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Integrated physical training: An experimental study on the overall performance of basketball players

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Abstract

Background: Basketball performance requires integrating multiple physical components, including strength, speed, agility, flexibility, and endurance. However, conventional training programs often emphasize isolated components, limiting optimal performance development. An integrated training approach is therefore needed to address the multidimensional physical demands of basketball.
Aims: Evaluate the effectiveness of an Integrated Physical Training (IPT) program in improving overall physical performance in basketball players, focusing on key components: strength, speed, agility, flexibility, and endurance.
Methods: A quasi-experimental pre-test–post-test control group design was employed. Twenty-four male basketball players were randomly assigned to an experimental group and a control group. The intervention was conducted over 12 sessions (three sessions per week). Physical performance was assessed using a standardized fitness test battery covering strength, speed, agility, flexibility, and endurance. Data were analyzed using inferential statistics and effect size (Cohen's d).
Result: The IPT group demonstrated significant improvements ($p < 0.05$) across all physical performance variables compared to the control group. Effect sizes ranged from large to very large (Cohen's d= 1.26–3.00), indicating substantial multidimensional performance gains.
Conclusion: Integrated Physical Training (IPT) is more effective than conventional training in improving overall physical performance in basketball players. This approach is recommended as a comprehensive training model to optimize sport-specific physical adaptations.

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INTRODUCTION

Basketball has become one of the most popular sports worldwide (Candra, 2020), both among professionals and at the high school and college levels. This popularity is evident from the large fan base and widespread recognition of the NBA (Amra et al., 2023; Thompson et al., 2021). Basketball is favored among junior high school, high school, and college students, highlighting its broad appeal across different age groups and educational environments (Herzog et al., 2019). The sport's popularity is further emphasized by its strong participation rates across all ages and levels of competition, making it one of the most popular team sports in the world (Liao, 2023). The increasing popularity of basketball is evident from its trajectory of potentially surpassing American football in global popularity (Hextrum & Kim, 2023).

Basketball is a sport that requires extraordinary physical abilities, including strength, endurance, agility, speed, and flexibility (Liu & Li, 2025). Players must be in good physical condition and have good technical skills to achieve optimal performance. Research by Guimarães et al. (2021) has highlighted the physical condition of young basketball players and identified that technical skills,

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training experience, anthropometric measurements, body composition, biological maturation, and physical performance play an important role in player development. Then, Ge et al. (2023) explain the significant trends in the development of aerobic exercise and physical endurance in basketball players. Raste & Solanki, (2023) found that indicators of physical condition and physical development affect the performance outcomes of individual basketball players. Studies by Paulauskas & Balčiūnas (2011) and Raste & Solanki (2023) examined strength and speed profiles based on age and gender differences in youth basketball players. In the training context. Mancha-Triguero et al. (2021) examined strength and speed profiles across age and gender groups in youth basketball players. In the context of training, Wu & Huang, (2023) discuss functional physical training methods for basketball players. They highlight the importance of a basic framework for physical training. Liu (2023) proposed an evaluative index system for basketball players' physical training that assessed the effects of a nutrition education intervention, combining physical condition attributes, physical activity behavior, dietary habits, and nutrition knowledge, on young basketball players (Sánchez-Díaz et al., 2022).

Although basketball coaches and teams have implemented various training methods, many still focus on specific aspects of physical condition, such as strength or endurance, without considering other components. This can lead to a lack of holistic development in players, ultimately affecting the athlete's overall performance on the court. Research has shown that training significantly improves athlete performance and skills in basketball players, improving strength, sprinting, jumping, balance, agility, shooting, dribbling, passing, rebounding, and stepping (Luo et al., 2023). In addition, high-intensity interval training is effective in improving aerobic performance in basketball players (D'Elia et al., 2021). Physiological changes in elite women's basketball players can be monitored throughout the season to assess the effectiveness of conditioning programs and measure changes in player fitness (Lleshi & Kurti, 2024). Cognitive-motor dual-task training has been shown to improve cognitive-motor skills in semi-elite basketball players, emphasizing the importance of cognitive aspects in training (Lucia, Aydin, et al., 2023).

