase, to support performance in high-intensity sports like basketball.

Keywords: Endurance training, LSD method, cardiovascular fitness, vo_2max improvement.

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INTRODUCTION

Basketball is a physically demanding team sport characterized by high-intensity intermittent sprints, frequent jumping, rapid directional changes, and complex technical execution, requiring both anaerobic

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bursts and sustained aerobic support (Gottlieb et al., 2021; Kusuma et al., 2025). To maintain performance across four quarters, players must possess not only technical and tactical proficiency but also a high level of physiological preparedness, particularly in terms of cardiorespiratory endurance. Maximal oxygen uptake (VO_2Max) is widely recognized as a primary indicator of aerobic fitness, reflecting the body's efficiency in transporting and utilizing oxygen during prolonged exertion (Sinurat, 2019). While the role of VO_2Max in endurance sports is well-established, its contribution to performance in intermittent, high-intensity sports like basketball has received comparatively less empirical attention (Ramirez-Campillo et al., 2023). Most existing training models for basketball continue to emphasize high-intensity or anaerobic-based protocols—such as plyometrics, sprint drills, and HIIT—often underestimating the foundational importance of aerobic capacity in sustaining performance, accelerating recovery between high-intensity efforts, and preventing fatigue accumulation (Kadek et al., 2023).

Although Long Slow Distance (LSD) training has long been recognized for its efficacy in building aerobic endurance in sports such as marathon running, triathlon, and cycling, its application in basketball remains notably limited. Basketball is inherently an intermittent sport that demands rapid transitions, explosive power, and high-intensity movements within short durations. Consequently, most basketball training programs globally have focused heavily on High-Intensity Interval Training (HIIT), repeated sprint training, and plyometrics—methods that are considered more aligned with the sport's physical demands (Buchheit & Laursen, 2013; Edwards et al., 2018; Ferioli, Bosio, La Torre, et al., 2018). This emphasis has inadvertently marginalized the role of aerobic development, including LSD training, in basketball conditioning programs.

However, emerging evidence and evolving perspectives in sports science suggest that a well-developed aerobic system plays a vital role even in high-intensity team sports. Aerobic capacity, commonly measured by VO_2Max, serves as the foundation for efficient energy metabolism, faster recovery between bouts of maximal effort, and sustained technical execution during prolonged match play. Coaches and sports physiologists in countries with advanced athlete development systems, such as the United States, Spain, and Australia, have increasingly begun to incorporate LSD phases during the general preparatory period (pre-season). These LSD sessions—typically lasting 40–90 minutes at 60–75% of HRmax—are strategically employed to enhance cardiovascular efficiency, improve lactate clearance, and minimize the risk of chronic fatigue and overtraining syndrome (Jones, 2024; Scanlan et al., 2012; Yu et al., 2024).

Despite its many benefits, the implementation of Long Slow Distance (LSD) training in basketball still faces several obstacles (Yilmaz et al., 2010). Coaches often lack time, especially during the competitive season, making it difficult to incorporate long aerobic training sessions. Additionally, the slow and monotonous nature of LSD is considered unappealing and irrelevant by players accustomed to intense and dynamic training. In some areas, coaches' understanding of the physiological benefits of LSD is also limited, leading them to believe it is incompatible with the energy demands of basketball.

The lack of research on LSD in the context of team sports, particularly basketball, also slows its implementation. Although proven effective in endurance sports, there is minimal scientific evidence that LSD is beneficial in basketball. As a result, many coaches doubt its usefulness, despite the importance of aerobic training for repeated sprint ability, recovery, and injury prevention (Pratiwi et al., 2018). Therefore, further research is needed on the effectiveness of LSD, particularly during the training preparation phase. Such research could provide a strong scientific foundation for coaches to incorporate LSD as part of a more comprehensive training approach, thereby maintaining peak performance throughout the competitive season.

