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ORIGINAL SCIENTIFIC PAPER

The Effects of Swim-Specific Dry-Land Training on 50-m Freestyle Performance in 12–13 Year Old Swimmers

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Abstract

This study aimed to examine the effects of swim-specific dry-land training on 50-m freestyle performance in 12–13 year old swimmers. This research employed a quantitative approach using a one-group pretest–posttest experimental design. The participants consisted of 15 male swimmers aged 12–13 years from FITT Swimming Club Padang, selected through purposive sampling. The intervention consisted of 16 sessions of swim-specific dry-land training, including plank, close-grip push-up, V-up, chin-up, flutter kicks, physioball upper-trunk rotation, and physioball bridge. Swimming performance was measured using a 50-m freestyle performance before and after the intervention, with time recorded in seconds using digital stopwatches operated by three independent timekeepers. Data were analyzed using descriptive statistics, Kolmogorov–Smirnov normality test, and paired-samples t-test through IBM SPSS Statistics version 26. The results showed that the mean pre-test time was 45.239 seconds, while the mean post-test time decreased to 44.495 seconds, indicating an improvement of 0.744 seconds. Normality testing confirmed that the data were normally distributed ($p > 0.05$). The paired-samples t-test revealed a statistically significant difference between pre-test and post-test results ($t = 9.117$; $p = 0.001 < 0.05$). It can be concluded that swim-specific dry-land training had a significant positive effect on improving 50-m freestyle performance in 12–13-year-old swimmers. These findings suggest that this training method can be effectively integrated into swimming conditioning programs to enhance sprint performance.

Keywords: swim-specific dry-land training, freestyle swimming, sprint swimming.

1. Introduction

Swimming is a highly competitive performance sport in which athletes' success is objectively measured through time efficiency. In modern training systems, swimming performance is determined by the integration of physical capacity, technical proficiency, and biomechanical efficiency in the water (Ruiz-Navarro et al. 2025). Among the various competitive events, the 50-m freestyle performance is considered one of the most physiologically demanding disciplines, requiring athletes to generate maximal speed within a very short duration while maintaining movement efficiency.

From a hydrodynamic perspective, swimming velocity results from the complex interaction between propulsion and water resistance (drag). Therefore, the ability to maximize propulsion while minimizing drag becomes a primary determinant of sprint performance (Takagi et al. 2021).

In swimming mechanics, the coordination between arm muscle strength and lower-limb explosive power forms the foundation of swimming speed. While the contribution of each physical component may vary across different swimming strokes, upper-body dominance in freestyle swimming remains a major consideration, as the arms contribute approximately 56–63% of total propulsion (Keller, Olstad, and Wahl 2024). This finding highlights the importance of systematically developing muscular strength and explosive power to improve the swimmer's power-to-drag ratio (Schreven, Smeets, and Beek 2022).

In addition to propulsion, core stability plays an important role in maintaining body posture and facilitating force transfer between the upper and lower extremities (Liu et al. 2025). However, practical conditions in the field indicate that many athlete development programs have not yet implemented scientifically based approaches to physical training. The absence of organized training programs (daily, weekly, and annual plans) and the limited application of coaching science represent serious barriers to achieving sustainable athletic performance.

In response to these limitations, swim-specific dry-land training has emerged as a strategy to bridge the gap between general strength training and the biomechanical demands of swimming. Previous studies have shown that the integration of dry-land training can significantly improve propulsive force and stroke efficiency (Amara et al. 2021; Wirth et al. 2022).

Furthermore, a recent meta-analysis by Wang et al. (2025) confirmed that combining swimming practice with dry-land strength training produces superior outcomes compared with those of conventional swimming training alone.

The urgency of this study is further reinforced by national competition standards. According to the Qualification Entry Times (QET) document for the Indonesia Open Swimming Championships 2025, male swimmers aged 12–13 years are expected to achieve a time of 29.82 seconds in the 50-meter freestyle event (Championships 2025). This demanding qualification standard highlights the need for optimal physical preparation from an early age. Observations conducted at FITT

Swimming Club Padang revealed that young swimmers often experience difficulty maintaining speed during the final phase of the race, indicating the need for more specific and measurable physical training interventions outside the pool.

Based on this background, the present study aims to analyze the effects of swim-specific dry-land training on 50-m freestyle performance in 12–13-year-old swimmers. This study is expected to provide scientific evidence for coaches regarding the importance of transitioning from experience-based training toward to data-driven and biomechanically oriented training approaches to improve young swimmers' performance.

2. Materials and Methods

This study was conducted in October 2025 at Wirabraja Swimming Pool, Padang City, Indonesia. The study employed a quantitative approach using a one-group pretest–posttest experimental design to examine the effects of swim-specific dry-land training on 50-m freestyle performance.

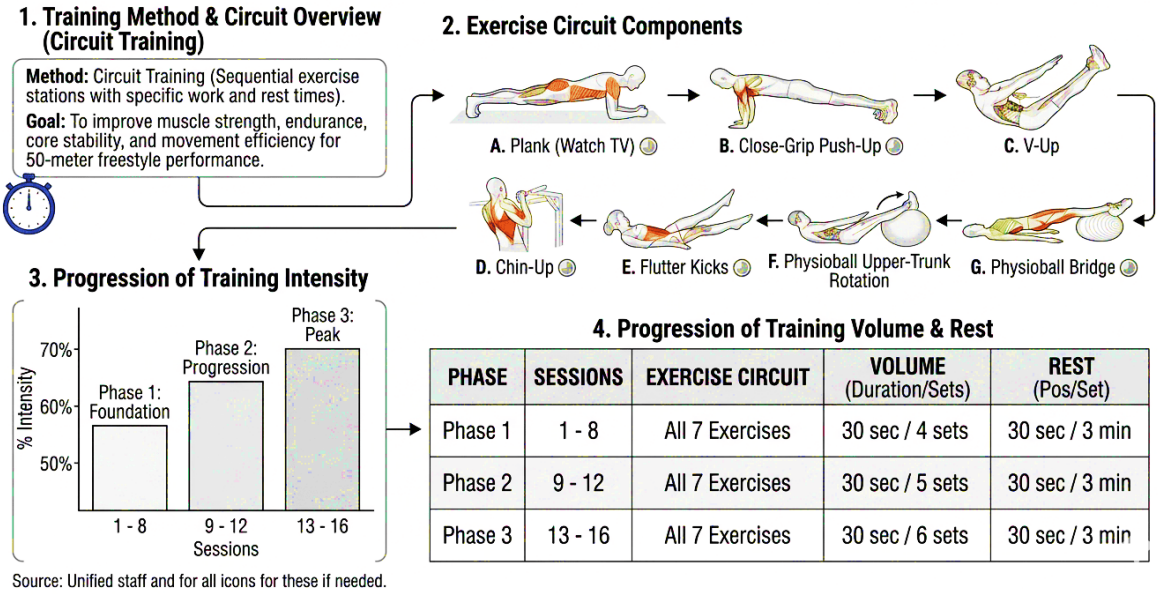
The participants consisted of 15 male swimmers aged 12–13 years from FITT Swimming Club Padang. Participants were selected using purposive sampling because this technique allowed the selection of participants with specific characteristics relevant to the objectives of the study, particularly young swimmers who met predetermined training and performance criteria. The selection criteria included actively participating in regular club training sessions, possessing basic freestyle swimming ability, being in healthy physical condition, and being willing to participate in the entire research procedure. All participants and their parents/guardians provided informed consent prior to the study. The research was conducted voluntarily while adhering to ethical principles involving human subjects in accordance with the Declaration of Helsinki. Ethical approval for this study was obtained from the Faculty of Sport Science under approval number 6865/UN35.3/AK/2025.