Integrated physical training (IPT) is an approach that combines various aspects of physical exercise in one holistic program. Integrated physical training (IPT) includes strength, endurance, agility, flexibility, and speed, to develop all components of physical condition in a balanced manner (Iserbyt et al., 2022). To address the lack of holistic development in basketball players and the need for comprehensive research on Integrated Physical Training (IPT), it is imperative to adopt a multidimensional training approach that encompasses multiple aspects of physical condition.

Integrative physical training, which combines different aspects of physical conditioning to improve skill-related components, has benefited various populations. Integrative training combines general and specific strength and conditioning activities to improve athlete performance and reduce sports-related injuries (Chen et al., 2025). Research has shown that integrating physical training with climbing practice significantly improves athletes' physical performance (Deng & Ding, 2023; Rekik et al., 2021). In addition, a study compared combined and integrated strength and aerobic training, which showed similar adaptations in countering the effects of a sedentary lifestyle on physical fitness (Jukic et al., 2019; Karatrantou et al., 2017). Integrative neuromuscular training in adolescents has been discussed to reduce sports injuries and improve health (Chen et al., 2025)

Training (IPT) in basketball involves incorporating various physical exercises to optimize performance and reduce injury risk. Research Bouteraa et al., (2018) showed that integrating balance and plyometric exercises into a basketball training program can improve vertical jump height, balance, and agility in adolescent female basketball players. In addition, incorporating core strength training has been found to improve basic skills such as fast dribbling and high-intensity running in collegiate men's basketball players (Xue, 2023). Furthermore, the use of high-intensity interval training (HIIT) is effective in improving aerobic and anaerobic performance in basketball players [(D'Elia et al., 2021). In addition, the application of artificial intelligence technology in designing basketball training programs can provide personalized strategies based on an individual's physical condition level, thereby increasing the effectiveness of training (Wang et al., 2022; Yang, 2020).

The main objective of this study was to determine the effect of integrated physical training (IPT) on basketball players' overall performance. Specifically, this study aimed to assess the components of physical condition (strength, endurance, agility, flexibility, speed) following an IPT program, evaluate the impact of IPT on player performance in training situations, and identify factors that influence IPT's effectiveness in basketball. The novelty of this study lies in its comprehensive approach that accounts for the overall movement of a basketball player's physical condition. However, there is still room to delve deeper into the effectiveness of integrated training programs in improving various physical components equally. The study explained that combined training programs, which integrate various physical training modalities, result in superior adaptations in biomotor abilities compared to single-mode training (Brini et al., 2022).

This training program has shown significant improvements in physical condition and basketball skills, with the experimental group outperforming the control group in various strength and agility tests (Cai et al., 2024). Multidirectional training has been shown to produce greater improvements in physical ability than unified directional training, highlighting the importance of varied training stimuli (Elgammal & Radwan, 2022). Furthermore, incorporating cognitive components into multicomponent training has been shown to improve physical performance and decision-making speed in elite players, which suggests that cognitive training can improve physical training outcomes (Lucia et al., 2023). The scope of this research includes the Mahameru Pekanbaru basketball club, with participation from coaches and players with experience in using the IPT method. Thus, the results of this study are expected to be widely applied across various levels of competition, to provide more scientific guidance for coaches in designing training programs, and to contribute to the development of basketball sports science.

METHOD

Research Design

This study adopted a true experimental design employing a pre-test–post-test control group approach to investigate the effectiveness of an Integrated Physical Training (IPT) program on basketball players' physical performance. Participants were randomly assigned to either an experimental group that received the IPT intervention or a control group that continued conventional basketball training. This design enabled the examination of both intra-group changes across time and inter-group differences following the intervention. The study was conducted and reported in accordance with CONSORT guidelines to ensure methodological transparency and rigor.

Participants

A total of 24 male basketball players from the Mahameru Basketball Club in Pekanbaru, Indonesia, participated in this study. All participants were actively involved in structured training and competitive activities. Their ages ranged from 16 to 20 years, with at least 2 years of formal basketball training. Eligibility criteria included being physically healthy, free from musculoskeletal injuries within the previous three months, and consistently attending training sessions at least three times per week. Participants undergoing rehabilitation or presenting medical conditions that could affect physical performance were excluded. Before participation, all athletes provided written informed consent.