Recent field observations and informal conversations with basketball coaches and athletes suggest that Long Slow Distance (LSD) training remains largely absent from structured basketball conditioning programs, particularly at the collegiate level. This trend aligns with findings by Buchheit & Laursen (2013), who noted that basketball coaches tend to prioritize high-intensity conditioning methods such as HIIT, repeated sprint training, and plyometric exercises due to their alignment with the game's intermittent, high-power nature. These methods are widely perceived as more directly applicable to game demands, leading to an underappreciation of the role of aerobic endurance.

However, emerging studies emphasize the importance of aerobic capacity as a foundational element for recovery, repeat sprint ability, and technical consistency over prolonged competition durations (Ferioli, Bosio, Bilsborough, et al., 2018; Scanlan et al., 2012). Athletes with higher VO_2Max are better able to sustain performance and recover more rapidly during high-intensity intermittent play. In fact, nations with advanced sports development models such as the United States, Spain, and Australia have begun integrating LSD phases during the general preparatory period to build cardiovascular efficiency and reduce the risk of overtraining (Jones, 2024; Yu et al., 2024).

Despite these advances, implementation challenges persist. Coaches often cite time constraints, lack of awareness of long-term physiological benefits, and athletes' resistance to low-tempo aerobic exercises as barriers (Buchheit & Laursen, 2013; Edwards et al., 2018). Moreover, conditioning models at the university level often lack periodization strategies that accommodate submaximal endurance sessions. Therefore, in light of both practical field observations and growing scholarly support for aerobic development in team sports, it is advisable for basketball coaches to incorporate LSD training, particularly during the general preparatory phase, to establish an aerobic foundation that supports recovery, enhances technical endurance, and promotes sustained performance throughout the game. This study aims to examine the impact of LSD training on VO_2Max improvement in male collegiate basketball athletes at Jakarta State University (UNJ). The findings are expected to contribute to the development of evidence-based aerobic conditioning protocols tailored to the unique physiological and logistical demands of university-level basketball training.

Nonetheless, within the realm of basketball, especially at the university tier in Indonesia, there exists a paucity of empirical research about the application of LSD training as a targeted approach for augmenting VO_2Max. Many conditioning programs for basketball athletes emphasize high-intensity intervals, frequently overlooking the essential function of aerobic base development in early-season training stages. Initial findings of diminishing endurance among male basketball athletes at Jakarta State University (UNJ), shown by recent unsatisfactory competition outcomes, suggest a possible deficiency in aerobic training. This decrease underscores the pressing necessity for systematic endurance training programs that are both empirically supported and contextually appropriate.

Therefore, this study aims to assess the effectiveness of the Long Slow Distance (LSD) training method in enhancing VO_2Max among male basketball athletes at Jakarta State University (UNJ). By examining the physiological adaptations resulting from LSD training in a university-level basketball context, this research is expected to contribute to the advancement of sports science, particularly in optimizing aerobic conditioning strategies tailored for team sports at the collegiate level.

METHOD

This research employed a quantitative experimental design with a one-group pre-test–post-test methodology to assess the effect of the Long Slow Distance (LSD) training technique on the VO_2Max of collegiate basketball players. This design was used to assess intra-subject variations due to the intervention, guaranteeing a regulated examination of physiological enhancements linked to the particular training protocol. The dependent variable was VO_2Max, defined as maximal oxygen uptake measured in millilitres per kilogram per minute (ml/kg/min). Considering that body composition influences cardiorespiratory efficiency and VO_2Max interpretation, BMI and body fat percentage were included as covariates in the analysis. Participants with lower fat mass and higher lean mass tend to exhibit greater oxygen utilization per kilogram of body weight. Therefore, incorporating these variables enhanced the physiological validity of the VO_2Max data.