The research design consisted of a pretest, an intervention program, and a posttest. The pretest was conducted to determine the participants' baseline 50-m freestyle performance. Subsequently, all participants completed a swim-specific dry-land training program consisting of 16 training sessions integrated into the club's regular training schedule. Participants also continued their regular in-water swimming training throughout the intervention period. The training program was implemented using a circuit training method, in which participants performed a sequence of exercise stations consecutively with predetermined work and rest intervals. Each training session applied a circuit training method consisting of several exercise stations performed consecutively. Each exercise was performed for 30 seconds with a 30-second rest interval between stations and a 3-minute rest interval between sets. The training program applied the principle of progressive overload across the 16 sessions. During sessions 1–8, participants trained at 50% intensity with 4 sets; during sessions 9–12, the intensity was increased to 60% with 5 sets; and during sessions 13–16, the intensity was further increased to 70% with 6 sets. Training load progression was implemented gradually through increases in exercise intensity and the number of sets performed.

This method was applied to improve muscular strength, endurance, core stability, and movement efficiency related to 50-m freestyle performance.

The training program included plank, close-grip push-up, V-up, chin-up, flutter kicks, physioball upper-trunk rotation, and physioball bridge exercises. These exercises were selected to enhance upper-body muscular strength, core stability, postural control, and movement efficiency that support freestyle swimming biomechanics. All training sessions were supervised directly by the coach and the researcher to ensure that each exercise was performed with proper technique.

FIGURE 1: Effects of Swim-Specific Dry-Land Training on 50-m Freestyle Performance.



PHASE	SESSIONS	EXERCISE CIRCUIT	VOLUME (Duration/Sets)	REST (Pos/Set)
Phase 1	1 - 8	All 7 Exercises	30 sec / 4 sets	30 sec / 3 min
Phase 2	9 - 12	All 7 Exercises	30 sec / 5 sets	30 sec / 3 min
Phase 3	13 - 16	All 7 Exercises	30 sec / 6 sets	30 sec / 3 min

Figure 1. Swim-Specific Dry-Land Training Program for 50-m Freestyle Performance

Performance measurements were conducted twice, namely during the pre-test and post-test sessions. Both tests consisted of a 50-m freestyle performance performed under the same conditions. Prior to testing, all participants completed a standardized 15-minute warm-up session. Swimming time was measured using a digital stopwatch with an accuracy level of 0.01 seconds. To improve measurement reliability, performance times were recorded by three independent timekeepers, and the value used for analysis was the average of the three recorded times.

Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistical analysis was used to obtain the mean, standard deviation, minimum value, and maximum value. Because the sample size was relatively small (n = 15), normality was assessed primarily using the Shapiro–Wilk test, which is considered more appropriate for small samples. The Kolmogorov–Smirnov test was used as an additional reference for distribution assessment. Differences between pre-test and

post-test results were then analyzed using a paired-samples t-test with a significance level of $p < 0.05$.

3. Results

The results of the study are presented through descriptive statistical analysis, normality testing, and hypothesis testing to determine the effects of swim-specific dry-land training on 50-m freestyle performance in 12–13-year-old swimmers.

3.1. Descriptive statistics

Table 1. Descriptive Statistics of Pre-Test and Post-Test Results in the 50-m freestyle performance

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Pre-test	15	34.56	55.34	45.239	6.38	40.74
Post-test	15	33.85	54.93	44.495	6.45	41.61
Valid N (listwise)	15					

Based on Table 1, the mean pre-test result was 45.239 seconds, while the mean post-test result was 44.495 seconds. This indicates a decrease in swimming time of 0.744 seconds after the implementation of the swim-specific dry-land training intervention. The reduction in swimming time reflects an improvement in 50-m freestyle performance among the study participants.

Table 2. Normality Test of the Data

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Preliminary test results for the 50-m freestyle performance (seconds)	0.122	15	0.200*	0.946	15	0.470
Final test results for the 50-m freestyle performance (seconds)	0.132	15	0.200*	0.941	15	0.394

Based on Table 2, all significance values in the Kolmogorov–Smirnov and Shapiro–Wilk tests were greater than 0.05. Therefore, the data were normally distributed and met the assumptions required for parametric analysis using the paired-samples t-test.

Table 3. Results of the Paired-Samples t-Test

Variable	Mean Difference	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pre-Test – Post-Test	0.7440	0.3160	0.0816	9.117	14	0.001

Based on Table 3, the results of the paired-samples t-test showed a mean difference of 0.7440 seconds, with a t-value of 9.117 and a significance value of 0.001. The 95% confidence interval (CI) for the mean difference ranged from 0.569 to 0.919 seconds, indicating a consistent reduction in swimming time following the intervention. Furthermore, the effect size analysis showed a Cohen's d value of 2.35, representing a very large practical effect of the intervention.

Since the significance value was lower than 0.05 ($p < 0.05$), there was a significant difference between the pre-test and post-test results. Therefore, the research hypothesis was accepted.

The findings of this study indicate that swim-specific dry-land training had a significant effect on improving 50-m freestyle performance in 12–13-year-old swimmers at FITT Swimming Club Padang. The training program proved effective in reducing swimming time, thereby increasing the participants' swimming speed after the intervention.

4. Discussion

This study demonstrated that swim-specific dry-land training had a positive effect on 50-m freestyle performance in 12–13-year-old swimmers. These findings indicate that dry-land exercises designed according to the biomechanical characteristics of swimming are capable of improving physical capacities that support sprint swimming performance.

The improvement in swimming performance observed in this study was likely associated with enhanced propulsion generated by the upper extremities. In freestyle swimming, the arms are the primary source of propulsive force and contribute substantially to swimming speed. Keller et al., (2024) reported that the upper extremities contribute approximately 56–63% of propulsion and freestyle swimming velocity. This finding is supported by Ruiz-Navarro et al. (2025) who stated that sprint swimming performance largely depends on the ability to generate propulsion through arm stroke actions. Therefore, exercises such as close-grip push-ups, chin-ups, and physioball upper-trunk rotations may have contributed to improvements in the participants' propulsive capacity.

The present findings are also consistent with the study by Amara et al. (2021) which showed that the combination of dry-land strength training and in-water resistance training improved upper-body strength and sprint swimming performance. In addition, Pratama et al. (2025) explained that arm muscle strength has a strong relationship with 50-m freestyle swimming performance. Compared with previous studies involving adolescent swimmers, the magnitude of improvement observed in the present study was comparable to findings showing that dry-land interventions can positively influence sprint swimming performance through enhancements in muscular strength and movement efficiency.

In addition to propulsion, the performance improvements found in this study may also be related to increased core stability. Exercises such as plank, V-up, flutter kicks, and physioball bridge likely enhanced trunk stability, allowing swimmers to maintain a more effective streamline position during swimming. Liu et al. (2025) stated that core stability plays an important role in maintaining body balance, movement efficiency, and drag reduction while swimming. Good core stability also facilitates more effective force transfer between the upper and lower extremities (Rodríguez et al. 2024).