Population and Sampling

The target population consisted of all registered athletes of Mahameru Basketball Club during the 2025 competitive season. Given the limited population size, a total sampling technique was employed, ensuring that all eligible athletes were included. Following eligibility screening, participants were randomly allocated into two groups of equal size (n = 12 per group). Randomization was implemented to minimize selection bias and to ensure baseline comparability between groups.

Instrument

Physical performance was assessed using a standardized, performance-based fitness test battery widely applied in sports science research. The battery measured five key biomotor components relevant to basketball performance: (1) Muscular strength**,** assessed a repetition-based test, with total valid repetitions recorded; (2) Speed**,** measured using a 30-meter sprint test, with time (seconds) recorded from the best of two trials; (3) Agility, evaluated a shuttle run test, with completion time recorded in seconds; (4) Flexibility, measured using the sit-and-reach test, recorded in centimeters; (5) Cardiorespiratory endurance, assessed the multistage fitness (beep) test, with the final level achieved recorded. All measurements were objective and quantifiable. For strength, flexibility, and endurance, higher scores indicated better performance, whereas for speed and agility, lower times reflected superior performance. The selected instruments demonstrate strong psychometric properties. Previous studies have reported test–retest reliability coefficients ranging from 0.82 to 0.95, with intraclass correlation coefficients (ICC) exceeding 0.80, indicating high reliability. Content validity is well-established, as these instruments are widely recognized for evaluating multidimensional physical fitness in athletic populations, particularly in basketball contexts.

Procedures

The study was conducted over a four-week intervention period. At baseline, all participants completed pre-test assessments under standardized conditions. Following baseline testing, participants were randomly assigned to either the experimental or control group. The experimental group participated in the IPT program, which met three times per week for 12 sessions, each lasting approximately 90 minutes. The IPT program integrated strength, speed, agility, flexibility, and endurance training into each session, applying the principle of progressive overload to ensure continuous physiological adaptation. In contrast, the control group continued their regular basketball training regimen, which primarily emphasized technical and tactical components without structured integration of multidimensional physical conditioning. Upon completion of the intervention, all participants underwent post-test assessments using identical instruments and protocols as those applied during the pre-test phase. To ensure measurement consistency, all testing sessions were conducted under controlled conditions, including standardized warm-up procedures, consistent environmental settings, calibrated equipment, and trained evaluators. Additionally, assessments were performed at the same time of day to minimize circadian variability.

Data Analysis

Data analysis was performed using SPSS version 22.0. Descriptive statistics, including means and standard deviations, were calculated for all variables. The assumption of normality was assessed using the Shapiro–Wilk test, while homogeneity of variance was examined using Levene's test. Within-group differences between pre-test and post-test scores were analyzed using paired-sample t-tests. In contrast, between-group differences at post-test were examined using independent-sample t-tests. Statistical significance was set at $p < 0.05$. To complement inferential analysis, Cohen's d effect size was calculated to determine the magnitude of the intervention effect. Effect sizes were interpreted as small (0.2), medium (0.5), large (0.8), and very large (>1.3).

Methodological Scope and Limitations

Despite the rigorous design, several limitations should be acknowledged. First, the relatively small sample size and single-club setting may limit the generalizability of the findings. Second, the four-week intervention period may not fully capture long-term physiological adaptations associated with integrated training. Third, outcome measures were limited to standardized physical fitness tests and did not include in-game performance metrics. Finally, although randomization was implemented, the study was conducted in a real-world training environment, which limited the ability to fully control extraneous variables. Future research is encouraged to involve larger multi-center samples, extended intervention durations, and the integration of match performance analytics to enhance ecological validity and practical applicability.

RESULTS AND DISCUSSION

Results

Prior to hypothesis testing using parametric statistical analyses, prerequisite assumption tests were conducted to ensure the suitability of the data. These tests included normality and homogeneity of variance assessments to verify whether the data were normally distributed and whether variances were equal across groups. The results of the normality and homogeneity tests for both the experimental and control groups are presented in the following tables.