This study used a one-group pre-test and post-test design to quantitatively assess the effect of Long Slow Distance (LSD) training on VO_2Max in collegiate basketball athletes. This quasi-experimental approach enabled the observation of physiological changes within subjects over time. The dependent variable, VO_2Max, was defined as the volume of oxygen consumed per kilogram of body weight per minute (ml/kg/min) and was measured using the Multistage Fitness Test (MFT), a validated field-based test for estimating aerobic capacity (Senanayake et al., 2024).

The LSD training was conducted over six weeks with three sessions per week (total: 18 sessions). Each session involved continuous running for 40–60 minutes at 60–75% HRmax (Petway et al., 2020). Athletes wore heart rate monitors to ensure adherence to the intensity zone, and all sessions were supervised on a 400-meter outdoor track by certified conditioning staff. No additional endurance training was allowed, isolating the effects of the LSD intervention on VO_2Max.

This study involved 17 male athletes from the Jakarta State University (UNJ) men's basketball team, aged 18 to 23 years (M = 20.1, SD = 1.4). The comprehensive sampling technique was utilized, encompassing the complete accessible population of eligible athletes from the university team (N = 20), with three players omitted owing to injury or insufficient training attendance. The inclusion criteria comprised active roster status, medical clearance for aerobic training, and a commitment to participate for the whole term of the study. The institutional ethics committee obtained ethical approval, and all participants submitted written informed consent.

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The Long Slow Distance (LSD) training program was conducted over six weeks, consisting of three sessions weekly, amounting to 18 sessions in total. Each training session consisted of continuous aerobic running for 40 to 60 minutes, maintained at 60–75% of the predicted maximal heart rate (HRmax), calculated using the standard formula of 220 minus age (Petway et al., 2020). This intensity range aligns with recent evidence suggesting that prolonged, submaximal aerobic training enhances cardiovascular function, mitochondrial biogenesis, and oxygen utilization efficiency, all of which contribute significantly to VO_2Max improvement and fatigue resistance in intermittent sports (Meixner et al., 2025; Shushan et al., 2023).

To ensure training precision, all participants wore heart rate monitors throughout each session. Supervising strength and conditioning coaches monitored the athletes in real time to ensure compliance with the target heart rate zone, encourage consistent effort, and maintain session integrity. Training took place on a standardized 400-meter outdoor track, and no other structured endurance interventions were permitted during the study period to isolate the physiological effects of the Long Slow Distance (LSD) protocol.

VO_2Max, or maximal oxygen uptake, was used as the primary measure of aerobic capacity. In basketball, where athletes are required to perform repeated high-intensity efforts with short recovery periods, VO_2Max plays a critical role in sustaining technical execution and accelerating recovery between sprints (Archiza et al., 2020; Mihajlovic et al., 2023). The Beep Test (Multistage Fitness Test) was selected due to its practicality in field-based settings and its high correlation with laboratory-based VO_2Max assessments (Senanayake et al., 2024).

Before each assessment session, participants were directed to refrain from strenuous physical activity for a minimum of 24 hours and to ensure proper hydration to guarantee physiological preparedness. All testing was performed at the same time of day throughout both the pre-test and post-test phases to mitigate the impact of circadian rhythms.

Evaluations were conducted under standardized environmental conditions and overseen by the same team of experienced research assistants to ensure procedural uniformity. This uniform testing protocol was established to improve the internal validity of the study and guarantee precise assessment of VO_2Max across all participants.

Data were processed and analyzed with IBM SPSS Statistics version 25.0. The preliminary study utilized descriptive statistics (mean, standard deviation) to encapsulate VO_2Max results before and after the intervention. The Shapiro–Wilk test analyzed the normality of data distribution, while Levene's test evaluated the homogeneity of variance assumptions. A paired sample t-test was employed for inferential analysis to compare VO_2Max results before and after the LSD training intervention. This test was chosen due to the study's focus on two related measurements (pre-test and post-test) within the same group, with the conditions of normality and homogeneity satisfied. Due to the lack of several time points or supplementary comparison groups, repeated measures ANOVA was inapplicable. Furthermore, given that the data exhibited a normal distribution, the application of non-parametric options, such as the Wilcoxon signed-rank test, was unnecessary. The criterion for statistical significance was established at $p < 0.05$. Furthermore, effect size (Cohen's d) was computed to assess the magnitude of the impact of the intervention. Based on conventional thresholds, effect sizes were interpreted as small (0.20–0.49), moderate (0.50–0.79), and large (≥0.80), providing additional context to the statistical significance of the findings (Pocaan, 2024).