The findings of this study further support the Specificity of Training theory proposed by Bompa and Haff, which states that training adaptations occur specifically according to the movement patterns and muscle groups being trained. The swim-specific dry-land training program in this study was designed to target the dominant muscles involved in freestyle sprint swimming. Wang et al. (2025) through a meta-analysis, reported that the combination of dry-land and swimming training produced greater improvements in sprint performance compared with swimming training alone. Similarly, Fone & Van Den Tillaar, (2022) stated that strength training with biomechanical relevance to swimming can positively transfer to swimming speed performance.

Beyond improvements in strength and body stability, the results of this study may also be explained through neuromuscular adaptation mechanisms. Khiyami et al. (2022) found that core training improved neuromuscular coordination, stroke efficiency, and freestyle swimming performance. These neuromuscular adaptations may allow swimmers to maintain propulsion effectiveness and movement efficiency throughout sprint performance. Improved neuromuscular coordination enables swimmers to sustain stroke frequency and movement control more consistently.

From a practical perspective, the mean improvement of 0.744 seconds observed in this study may be considered meaningful in youth competitive swimming. In sprint events such as the 50-m freestyle, performance differences between athletes are often determined by fractions of a second. Therefore, a reduction of approximately 0.744 seconds may substantially increase competitiveness and potentially contribute to achieving qualification standards in youth swimming competitions.

Nevertheless, this study has several limitations, particularly the relatively small number of participants, the absence of randomization, the lack of a control group, and the inclusion of only

male participants. These limitations may reduce the generalizability of the findings. Therefore, future studies are recommended to employ more complex experimental designs with larger and more diverse sample sizes to allow a more comprehensive evaluation of the effectiveness of swim-specific dry-land training programs.

5. Conclusions

Based on the findings of this study, swim-specific dry-land training significantly improved 50-m freestyle performance in 12–13-year-old swimmers. Therefore, this type of training may be considered an effective complementary approach within structured training programs for enhancing youth swimming performance.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this study.

References

1. Amara, Sofiene, Tiago M. Barbosa, Yassine Negra, Raouf Hammami, Riadh Khalifa, and Sabri Gaied Chortane. 2021. "The Effect of Concurrent Resistance Training on Upper Body Strength, Sprint Swimming Performance and Kinematics in Competitive Adolescent Swimmers. A Randomized Controlled Trial." International Journal of Environmental Research and Public Health 18(19):10261. doi: 10.3390/ijerph181910261.
2. Championships, Indonesia Open Swimming. 2025. Qualification Entry Times (QET) Indonesia Open Swimming Championships 2025. Akuatik Indonesia.
3. Fone, L., and R. Van Den Tillaar. 2022. "Effect of Different Types of Strength Training on Swimming Performance in Competitive Swimmers: A Systematic Review." Sports Medicine - Open 8. doi: 10.1186/s40798-022-00410-5.
4. Keller, S., B. Olstad, and P. Wahl. 2024. "Lower and Upper Extremity Contributions to Propulsion and Resistance During Semi-Tethered Load-Velocity Profiling in Front Crawl Swimming." Journal of Sports Sciences 42:215–21. doi: 10.1080/02640414.2024.2326347.
5. Khiyami, A., S. Nuhmani, R. Joseph, T. Abualait, and Q. Muaidi. 2022. "Efficacy of Core Training in Swimming Performance and Neuromuscular Parameters of Young Swimmers: A Randomised Control Trial." Journal of Clinical Medicine 11. doi: 10.3390/jcm11113198.
6. Liu, S., J. Dai, P. Gou, and M. Lin. 2025. "The Effects of Core Stability Training on Swimming Performance in Youth Swimmers: A Systematic Review and Meta-Analysis." BMC Sports Science, Medicine and Rehabilitation 17. doi: 10.1186/s13102-025-01366-1.
7. Pratama, A., M. Personi, and F. Perdima. 2025. "Contribution of Arm Muscle Strength to Freestyle Swimming Speed in SPC Swimming Club Athletes." Journal of Physical Education and Sports. doi: 10.37676/jpes.v1i2.690.

8. Rodríguez, S., C. León-Prieto, M. Jaime, and A. Peña. 2024. "Meta-Analysis of the Effects of Core Stability Training on 50-Meter Freestyle Performance in Men and Women." Revista de Investigación e Innovación En Ciencias de La Salud. doi: 10.46634/riics.359.
9. Ruiz-Navarro, Jesús J., Catarina C. Santos, Dennis-Peter Born, Óscar López-Belmonte, Francisco Cuenca-Fernández, Ross H. Sanders, and Raúl Arellano. 2025. "Factors Relating to Sprint Swimming Performance: A Systematic Review." Sports Medicine 55(4):899–922. doi: 10.1007/s40279-024-02172-4.
10. Schreven, S., J. Smeets, and P. Beek. 2022. "Sprint Performance in Arms-Only Front Crawl Swimming Is Strongly Associated With the Power-To-Drag Ratio." Frontiers in Sports and Active Living 4. doi: 10.3389/fspor.2022.758095.
11. Takagi, H., M. Nakashima, Y. Sengoku, T. Tsunokawa, D. Koga, K. Narita, S. Kudo, R. Sanders, and T. Gonjo. 2021. "How Do Swimmers Control Their Front Crawl Swimming Velocity? Current Knowledge and Gaps from Hydrodynamic Perspectives." Sports Biomechanics 22:1552–71. doi: 10.1080/14763141.2021.1959946.
12. Wang, Z., K. Liu, X. Zhao, and J. Gao. 2025. "Comparative Effectiveness of Physical Training Modalities on Swimming Performance: A Two-Tier Network Meta-Analysis." Frontiers in Physiology 16. doi: 10.3389/fphys.2025.1636595.
13. Wirth, K., M. Keiner, S. Fuhrmann, A. Nimmerichter, and G. Haff. 2022. "Strength Training in Swimming." International Journal of Environmental Research and Public Health 19. doi: 10.3390/ijerph19095369.

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ORIGINAL SCIENTIFIC PAPER

The Impact of Parental Support on Children's Orientation Toward Sport

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Abstract

Parental support plays a critical role in shaping children's participation and persistence in sports. However, the perspectives of parents with athletic backgrounds remain underexplored in the literature. This study aims to examine the role of parents with sporting backgrounds in shaping their children's orientation toward sports and to explore their perceptions of this process. A qualitative phenomenological design was employed. The study included 15 parents of children actively engaged in sports at various school levels. Data were collected through semi-structured interviews and analysed using thematic analysis. Findings indicate that sport contributes to children's discipline, self-confidence, socialisation, and academic achievement, although exam periods present challenges. Parental approaches to professional athletic careers varied: some prioritised individual happiness and talent, whereas others emphasised balancing sport with academic success and societal values. Although the egalitarian nature of sport was widely acknowledged, cultural and patriarchal norms were found to limit this potential, particularly in girls' discipline choices. In conclusion, sport plays a central role in children's personal development and social value production. Parental education programmes and balanced sport-academic policies are essential for sustainable youth development, particularly to address gender-based limitations and infrastructure deficiencies.