Table 1. Normality Test Results (Shapiro–Wilk Test)

Variable	Group	Statistic (W)	Sig. (p-value)	Interpretation
Strength	Experimental	0.962	0.284	Normal
	Control	0.954	0.217	Normal
Speed	Experimental	0.971	0.412	Normal
	Control	0.948	0.189	Normal
Agility	Experimental	0.958	0.251	Normal
	Control	0.963	0.296	Normal
Flexibility	Experimental	0.969	0.387	Normal
	Control	0.956	0.234	Normal
Endurance	Experimental	0.961	0.271	Normal
	Control	0.952	0.205	Normal

Table 2. Homogeneity of Variance Test Results (Levene's Test)

Variable	Levene Statistic	Sig. (p-value)	Interpretation
Strength	1.42	0.241	Homogeneous
Speed	1.87	0.181	Homogeneous
Agility	0.96	0.334	Homogeneous
Flexibility	1.15	0.291	Homogeneous
Endurance	2.01	0.164	Homogeneous

The results of the Shapiro–Wilk normality test indicated that all variables in both experimental and control groups were normally distributed ($p > 0.05$). Furthermore, Levene's test confirmed that the variances between groups were homogeneous for all measured physical condition components. Therefore, the data met the assumptions for conducting parametric statistical analyses.

The paired sample t-test results for the experimental group revealed statistically significant improvements across all measured physical performance variables between pre-test and post-test ($p < 0.05$). Specifically, strength ($t = 14.45$), agility ($t = 9.38$), flexibility ($t = 11.68$), and endurance ($t = 8.03$) showed substantial positive increases, indicating enhanced physical capacity following the intervention. Although the mean difference in speed was negative ($t = -6.35$), this reflects a performance improvement, as evidenced by reduced sprint time. Overall, these findings confirm that the Integrated Physical Training (IPT) program produced significant and consistent improvements in all components of physical performance within the experimental group.

Tabel 3. Paired Sample T-Test (Pre Vs Post) Experimental Group

Variable	Mean Diff	SD	t	df	Sig. (2-tailed)
Strength	4.80	1.15	14.45	11	0.000
Speed	-0.95	0.52	-6.35	11	0.000
Agility	3.25	1.20	9.38	11	0.000
Flexibility	7.08	2.10	11.68	11	0.000
Endurance	7.88	3.40	8.03	11	0.000

The paired sample t-test results for the control group indicated no statistically significant improvements in most physical performance variables between pre- and post-tests ($p > 0.05$). Variables such as strength ($t = 1.35$), agility ($t = 0.59$), flexibility ($t = 0.94$), and endurance ($t = 1.16$) showed only minimal and non-significant changes. Although speed demonstrated a statistically significant difference ($t = -2.23$, $p < 0.05$), the magnitude of improvement was relatively small. Overall, these findings suggest that conventional training did not produce meaningful improvements in physical performance compared to the experimental intervention.

Tabel 4. Paired Sample T-Test (Pre Vs Post) Control Group

Variable	Mean Diff	SD	t	df	Sig. (2-tailed)
Strength	0.41	1.05	1.35	11	0.204
Speed	-0.26	0.40	-2.23	11	0.048
Agility	0.15	0.88	0.59	11	0.567
Flexibility	0.48	1.75	0.94	11	0.366
Endurance	0.71	2.10	1.16	11	0.270

The independent-samples t-test results at the post-test stage revealed statistically significant differences between the experimental and control groups on all measured physical performance variables ($p < 0.05$). Specifically, strength ($t = 6.87$), agility ($t = 7.20$), flexibility ($t = 7.25$), and endurance ($t = 5.10$) showed highly significant differences, indicating that the experimental group achieved substantially higher performance than the control group. These differences were accompanied by large to very large effect sizes (Cohen's d = 1.26–3.00), suggesting strong practical significance of the intervention. For the speed variable, a significant difference was also observed ($t = -3.13$, $p < 0.05$). The negative mean difference (-0.64) indicates that the experimental group achieved faster sprint times, reflecting improved movement velocity and acceleration capacity. This finding is particularly important given that speed is a critical determinant of performance in high-intensity, intermittent sports such as basketball.