RESULT

This study examined the effectiveness of the Long Slow Distance (LSD) training method in improving the VO_2Max and endurance capability of male basketball athletes at Jakarta State University. A total of 17 athletes completed both pre-test and post-test assessments. The analysis focused on two primary outcome variables: (1) aerobic endurance

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measured in VO_2Max (ml/kg/min), and (2) endurance capability measured by the level/shuttle score in the Beep Test.

Table 1. Descriptive statistics of vo_2max and endurance capability (n = 17)

Variable	Test	Mean ± SD	Min	Max	% Improvement
VO_2Max (ml/kg/min)	Pre-Test	43.37 ± 4.12	36.4	51.4	8.01%
	Post-Test	47.15 ± 4.62	39.2	54.8	
Endurance Capability (Level)	Pre-Test	9.01 ± 1.18	7.1	11.4	10.73%
	Post-Test	10.09 ± 1.33	7.9	12.4	

Table 1 presents that prior to the intervention, the mean VO_2Max score was 43.37 ± 4.12 ml/kg/min, with a range between 36.40 and 51.40 ml/kg/min. After six weeks of LSD training, the mean VO_2Max score increased to 47.15 ± 4.62 ml/kg/min, ranging from 39.20 to 54.80 ml/kg/min. This descriptive comparison indicates an average increase of 3.78 ml/kg/min, equivalent to an 8.01% improvement in aerobic capacity.

Inferential analyses were conducted to determine whether this observed difference was statistically meaningful. The Shapiro–Wilk test confirmed that the data were normally distributed ($p > 0.05$), and Levene's test showed homogeneity of variances between pre- and post-test conditions ($p = 0.561$). A paired sample t-test revealed a statistically significant increase in VO_2Max scores following the intervention ($t(16) = 13.40$, $p < 0.001$). The effect size, calculated using Cohen's d, was 1.83, which is categorized as large (≥ 0.80), indicating a substantial practical impact of the LSD training intervention on aerobic performance.

Table 2. Paired sample t-test results

Variable	t-value	p-value	Significance
VO_2Max (ml/kg/min)	13.40	0.000	**Highly Significant**
Endurance Capability (Level)	10.11	0.000	**Highly Significant**

Table 2 presents the outcomes of the paired sample t-test, demonstrating a statistically significant enhancement in both VO_2Max and endurance capacity subsequent to the LSD training intervention. The VO_2Max variable produced a t-value of 13.40 ($p = 0.000$), whilst the Beep Test level score exhibited a t-value of 10.11 ($p = 0.000$). The results validate that the observed changes are statistically significant ($p < 0.001$), corroborating the efficacy of the training program.

Data were first subjected to normality and homogeneity testing. The Shapiro–Wilk test results indicated that both VO_2Max and endurance capability data were normally distributed ($p > 0.05$ for all variables). Levene's test also confirmed the homogeneity of variances between pre- and post-test groups (VO_2Max: $p = 0.561$; Endurance Capability: $p = 0.453$).

The main aim of this study was to assess the efficacy of Long Slow Distance (LSD) training in enhancing aerobic capacity—quantified by VO_2Max—among male basketball players at Jakarta State University. The paired sample t-test results demonstrated a statistically significant enhancement in both VO_2Max and endurance performance after the six-week intervention. Mean VO_2Max increased by 8.1%, from 43.37 ± 4.12 to 47.15 ± 4.62 ml/kg/min. This enhancement signifies a significant physiological adaptation, indicating improved oxygen uptake and utilization during extended aerobic exercise. Considering that VO_2Max is a well-established measure of cardiorespiratory fitness, our results indicate that prolonged submaximal aerobic training, such as long slow distance (LSD) running, might induce substantial cardiovascular and metabolic changes in team-sport athletes.