Keywords: Academic achievement, gender equality in sport, parental support, phenomenological analysis, youth sport participation

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1. Introduction

In contemporary societies, family support emerges as a decisive factor in directing children toward sports, influencing not only their choice of sport but also their processes of discipline, self-confidence, socialization, and academic achievement. Knight and Holt (2014) emphasize that the psychological and practical contributions provided by parent's shape children's motivation, continuity in sports, and the life skills acquired through sports, while also creating a transformative impact on personal development and social adaptation. At this point, Wolfenden and Holt (2005) highlight that parents are key actors in shaping their children's talents at an early stage, and that the support they provide not only facilitates participation in sport but also serves as a powerful source of energy and motivation, encouraging children's personal interests. These findings demonstrate that parental support enhances the quality of sporting experiences and plays a transformative role in children's developmental processes. Lauer et al. (2010) argue that parents provide opportunities for their children to try and experience physical activity, that their investments in this process are decisive in the development of young people's talents, and that the financial support required for access to training, matches, camps, and tournaments is covered by parents. In this context, Harwood and Knight (2015) stress the critical importance of parents understanding what their children aim to achieve through participation and what they themselves expect their children to accomplish.

Parents are generally the first and most enduring social actors in children's participation in sport; by providing opportunities, resources, and emotional support, they shape motivation and commitment. However, excessive pressure and unrealistic expectations may lead to stress and withdrawal from sports (Jowett & Lavallee, 2007). Therefore, the quality of parental involvement is decisive. Supportive behaviours foster self-confidence and autonomy, whereas controlling attitudes can undermine intrinsic motivation (Horn, 2008). Moreover, parents' attitudes toward competition, achievement, and success are transmitted to children, shaping their goal orientations and responses to challenges (Smoll & Smith, 2002). In sporting contexts, the quality of the parent–child relationship is a significant determinant of motivational outcomes independent of peer influence, and when supportive parental behaviours are combined with peer support, the most adaptive motivational profiles emerge (Ullrich-French & Smith, 2006). Mothers play a central role in the development of children's perceived competence in sports. Maternal expectations are directly related to adolescents' perceptions of physical competence throughout the year; positive expectations enhance confidence, while negative expectations lead to declines. This demonstrates that family influences shape not only participation but also self-perception. Maternal beliefs are also critical in sustaining adolescents' early confidence in their physical abilities (Bois et al., 2002).

Accordingly, family support multidimensionally shapes children's participation in sport, motivational processes, and self-perceptions; balanced, autonomy-supportive, and encouraging parental attitudes stand out as the fundamental factor supporting young people's long-term commitment to sports, healthy development, and sustainable motivational profiles.

Parental education programs in youth sports are an important tool to support healthy participation and enhance positive parental behaviours. These initiatives help parents sustain their

children's sporting experiences within a more adaptive motivational environment, while simultaneously reducing stress factors on athletes and coaches. Parents are the most influential social actors in youth sports. Since the quality of participation can yield both positive and negative outcomes, education programs facilitate a balanced provision of encouragement and autonomy support. Moreover, such programs reduce controlling attitudes and strengthen children's intrinsic motivation. Therefore, parental education initiatives are regarded as a critical strategy for fostering sustainable motivational profiles and supporting healthy psychological outcomes in youth sports (Burke et al., 2024). Within this framework, the historical transformation of parental involvement underscores the growing importance of structured education programs in fostering sustainable motivation and healthy development in youth sports (Dorsch et al., 2021). Finally, parental involvement has been consistently associated with athletes' enjoyment of sport, self-esteem, and persistence. Conversely, perceived parental pressure has been linked to higher competitive anxiety and lower intrinsic motivation. This indicates that the quality of parental support is a critical factor in determining the nature of children's sporting experiences and their long-term commitment. Accordingly, autonomy-supportive and encouraging parental attitudes strengthen young athletes' motivational profiles, whereas coercive approaches increase the risk of sport withdrawal (Hayre, 2024). In conclusion, the literature reveals that parents in youth sports are not merely facilitators of participation but also primary actors shaping motivational environments and psychosocial outcomes. Balanced, autonomy-supportive, and encouraging parental attitudes are considered the most critical elements in sustaining children's long-term commitment to sports, healthy development, and sustainable motivational profiles.

The primary aim of this study is to reveal how parents with a sporting background shape their children's orientation toward sports and to find the answer for these questions.

- What role does parental support play in the academic achievement of children engaged in sports?
- How do parents' attitudes toward professional sports influence children's sport preferences?
- How does the perception of gender equality in sport shape the way families guide their children?
- What is the relationship between children's wishes, talents, and parental support in the selection of elite sport branches?
- How does the adequacy of state sport infrastructure and policies affect families' decisions to direct their children toward sport?
- What are parents' observations regarding the impact of sport on time management and academic success during exam periods?

Methods

A qualitative research method was employed to understand the support provided by parents with sporting experience for their children's participation in sport, their expectations of sporting activities, their views on gender discrimination in sport, their approach to choosing a sport at elite level, their opinions on the country's sporting infrastructure and policies, and their attitudes towards the impact of sport on academic achievement and time management during exam periods. This approach examines individuals' perceptions within natural contexts using observation, interviews and document analysis (Yıldırım & Şimşek, 2013). The process involves examining the meanings attributed to issues, collecting data in natural settings, identifying themes and conducting analyses. The comprehensive report resulting from this process brings together the participants' perspectives, the researcher's evaluations, and contributions to the literature (Creswell, 2018).

Research design

In this study, a phenomenological research design was employed as part of qualitative methodologies. Phenomenology was considered the most appropriate approach due to its emphasis on individuals lived experiences and the meanings they attribute to those experiences (Yıldırım & Şimşek, 2013). Within this framework, participants were asked to reinterpret their experiences regarding sport and family support from a fresh perspective. Accordingly, the study adopted a transcendental (experimental-abstract) phenomenological approach. Transcendental phenomenology does not merely require individuals to recount their experiences; rather, it enables them to reframe and re-assign meaning to those experiences (Creswell, 2018). Through this approach, the study examined participants' perspectives in a renewed context, thereby enhancing methodological depth and allowing the findings to be interpreted within a broader framework.

Identification of participants

The study group of this research consists of 15 parents whose children are actively engaged in sports or related activities (Table 1). Participants were selected through convenience sampling based on accessibility and willingness. However, specific inclusion and exclusion criteria were applied to ensure the validity of the research. This approach allowed the sample to be both practically accessible and directly relevant to the research questions, thereby aiming to achieve an in-depth understanding (Yıldırım & Şimşek, 2013; Creswell, 2018). In line with the directives of the SRQR and COREQ guidelines, the processes of sampling, data collection, and analysis were structured to ensure methodological transparency, and the inclusion and exclusion criteria were clearly defined to guarantee the reliability of the findings.

Inclusion criteria:

The participant must be a parent of a child actively engaged in sports (at amateur or licensed level).

The child must be of primary, middle, or high school age.

The parent must have experience regarding the effects of sport on individuals and society.

The participant must agree to take part in the study, sign the informed consent form, and voluntarily participate in the interview process.

Exclusion criteria:

Parents whose children do not engage in sports or have no direct relation to sports.

Families whose children are not of school age (e.g., preschool or university level).

Individuals who refuse to participate in the interview, do not provide informed consent, or provide incomplete/misleading information.

Persons without experience regarding the effects of sport on individuals and society.