Overall, the consistent statistical significance, combined with substantial effect sizes, confirms that the Integrated Physical Training (IPT) program was more effective than conventional training in improving multidimensional physical performance. These findings suggest that IPT facilitates comprehensive physiological adaptations across multiple biomotor components, thereby supporting a more holistic and sport-specific conditioning approach for basketball players.

Tabel 5. Independent Sample T-Test (Post-Test)

Variable	t	df	Sig. (2-tailed)	Mean Difference	Std. Error
Strength	6.87	22	0.000	4.72	0.69
Speed	-3.13	22	0.005	-0.64	0.20
Agility	7.20	22	0.000	3.35	0.46
Flexibility	7.25	22	0.000	7.25	1.00
Endurance	5.10	22	0.000	7.42	1.45

Hypothesis testing is conducted to determine whether using the Integrated Physical Training (IPT) exercise form can improve performance in basketball. For more details, see the table and graph below:

Table 6. Effect Size (Cohen's d) Results Between Experimental and Control Groups

Variable	Experimental Mean	Experimental SD	Control Mean	Control SD	Cohen's d	Effect Category
Strength	18.55	1.08	13.83	2.16	2.77	Very Large
Speed	6.90	0.61	7.54	0.38	1.26	Large
Agility	22.35	1.26	19.00	0.95	3.00	Very Large
Flexibility	46.83	2.40	39.58	2.50	2.96	Very Large
Endurance	48.13	4.51	40.71	2.47	2.04	Very Large