While the findings demonstrate promising improvements in aerobic endurance, the generalizability of this study is limited due to the absence of a control group and the relatively small sample size. Future research should consider implementing randomized controlled trials (RCT) to establish causal relationships with greater confidence. Additionally, incorporating direct physiological measurements such as blood lactate analysis or gas exchange testing would provide more accurate insights into the underlying metabolic adaptations resulting from LSD training.

In the same way, the athletes' endurance, as shown by their level/shuttle number on the Beep Test, went up from an average of 9.01 to 10.09, a 10.73% increase. This result shows that the athletes were not only able to keep up aerobic activity for more extended periods but also better avoid getting tired during repeated bouts of hard work, which is an important physical trait for basketball players.

DISCUSSION

The findings of this study confirm that the implementation of Long Slow Distance (LSD) training significantly improved VO_2Max and aerobic endurance among male basketball athletes at Jakarta State University. This outcome is directly aligned with the primary research objective: to evaluate the effectiveness of LSD training in enhancing cardiorespiratory fitness during the general preparation phase of athletic conditioning. The recorded increase of 8.01% in VO_2Max and a 10.73% improvement in endurance capacity, as indicated by the level/shuttle scores on the Beep Test, support the hypothesis that prolonged submaximal aerobic training can elicit measurable physiological adaptations. These findings are consistent with prior research on aerobic training methods and further underscore the relevance of LSD in structured team sport conditioning programs. VO_2Max is acknowledged as the definitive metric for aerobic capacity and a vital factor influencing performance in intermittent, high-intensity sports like basketball (Fachrul Ihsan et al., 2021; Porcari et al., 2016). Basketball necessitates players to execute frequent sprints, rapid directional shifts, and extended durations of moderate exertion, all of which are significantly reliant on the efficacy of the cardiovascular and respiratory systems (Candra et al., 2023; Cao et al., 2025).

In contrast to earlier research that predominantly emphasized the advantages of high-intensity interval training (HIIT) for enhancing aerobic and anaerobic performance in team sports (Buchheit & Laursen, 2013; Ferioli, Bosio, La Torre, et al., 2018), the current study provides novel evidence that Long Slow Distance (LSD) training can also effectively improve VO_2Max and endurance capacity in basketball players. This discovery corroborates the periodization theory posited by Huang et al. (2023), which underscores the necessity of developing a robust aerobic foundation during the general preparatory phase prior to advancing to more severe, sport-specific training loads.

The present study demonstrated that athletes experienced an 8.01% enhancement in VO_2Max and a 10.73% advancement in endurance performance, signifying significant physiological adaptation due to extended submaximal aerobic exercise. These results align with aerobic training studies indicating that long slow distance (LSD) approaches can significantly enhance mitochondrial density, stroke volume, and capillary perfusion (Christy et al., 2022). Furthermore, the enhancement in fatigue resistance and recovery efficiency corresponds with the findings of Touron et al. (2021), who indicated that submaximal training fosters superior lipid metabolism and glycogen sparing, both essential for sustaining optimal performance in extended intermittent activities such as basketball.

HIIT is frequently regarded as the optimal method for basketball fitness because of its efficiency and anaerobic focus (Bishop et al., 2011). However, it necessitates a foundational aerobic ability to endure volume and intensity without risking overtraining (Wan, 2011). This study underscores that LSD training, although neglected, can complement early-phase conditioning to improve foundational aerobic fitness and facilitate subsequent high-intensity training phases. Collectively, these findings enhance the current research by illustrating that systematic LSD training is both physiologically effective and practically applicable in university-level basketball, especially during pre-season conditioning programs.