Table 1. Distribution of information about the participants in the study

Participant Code	Gender	Age	Educational Background	Parents' Sport Participation	Number of Children	Number of licenced child	Children's Licensed Sports Branches
P1	Male	43	Bachelor's Degree	Not Active	1	1	Badminton
P2	Female	40	Master's Degree	Not Active	3	2	Badminton, Swimming
P3	Female	26	Bachelor's Degree	Active	2	1	Swimming
P4	Male	39	Master's Degree	Not Active	2	1	Basketball, Taekwondo
P5	Male	37	Master's Degree	Not Active	2	1	Basketball, Muay-Thai
P6	Male	32	Bachelor's Degree	Active	1	1	Archery
P7	Female	43	Bachelor's Degree	Active	2	2	Basketball, Gymnastics
P8	Male	42	Master's Degree	Active	1	1	Taekwondo
P9	Female	49	Bachelor's Degree	Not Active	2	1	Soccer

P10	Female	53	Bachelor's Degree	Active	1	1	Tennis
P11	Male	57	Bachelor's Degree	Not Active	1	1	Volleyball
P12	Male	30	Bachelor's Degree	Active	2	1	Archery
P13	Male	61	Bachelor's Degree	Active	4	2	Taekwondo, Fitness
P14	Male	38	Bachelor's Degree	Not Active	1	1	Basketball
P15	Male	53	Master's Degree	Active	5	5	Taekwondo, Kickboxing

A total of 15 parents participated in this study. The participants' ages ranged from 26 to 61, encompassing both younger parents and those in older age groups. This diversity enabled an examination of the role of sport in children's lives from different generational perspectives.

Data collection techniques and tools

Semi-structured interviews were used as the primary data collection method. The interview protocol was developed through a systematic review of national and international literature, with the guidance of two experts in sports science, both holding PhDs, and one expert in measurement and evaluation, also holding a PhD. A pilot interview was subsequently conducted, followed by some minor revisions. In its final form, the interview consisted of six questions designed to elicit the reasons why parents with sporting experience encourage their children to take up sport and the effects of sport on their children's individual, social and academic development. The interview guide for these questions is provided below (Table 2).

Table 2. Interview guide (sample questions)

Theme	Questions
Academic Achievement	How do you think sports affect students' academic achievement?
Professional Career	How do you approach the possibility of your child becoming a professional athlete?
Gender Equality	Do you think boys and girls have equal opportunities in sports?
Elite-Level Choice	If your child chooses an elite-level sport branch, what factors should be decisive?
State Policies	Do you find the state's sports infrastructure and policies sufficient?

Exam Periods	How does sports participation affect your child's academic performance and time management during exam periods?

Data analysis

The data in this study were analysed using a qualitative thematic analysis method. Interview recordings were transcribed verbatim to ensure holistic familiarity with the content. Inductive codes were generated from participants' statements regarding the impact of sport on academic achievement, expectations of professional athletic careers, perceptions of gender equality, the selection of elite-level disciplines, state policies, and experiences during examination periods. These codes were then grouped into categories based on similarities and differences, and themes were developed through the constant comparison method. The coding process was conducted independently by two researchers, after which consensus meetings were held to resolve discrepancies (Creswell, 2018). Data saturation was confirmed when no new codes or themes emerged. During the analysis, Maxqda 2020 software was utilized to systematically organize codes and themes (Braun & Clarke, 2006). This approach enabled a comprehensive presentation of how parents with sporting experience perceive their children's orientation toward sport, making visible the interaction of individual, familial, and structural factors within a holistic framework.

Trustworthiness and credibility

Reliability and validity in this study were strengthened through the combined use of multiple data collection methods (interviews, observations, and document reviews). The use of convenience sampling enabled the inclusion of diverse parental profiles, thereby contributing to the breadth of the study (Patton, 2002). The coding process was grounded in systematic thematic analysis, and methodological rigor was supported through the meticulous examination of the data (Braun & Clarke, 2006). Researcher reflexivity was incorporated to maintain impartiality and minimize potential biases (Lincoln & Guba, 1985).

Research ethics

All procedures carried out in this study were conducted in accordance with institutional guidelines and the Declaration of Helsinki and its subsequent amendments. Great care was taken to ensure that participants agreed to take part in the study, signed the informed consent form, and participated voluntarily in the interview process. Parents who agreed to participate in the study were informed that their confidentiality would be safeguarded and that all data would be collected solely for academic purposes. Interviews were conducted with volunteer participants who accepted the conditions. Participants were identified using codes such as P1, ..., P15; the interviews were conducted face-to-face in settings where participants could feel at comfortable. The interviews lasted an average of 35 minutes.

Findings

The findings obtained from the analysis process are presented in detail below, and parents' views on the role of sport in children's lives are evaluated under thematic headings.

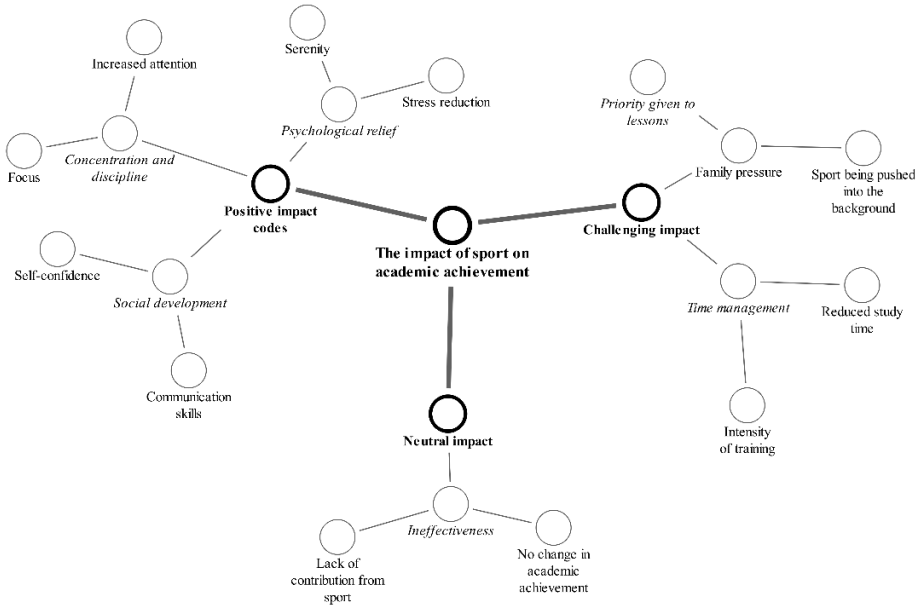

Figure 1. Participants' perspectives on the impact of sports on academic achievement

Participants evaluated the impact of sport on students' academic achievement from different perspectives. The majority emphasized that sport contributes positively to concentration and discipline, increasing students' focus on lessons and their attention span. Regular habits gained through sport, its support for study motivation, and its indirect contribution to academic success were among the prominent findings (P5, P6).

P5: *My child's involvement in sport can make time management difficult during exam periods. However, with proper planning, the disciplinary effect of sport supports academic success.*

P6: *I do not think sport negatively affects my child's academic performance during exam periods. Sport provides discipline and order, which helps in exam preparation.*

Some participants stated that sport has a neutral effect on academic achievement, noting no significant changes. These views suggest that the impact of sport may vary depending on individual differences and contextual conditions (P4, P8).

P4: My child currently attends basketball training four days a week, and the teachers have also stated that these trainings have no negative effect on his academic performance.