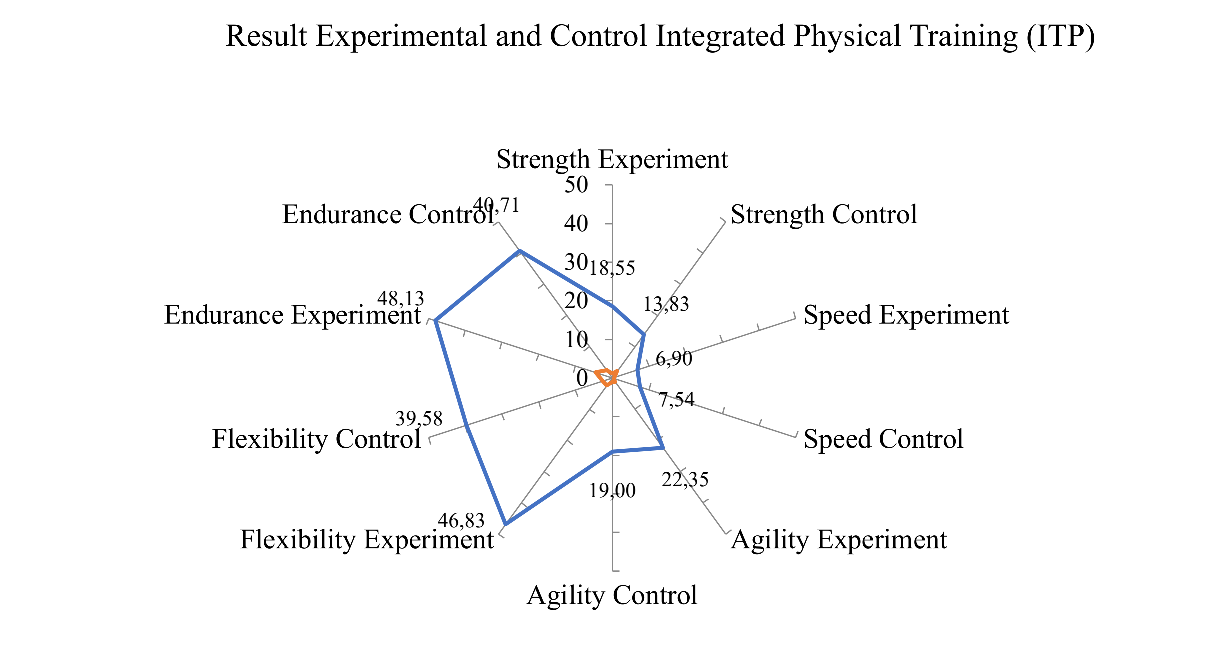

Figure 1. Experimental and Control Graphs in Basketball Performance

Table 1 presents the effect size (Cohen's d) analysis comparing the experimental and control groups across five physical fitness components. Overall, the results demonstrate that the implemented intervention produced large to very large practical effects on all measured variables. The effect size values ranged from 1.26 to 3.00, exceeding the threshold for a large effect as proposed by Cohen (1988). These findings indicate that the observed differences between the two groups are not only statistically meaningful but also substantial in practical impact within the context of physical education and training.

Building upon this general pattern, the most pronounced effect was observed in the agility variable (d = 3.00), which fell into the category of a very large effect. This result suggests that the experimental program was particularly effective in enhancing rapid directional changes, postural control, and neuromuscular coordination. The magnitude of this effect implies that the intervention likely incorporated movement tasks that required continuous perceptual–motor adjustment, thereby fostering more efficient and adaptive movement patterns compared to those developed through conventional instruction.

In a similar vein, flexibility demonstrated a very large effect size (d = 2.96), indicating a substantial improvement in joint mobility among participants in the experimental group. This finding reinforces the notion that the intervention systematically stimulated musculoskeletal adaptability through repeated and varied movement activities. Consequently, improvements in flexibility appear to be closely aligned with the overall training design, which emphasized functional movement rather than isolated or static exercises. Consistent with the improvements observed in flexibility, the strength variable also exhibited a very large effect (d = 2.77). This outcome reflects a marked enhancement in muscular capacity following the experimental treatment. The magnitude of the effect suggests that the intervention provided sufficient mechanical load and movement variability to stimulate strength adaptations more effectively than traditional approaches, thereby improving force production and movement efficiency.

Following these findings, the endurance component revealed a very large effect size (d = 2.04), highlighting the intervention's effectiveness in improving participants' ability to sustain physical activity over time. This result indicates that the experimental program likely promoted cardiovascular and metabolic adaptations through appropriately structured activity intensity and duration. As such, endurance gains appear to complement the observed improvements in other physical components, thereby supporting the intervention's holistic impact. Although relatively smaller in comparison, the speed variable still demonstrated a large effect size (d=1.26). Given that lower values represent better performance in speed-related assessments, this finding signifies a meaningful improvement in movement velocity for the experimental group. Importantly, this result suggests that the intervention enhanced explosive movement and acceleration, even within a limited training period, a physical attribute often considered challenging to improve.

Taken together, the consistently large and very large effect sizes across all variables underscore the comprehensive effectiveness of the experimental program. The interconnected improvements in agility, flexibility, strength, endurance, and speed indicate that the intervention facilitated multidimensional physical development. Therefore, these findings provide strong empirical support for the practical applicability of the experimental approach in physical education and sports training contexts.

Discussion

Integrated physical training (IPT) that incorporates a variety of strength exercises targeting major muscle groups has been shown to produce significant muscle strength gains among athletes (Yang, 2023). Combining endurance training with explosive or heavy strength training has been highlighted as a strategy to improve running performance. This suggests that integrating different training methodologies can result in better athlete outcomes. In addition, functional strength training has been found to improve athletic performance and optimize muscle function (Wang & Wang, 2023). Core strength training has been emphasized as an important component in conditioning and fitness programs for athletes (Cho & Kim, 2023). Furthermore, core resistance training has been recommended to supplement athletes during regular training routines. This type of exercise can improve athletes' physical capacity and sportsmanship (Zhang et al., 2023).

The endurance training that is part of IPT also showed positive results. Endurance tests such as the beep test showed significant improvements in players' cardiovascular capacity. This improvement is important because good endurance allows players to maintain high performance throughout the match without experiencing excessive fatigue. Endurance training is an important component of integrated physical training (IPT) for athletes, including soccer players. Various studies have shown that endurance testing significantly improves the cardiovascular capacity of players (Moran & Carter, 2016). The ability to complete more sprints and long runs during interval and fartlek training sessions further highlights the positive impact of endurance training on player performance (Kunz et al., 2019). In addition, developing an endurance training model based on technical training has been shown to improve endurance (Bahtra et al., 2022). Although endurance training is essential, the training program should also improve the anaerobic ability to achieve a comprehensive physical conditio (Deliceoğlu et al., 2024).