The findings of this study provide empirical support for the integration of Long Slow Distance (LSD) training into the conditioning programs of basketball players, particularly during the general preparation phase. The significant improvements in VO_2Max and endurance capacity underscore the critical role of aerobic base development in enhancing athletic performance. Coaches and sports scientists are encouraged to consider LSD as an essential component of the training program, facilitating the development of the physiological endurance necessary for players to endure the demands of high-intensity competition.

These findings provide coaches with evidence-based direction for structuring pre-season programs that equilibrate aerobic and anaerobic workloads. Integrating LSD training early in the training cycle enables athletes to establish a strong cardiovascular foundation, mitigate injury risk from overexertion, and enhance recovery during high-intensity game phases. For athletes, comprehending the enduring advantages of submaximal aerobic exercise may alter their training perspective, fostering increased commitment and persistence to conditioning regimens that enhance optimal performance during competitions.

CONCLUSION

This study demonstrated that Long Slow Distance (LSD) training significantly improved aerobic capacity (VO_2Max) and endurance among male basketball athletes, with an 8.01% increase in VO_2Max and a 10.73% enhancement in endurance performance following a six-week intervention. These findings validate the physiological benefits of submaximal, continuous aerobic training and underscore LSD's relevance in the general preparatory phase of basketball conditioning. While contemporary basketball training often prioritizes high-intensity and sport-specific modalities, this research highlights LSD as a foundational aerobic strategy that mitigates injury risk and enhances training adaptability. The simplicity, accessibility, and effectiveness of LSD make it a viable component in periodized training models.

Importantly, this study contributes to the limited body of research on aerobic base development in intermittent team sports. It offers empirical support for integrating LSD into structured conditioning programs and provides a scientific foundation for future comparative trials with other endurance modalities (e.g., HIIT). The outcomes serve as a practical guide for coaches and sports scientists in optimizing long-term athlete development through balanced aerobic training interventions.

REFERENCES

Archiza, B., Andaku, D. K., Beltrame, T., Libardi, C. A., & Borghi-Silva, A. (2020). The Relationship between Repeated-Sprint Ability, Aerobic Capacity, and Oxygen Uptake Recovery Kinetics in Female Soccer Athletes. *Journal of Human Kinetics*, *75*(1), 115–126.

https://doi.org/10.2478/hukin-2020-0042

Bishop, D., Girard, O., & Mendez-Villanueva, A. (2011). Repeated-sprint ability - part II: recommendations for training. *Sports Medicine (Auckland, N.Z.)*, *41*(9), 741–756. https://doi.org/10.2165/11590560-000000000-00000

Buchheit, M., & Laursen, P. B. (2013). High-intensity interval training, solutions to the programming puzzle: Part I: cardiopulmonary emphasis. *Sports Medicine (Auckland, N.Z.)*, *43*(5), 313–338. https://doi.org/10.1007/s40279-013-0029-x

Candra, O., Zulrafli, Z., Rahmadani, A., Renanda, A., & Ramadan, F. (2023). Interval training short duration dan long duration: Perbedaan pengaruhnya terhadap VO2max atlet bola basket. *Multilateral : Jurnal Pendidikan Jasmani Dan Olahraga*, *22*(1), 28. https://doi.org/10.20527/multilateral.v22i1.14709

Cao, S., Li, Z., Wang, Z., Geok, S. K., & Liu, J. (2025). The Effects of High-Intensity Interval Training on Basketball Players: A Systematic Review and Meta-Analysis. *Journal of Sports Science and Medicine*, *24*(1), 31–51. https://doi.org/10.52082/jssm.2025.31

Christy, B. E., Raharjo, S., Andiana, O., & Yunus, M. (2022). Pengaruh Latihan Circuit dan Interval Training terhadap Peningkatan Daya Tahan Vo2max pada Anggota Ekstrakurikuler Bola Basket SMK Negeri 3 Malang. *Sport Science and Health*, *4*(10), 909–916. https://doi.org/10.17977/um062v4i102022p909-916