P8: I observe that sport does not negatively affect my child's academic performance during exam periods. Sport provides discipline and order.

Other participants indicated that sport could create challenges during exam periods, particularly due to intensive training schedules and time management difficulties, which may negatively affect academic achievement. The prioritization of exams, their non-recoverable nature, and fatigue were highlighted in these views (P1, P2, P3).

P1: Unfortunately, in our country everything is indexed to academic success, so we prioritize it slightly. The intensity of training hours inevitably has an impact.

P2: I observe that sport falls into second place during exam periods. Sport can be compensated, but exams cannot.

P3: Sport should be part of our lives, but if it is not pursued professionally, I believe it is better to take a short break during exam periods.

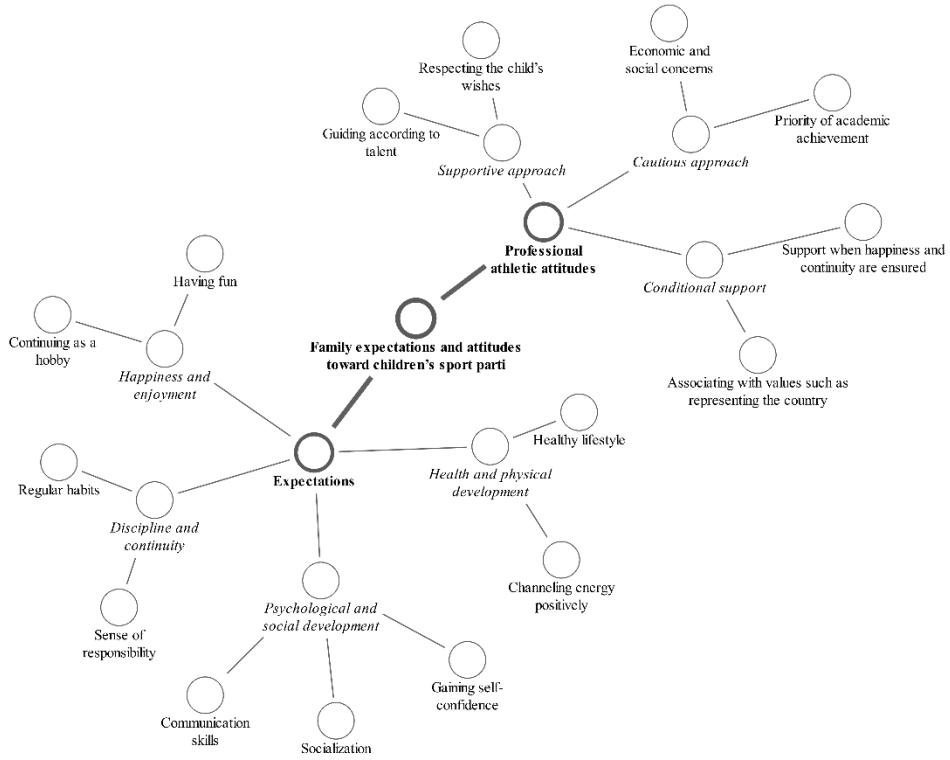

Figure 2. Parental approaches toward the possibility of children becoming professional athletes

Participants expressed their expectations from their children's involvement in sports primarily in terms of health, discipline, self-confidence, and socialization. Statements highlighting that sport channels children's energy positively, enhances their social relationships, and increases their personal happiness were prominent. These findings reveal that sport is perceived primarily as a tool for quality of life and personal development (P1, P7, P12).

P1: My expectation is for my child to be healthy, to build good relationships with society, and to express himself better socially. I do not prioritize becoming a professional athlete, but if circumstances lead him in that direction, I will not prevent it.

P12: I want my child to gain discipline and be healthy through sport. I would like him to become a professional athlete and will guide him according to his talent.

Approaches to the possibility of professional athletic careers were more diverse. Most participants stated that they would support their children's decision to become professional athletes according to their own preferences, with this support being closely linked to the child's happiness and talent (P2, P5, P9).

P2: My priority is my child's happiness… if he advances professionally, I believe he should represent the country.

P5: I want my child to live a healthy life through sport. If he becomes a professional athlete, I will support him, but I also prioritize his academic success.

Some participants viewed professional athletic careers positively but emphasized that academic achievement must remain a priority, noting that professional sport can only be sustainable when balanced with education (P5, P9, P11, P14).

P5: I want my child to live a healthy life through sport. If he becomes a professional athlete, I will support him, but I also prioritize his academic success.

P11: I expect my child to live a healthy life through sport. I would support his professional career only if it is conditional on academic success.

Another group associated professional athletic careers with representing the country and contributing to social values. In this perspective, sport was seen not only as a means of individual development but also as a tool of national identity and social contribution (P2, P13).

P2: If he advances professionally, I believe he should do so by representing the country.

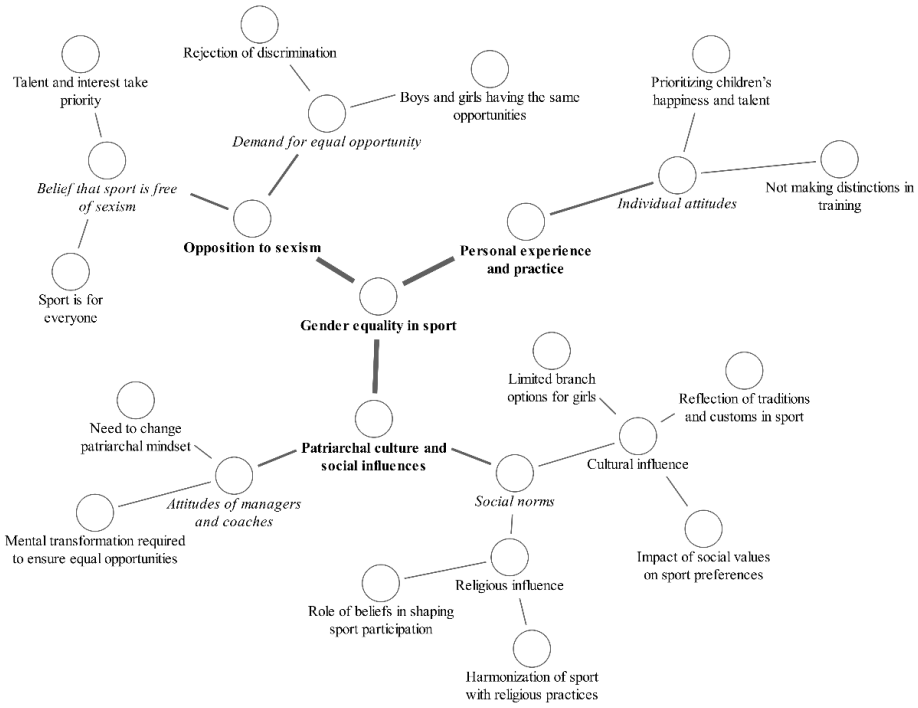

Figure 3. Perceptions of equal opportunities for boys and girls in sports

Participants emphasized that, by its very nature, sport should not allow space for gender discrimination. The majority stated that girls and boys should have equal opportunities, and that sport should be evaluated based on talent and interest. A strong view emerged that sport must be free from sexism, enabling children to freely choose their disciplines and be supported with equal opportunities (P6, P10).

P6: I believe sport has no sexism. Children should be guided according to their talents.