Agility and speed are important attributes for basketball players, especially in defensive movements and quick transitions between offense and defense. Integrated physical training (IPT) programs that include agility exercises, such as ladder and cone drills, have been shown to improve player agility, as shown by improvements in agility tests such as the T-test and shuttle run (Deliceoğlu et al., 2024). In addition to agility training, the IPT program also concentrates on improving speed through plyometric exercises and speed drills such as high knees and butt kicks. These training techniques have been shown to improve players' running speed, as evidenced by improvements in sprint tests (Meszler & Váczi, 2019). The research underscores the importance of agility in basketball, highlighting its role in improving players' ability to dribble in various situations and quickly change direction without losing balance (Annasai et al., 2023a). In addition, the research shows that the agility training model based on technical exercises can not only improve agility but also improve the basic technical skills of basketball (Bahtra et al., 2022). Overall, agility and speed training within the IPT framework are essential for basketball players to excel.

Flexibility is an important component of fitness that plays an important role in preventing injury and improving performance. Integrated Physical Training (IPT) programs that incorporate dynamic stretching and Yoga have been shown to produce significant improvements in flexibility among athletes (Hegishte & Kumar, 2023; Iftekher et al., 2017). Studies have shown that virtual reality-based Yoga can positively affect pain, functionality, and myofascial trigger points in patients with chronic nonspecific low back pain (Bağcıer, 2020). This suggests that incorporating innovative approaches such as virtual reality-based Yoga may improve flexibility and reduce pain in individuals with chronic conditions.

Physical condition is essential to maintain high performance during games, as basketball is anaerobic, mainly in nature, requiring exceptional speed and agility (Mancha-Triguero et al., 2021). The study showed a strong correlation between strength and basketball performance, with significant relationships identified in vertical jump height and overall athletic ability (Mancha-Triguero et al., 2021). Training programs focusing on strength development can improve scores and defensive abilities (Annasai et al., 2023b). Coordination and balance are essential for performing complex skills such as dribbling and shooting. Improved coordination allows for better movement control, while balance is essential for stability during play (Arainru, 2022). An integrated physical training program significantly improves the relationship among basketball, coordination, strength, and balance.

Integrated training improves coordination skills, which are important for basketball performance. Studies show that systematic training can optimize coordination quality in players (Kurilova & Synigovets, 2024). When added to regular practice, core strength training significantly improves coordination and balance, leading to better shot accuracy (Kooroshfard & Rahimi, 2022).Strength and neuromuscular training methodologies are effective in improving endurance in basketball players. This approach focuses on sport-specific skills and decision-making essential for competitive play (Schelling & Torres-Ronda, 2016). Research shows that combined training methods produce the largest effect sizes in improving strength-related performance metrics, such as vertical jump and sprinting ability. Dynamic stability and balance are essential for basketball players, with integrated training programs showing significant improvements (Garbenytė-Apolinskienė et al., 2018).

In addition to improvements in physical fitness components, the study also showed that the IPT program had a positive influence on player performance in matches (Savaş et al., 2018). Several studies have investigated the impact of different training programs on the physical fitness and performance of basketball players. Chen et al., (2023) studying the effects of simulation-based training on athlete performance among female basketball players Cabarkapa et al., (2023); Javanmardi et al., (2021) explored the acute influence of endurance training on basketball shot mechanics and accuracy. Studies by Cabarkapa et al., (2023); Luo et al., (2023) were systematic reviews of the effects of core training on athlete performance and basketball player skills.