Edwards, T., Spiteri, T., Piggott, B., Bonhotal, J., Haff, G. G., & Joyce, C. (2018). Monitoring and managing fatigue in basketball. *Sports*, *6*(1), 1–14. https://doi.org/10.3390/sports6010019

Fachrul Ihsan, M., Purba, A., Goenawan, H., Satia Graha, A., & Womsiwor, D. (2021). Measurable training program to improve physical performance: literature review. *Jurnal SPORTIF : Jurnal Penelitian Pembelajaran*, *7*(2), 159–179. https://doi.org/10.29407/js_unpgri.v7i2.16046

Ferioli, D., Bosio, A., Bilsborough, J. C., Torre, A. La, Tornaghi, M., & Rampini, E. (2018). The preparation period in basketball: Training load and neuromuscular adaptations. *International Journal of Sports Physiology and Performance*, *13*(8), 991–999. https://doi.org/10.1123/ijspp.2017-0434

Ferioli, D., Bosio, A., La Torre, A., Carlomagno, D., Connolly, D. R., & Rampinini, E. (2018). Different Training Loads Partially Influence Physiological Responses to the Preparation Period in Basketball. *Journal of Strength and Conditioning Research*, *32*(3), 790–797. https://doi.org/10.1519/JSC.0000000000001823

Gottlieb, R., Shalom, A., & Calleja-Gonzalez, J. (2021). Physiology of Basketball-Field Tests. Review Article. *Journal of Human Kinetics*, *77*(1), 159–167. https://doi.org/10.2478/hukin-2021-0018

Huang, Z., Yang, S., Li, C., Xie, X., & Wang, Y. (2023). The effects of intermittent hypoxic training on the aerobic capacity of exercisers: a systemic review and meta-analysis. *BMC Sports Science, Medicine and Rehabilitation*, *15*(1), 1–13. https://doi.org/10.1186/s13102-023-00784-3

Jones, A. M. (2024). The fourth dimension: physiological resilience as an independent determinant of endurance exercise performance. *Journal of Physiology*, *602*(17), 4113–4128. https://doi.org/10.1113/JP284205

Kadek, I., Astawan, T., Ayu, K., & Widhiyanti, T. (2023). Pelatihan High Intensity Interval Training (HIIT) Meningkatkan VO2Max Atlet Basket. *Jurnal Pendidikan Kesehatan Rekreasi*, *9*(1), 11–20. https://doi.org/10.5281/zenodo.7497766

Kusuma, P. A., Riyadi, S., & Handayani, S. (2025). Regular exercise has a beneficial effect on increasing aerobic capacity in army students. *Jurnal SPORTIF : Jurnal Penelitian Pembelajaran*, *11*(1), 1–17. https://doi.org/10.29407/js_unpgri.v11i1.23935 Regular

Meixner, B., Filipas, L., Holmberg, H. C., & Sperlich, B. (2025). Zone 2 Intensity: A Critical Comparison of Individual Variability in Different Submaximal Exercise Intensity Boundaries. *Translational Sports Medicine*, *2025*(1). https://doi.org/10.1155/tsm2/2008291

Mihajlovic, M., Cabarkapa, D., Cabarkapa, D. V., Philipp, N. M., & Fry, A. C. (2023). Recovery Methods in Basketball: A Systematic Review. *Sports*, *11*(11). https://doi.org/10.3390/sports11110230

Petway, A. J., Freitas, T. T., Calleja-González, J., Leal, D. M., & Alcaraz, P. E. (2020). Training load and match-play demands in basketball based on competition level: A systematic review. *PLoS ONE*, *15*(3), 1–21. https://doi.org/10.1371/journal.pone.0229212