P10: I am against gender discrimination. Sport is for everyone, regardless of being a girl or boy.

Some participants noted that, particularly in Anatolia, cultural and religious norms limit girls' choices of disciplines, and that patriarchal thinking still influences the field of sport. These findings show that while sport should be an egalitarian domain, social norms restrict this equality (P2, P4).

P2: Unfortunately, Turkish society is patriarchal… if managers and coaches change their patriarchal mindset, we will have no concerns about sexism.

P4: Families who allow girls to do sports usually limit the disciplines… why shouldn't girls play football, why shouldn't girls play basketball? There should be no distinction.

Other participants, drawing from personal experience, stressed that sport must remain free from discrimination, and stated that in their own practice they treat boys and girls equally (P3, P9).

P3: No discrimination can be made in a sport field based on gender, and I absolutely do not approve of it. Personally, I do not make distinctions among those I train.

P9: I believe girls and boys should have equal opportunities. Sport should progress with equality of opportunity, not discrimination.

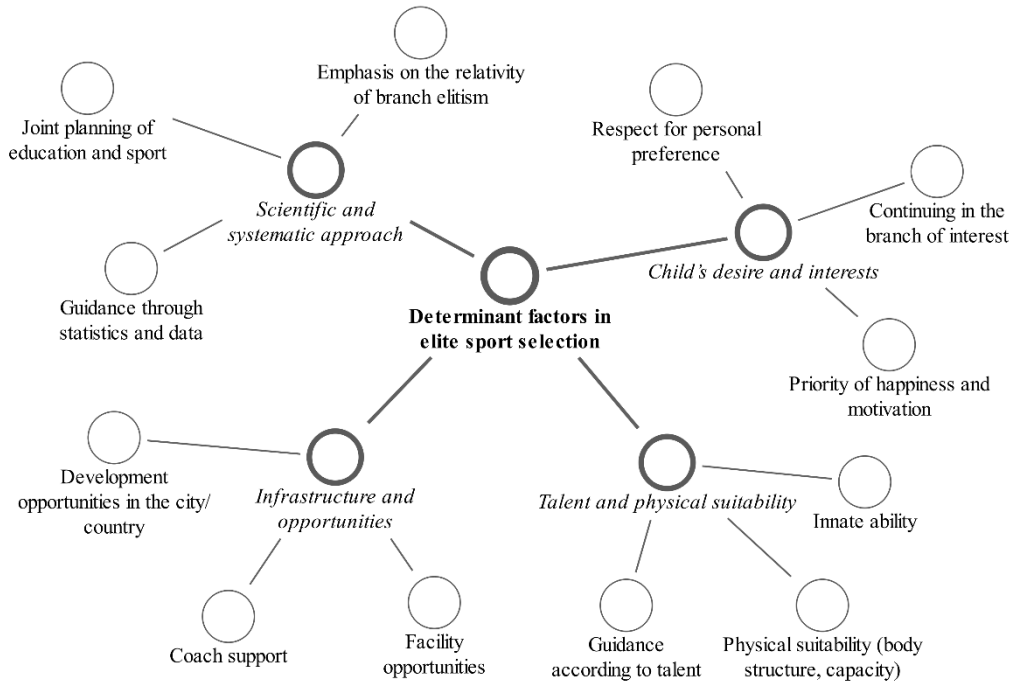

Figure 4. Determinant factors in choosing an elite-level sport branch

Participants emphasized that the most important factor in choosing an elite-level sport discipline is the child's own interest and desire. Respecting the child's preference, maintaining motivation, and prioritizing happiness were highlighted as essential. Rather than whether a discipline is considered "elite," what matters is the child's willingness to develop in that branch (P1, P5, P7).

P1: What the child loves is important… I don't separate sports into 'this branch is elite, that one is not.'

P5: Talent and interest are important. The child's own preference and physical suitability should be decisive in branch selection.

P7: The child's talent and happiness are important. If they are not interested in a branch, they cannot succeed in it.

Another prominent finding was that talent and physical suitability are decisive factors in branch selection. Participants stressed that children's innate abilities and physical structure should be considered when determining which discipline is most appropriate (P2, P3, P10).

P2: They should choose a branch in which they have ability… talent is necessary to prefer that branch.

P3: Whichever sport they have talent for, I think they can achieve better success with specialized guidance. I direct them according to what their physical condition allows.

P10: Talent and interest should be decisive. The child's physical suitability must also be considered.

Participants also emphasized the importance of infrastructure and facility opportunities in branch selection. The availability of development opportunities, coaching support, and facilities in the child's city or country were seen as determining factors (P2, P8).

P2: They must have opportunities to develop in that field in the city or country we live in. I pay attention to facilities, talent, and the coach's opinion.

P8: Talent and facility opportunities should be decisive. If there is infrastructure for that branch in the child's city, I support it.

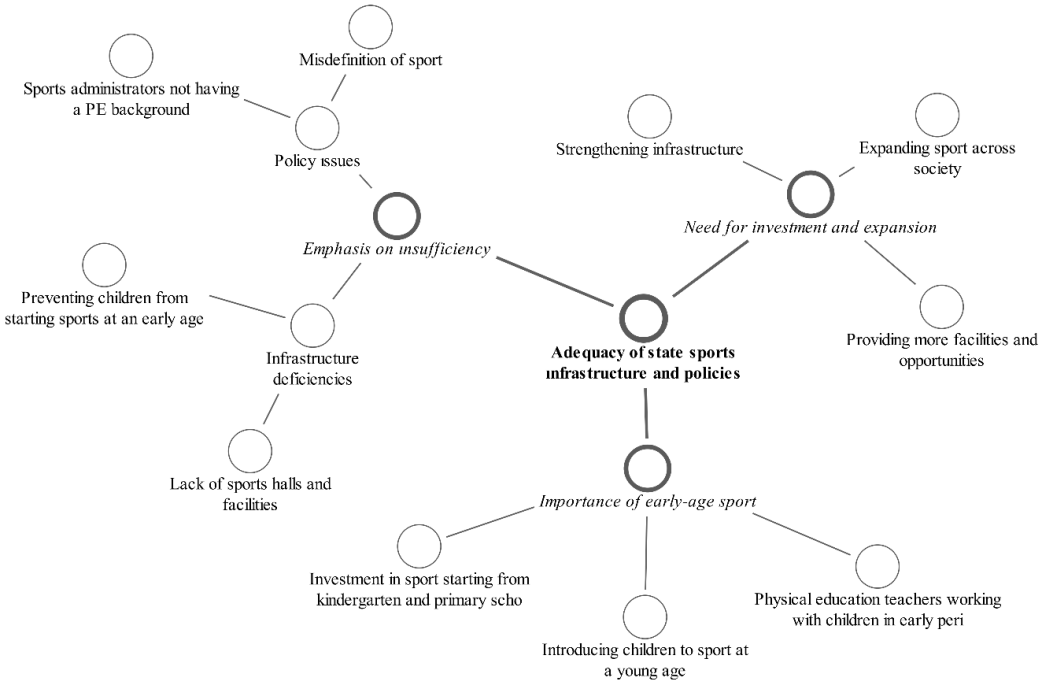

Figure 5. Participants' evaluations of the adequacy of state sports infrastructure and policies

Participants expressed strong views regarding the role of the state in sports infrastructure and policies, generally finding them inadequate. The most frequently mentioned issue was the lack of support for sport at an early age and insufficient facility development starting from primary school. The absence of gyms and facilities delays children's introduction to sport and hinders its widespread adoption (P1, P4, P6).