Interviews with coaches and players provided additional insight into IPT's effectiveness. Coaches reported that players who underwent the IPT program showed improvements in training commitment and discipline. Players also reported feeling stronger, faster, and more physically prepared to deal with the demands of matches. This suggests that IPT not only improves the physical aspects but also the mental and motivational aspects of players. The physical characteristics of elite female basketball players have been linked to match performance, including game-related statistics such as points, rebounds, assists, steals, and blocks per game (Fort-Vanmeerhaeghe et al., 2016. Balance training is proven to significantly improve coordination and shooting ability in basketball players (Jing, 2023). Plyometric training is proven to increase strength and agility in high school basketball players (Namrata & Surabhi, 2023). Strength training that is optimized and tailored for basketball players is believed to improve athletic performance (Zhang & Zhang, 2023). An 8-week core training program was shown to positively impact free-throw shooting and vertical jump performance in 16-18-year-old basketball players (Şahiner & Koca, 2021). Physical training is proven to improve basketball players' strength, agility, endurance, and speed (Lu & Yin, 2022).

Implications

The findings of this study have both practical and theoretical implications for basketball training and sports science. In practice, the results suggest that coaches should adopt integrated, multidimensional training approaches, such as the Integrated Physical Training (IPT) model, to optimize athletes' physical development. By simultaneously targeting strength, speed, agility, flexibility, and endurance within a structured framework, IPT provides a time-efficient and performance-oriented training strategy aligned with the physiological demands of basketball. From a theoretical perspective, the study reinforces the concept that holistic training approaches yield more comprehensive performance outcomes than isolated conditioning methods. The integration of multiple biomotor components within a single training program appears to promote synergistic adaptations, thereby enhancing overall athletic performance. This supports contemporary training paradigms emphasizing specificity, integration, and functional transfer in sports conditioning.

Research Contribution

This study contributes to the existing body of knowledge by providing empirical evidence on the effectiveness of an Integrated Physical Training (IPT) model in improving multidimensional physical performance among basketball players. Unlike prior studies that predominantly examine isolated training components, this research highlights the cumulative and interactive effects of combining strength, endurance, agility, and flexibility training within a unified program. Additionally, this study offers a practical training framework that can be directly implemented in real-world coaching settings. The structured IPT model presented in this research serves as a reference for designing evidence-based training programs that are both efficient and contextually relevant for basketball athletes. Therefore, this study bridges the gap between theoretical training principles and applied sports practice.

Limitations

Several limitations should be acknowledged. First, the relatively small sample size and the use of participants from a single basketball club may limit the generalizability of the findings to broader populations. Second, the short duration of the intervention (four weeks) restricts the ability to observe long-term physiological adaptations. Third, the study relied solely on standardized physical fitness tests without incorporating match performance statistics or advanced biomechanical and physiological measurements. Furthermore, psychological variables such as motivation, confidence, and cognitive performance were not assessed, limiting a more comprehensive understanding of the training effects. Lastly, although randomization was applied, the study was conducted in a natural training environment, which may have introduced uncontrolled external variables.

Suggestions

Future research is recommended to address the limitations identified in this study. First, studies involving larger and more diverse samples across multiple teams and competitive levels are necessary to enhance external validity. Second, longer intervention periods should be implemented to examine the sustainability and long-term impact of Integrated Physical Training. Moreover, future studies should incorporate a more comprehensive set of performance indicators, including match performance analytics, biomechanical assessments, physiological markers, and psychological variables. Comparative studies evaluating IPT against other contemporary training models would also provide deeper insights into its relative effectiveness. Finally, integrating technology-based monitoring systems, such as wearable sensors and performance tracking tools, may further enhance the accuracy and applicability of future research in sports training and performance optimization.

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AUTHOR CONTRIBUTION STATEMENT

The author conceptualized and designed the study. The author performed data collection, exercise intervention implementation, and field implementation. The author performed data analysis and interpretation. The author performed writing, review, and final approval of the manuscript. All authors have read and approved the final version of the published manuscript.

AI DISCLOSURE STATEMENT

The authors declare that artificial intelligence tools were used only to assist with language editing and improve the clarity of the manuscript. The use of AI did not influence the research design, data collection, data analysis, interpretation of results, or scientific conclusions. The authors bear full responsibility for the content and scientific integrity of the manuscript.

CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest related to the publication of this article.

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