Pratiwi, F. Z., Setijono, H., & Fuad, Y. (2018). Pengaruh Latihan Plyometric Front Cone Hops dan Counter Movement Jump Terhadap Power dan Kekuatan Otot Tungkai. *Jurnal SPORTIF : Jurnal Penelitian Pembelajaran*, *4*(1), 105. http://ojs.unpkediri.ac.id/index.php/pjk/article/view/12073

Pocaan, J. M. (2024). Effect of Tabata resistance training program on body capacities and 50m sprint performance of intermediate swimmers. *Journal of Physical Education and Sport*, *24*(4), 846–854. https://doi.org/10.7752/jpes.2024.04097

Porcari, J. P., Probst, L., Forrester, K., Doberstein, S., Foster, C., Cress, M. L., & Schmidt, K. (2016). Effect of wearing the elevation training mask on aerobic capacity, lung function, and hematological variables. *Journal of Sports Science and Medicine*, *15*(2), 379–386. https://doi.org/10.1249/01.mss.0000488131.38685.16

Ramirez-Campillo, R., Sortwell, A., Moran, J., Afonso, J., Clemente, F. M., Lloyd, R. S., Oliver, J. L., Pedley, J., & Granacher, U. (2023). Plyometric-Jump Training Effects on Physical Fitness and Sport-

Specific Performance According to Maturity: A Systematic Review with Meta-analysis. *Sports Medicine - Open*, *9*(1). https://doi.org/10.1186/s40798-023-00568-6

Scanlan, A. T., Dascombe, B. J., Reaburn, P., & Dalbo, V. J. (2012). The physiological and activity demands experienced by Australian female basketball players during competition. *Journal of Science and Medicine in Sport*, *15*(4), 341–347. https://doi.org/10.1016/j.jsams.2011.12.008

Senanayake, S. P., Dabare, P., Silva, A. R. N., Pushpika, S., & Maddumage, R. (2024). Validation Study to Assess the Concurrent Validity of the Beep Test as a Proxy for Cardiopulmonary Endurance, Using VO2 Max as the Criterion Standard. *European Journal of Sport Sciences*, *3*(1), 38–42. https://doi.org/10.24018/ejsport.2024.3.1.131

Shushan, T., Lovell, R., Buchheit, M., Scott, T. J., Barrett, S., Norris, D., & McLaren, S. J. (2023). Submaximal Fitness Test in Team Sports: A Systematic Review and Meta-Analysis of Exercise Heart Rate Measurement Properties. *Sports Medicine - Open*, *9*(1). https://doi.org/10.1186/s40798-023-00564-w

Sinurat, R. (2019). The profile of the maximum oxygen volume level (vo2max) of football athlete of Pasir Pengaraian University. *Jurnal SPORTIF : Jurnal Penelitian Pembelajaran*, *5*(1). https://doi.org/10.29407/js_unpgri.v5i1.12801

Touron, J., Costes, F., Coudeyre, E., Perrault, H., & Richard, R. (2021). Aerobic Metabolic Adaptations in Endurance Eccentric Exercise and Training: From Whole Body to Mitochondria. *Frontiers in Physiology*, *11*(January), 1–14. https://doi.org/10.3389/fphys.2020.596351

Wan, Z. (2011). *The Theory and Method of Basketball Player Physical Ability Training*. https://doi.org/10.1109/PACCS.2011.5990184

Yilmaz, G., Iri, R., & Cozeli, M. S. (2010). The long term effects of different training models on power, speed, ability and anaerobic capacity of 13-16 years old female basket ball players. *British Journal of Sports Medicine*, *44*(Suppl_1). https://doi.org/10.1136/bjsm.2010.078725.84

Yu, L., Chen, Z., Wu, W., Xu, X., Lv, Y., & Li, C. (2024). Effects of Precooling on Endurance Exercise Performance in the Heat: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. *Nutrients*, *16*(23). https://doi.org/10.3390/nu16234217