P1: All primary and secondary schools should have sports halls and facilities… otherwise it becomes too late.

P4: If the state invests from kindergarten and primary school onwards, the reflections in later years will be much better.

P6: Sport needs to be supported at younger ages and infrastructure strengthened.

Some participants highlighted that the shortcomings of state sport policies extend beyond infrastructure to managerial issues. They noted that sports administrators often lack a background in physical education and that sport is misdefined, reducing the effectiveness of policies (P2, P3).

P2: Unfortunately, in our country, those in positions of authority in sports management are not physical education specialists… I believe children should meet physical educators at much earlier ages.

P3: In Turkish society, people think sport is just running around a stadium or doing a few stretches… I believe we do not receive adequate support.

Additionally, participants emphasized the need for greater investment to ensure children encounter sport at an early age (P7).

P7: More investment should be made so that children can meet sport at an early age.

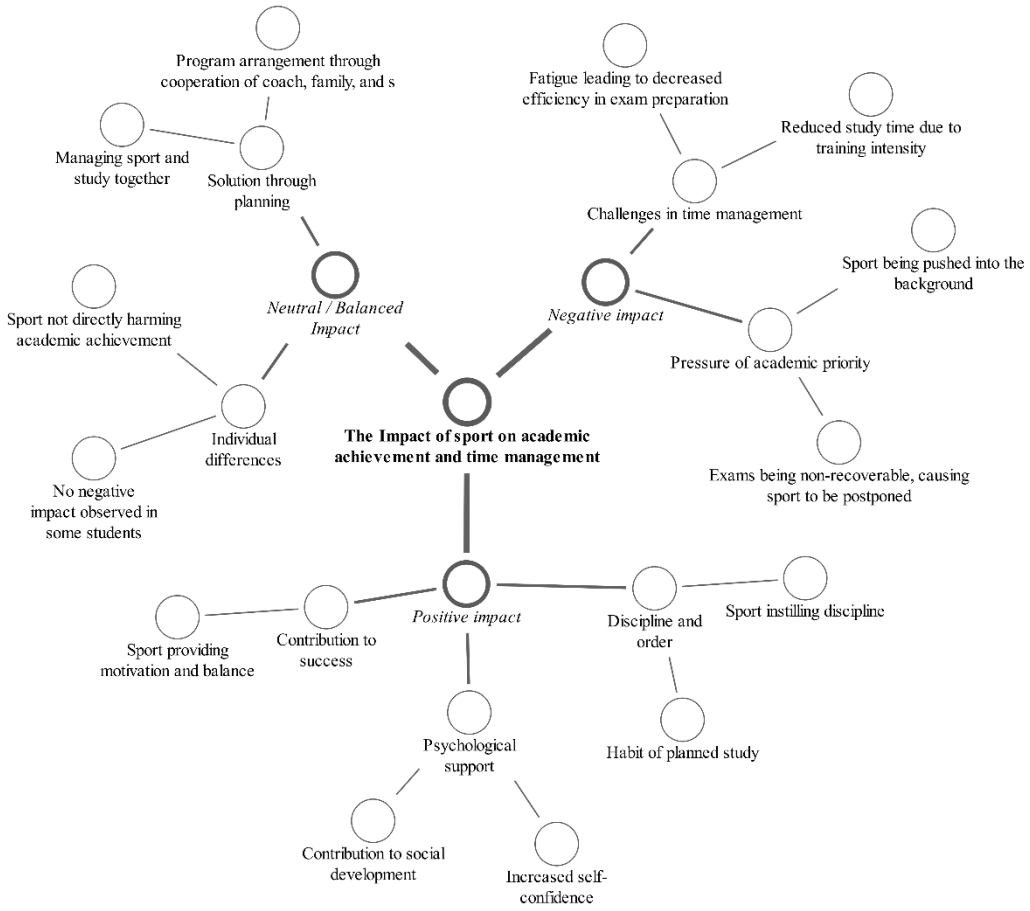

Figure 6. The influence of sports on academic performance and time management during exam periods

Participants evaluated the impact of sport on academic achievement and time management during exam periods in different ways. One group stated that intensive training programs make time management difficult and may negatively affect academic success. In these views, the irreversibility of exams, fatigue, and reduced study time were emphasized (P1, P2, P3).

P1: Unfortunately, in our country everything is indexed to academic success, so we prioritize it slightly. The intensity of training hours inevitably has an impact.

P2: Sport falls into second place during exam periods. However, sport can be compensated, exams cannot.

P3: Sport should be part of our lives, but if it is not pursued professionally, I believe a short break should be taken during exam periods.

Another group expressed that sport does not have a negative effect during exam periods; on the contrary, it provides discipline and order, helping with exam preparation. Findings highlighted that sport increases motivation and supports academic success (P4, P10).

P4: My child attends basketball training four days a week, and the teachers have also stated that these trainings have no negative effect on his academic performance.

P10: I do not think sport negatively affects my child's academic performance during exam periods. Sport provides discipline.

Some participants noted that sport creates both challenges and supportive effects during exam periods. While sport makes time management more difficult, it also contributes to self-confidence, discipline, and social development, thereby supporting academic success (P2, P5).

P2: I observe that sport falls into second place during exam periods. Sport can be compensated, but exams cannot.

P5: My child's involvement in sport can make time management difficult during exam periods. However, with proper planning, the disciplinary effect of sport supports academic success.

Discussion

In this study examining the support of parents with a sporting background for their children's participation in sport, parents emphasized that the impact of sport on academic achievement cannot be evaluated in a one-dimensional way. Some participants highlighted that sport develops discipline, focus, and motivation, supporting academic performance. Others stated that sport has a neutral effect, indicating that its impact varies according to individual characteristics and contextual conditions. During exam periods, sport presents a dual experience: intensive training and time management problems can negatively affect academic success, while self-confidence, discipline, and social development can support exam preparation. Knight and Holt (2014) and Jowett and Lavallee (2007) confirm that the quality of parental involvement shapes children's motivation and experiences. Zhang et al. (2022) argue that balanced parental involvement supports sustainable success in both sport and education. Critically, the impact of sport on academic achievement is multi-layered, shaped by personal characteristics, exam intensity, and parental support strategies. Therefore, balanced integration of sport into education is fundamental for sustaining both academic and personal development.

Parents' expectations regarding their children's sports activities are shaped around health, discipline, self-confidence, and socialization. Sport is perceived as a tool that enhances quality of life and supports personal development. Regarding professional athletic careers, most participants stated they would support their children's decisions based on individual happiness and talent. However, some parents stressed that academic achievement must remain a priority, while others associated professional careers with national identity and social values. Harwood and Knight (2015) and Ullrich-French and Smith (2006) show that supportive parental behaviours increase

self-determined motivation and commitment. Critically, balanced and supportive parental involvement is essential for sustaining children's success in both academic and sporting contexts. Most participants emphasized that sport should not allow gender discrimination, underlining equal opportunities based on talent and interest. However, some participants noted that cultural and religious norms limit girls' discipline choices, and that patriarchal thinking remains influential. Smoll and Smith (2002) and Bois et al. (2002) confirm that cultural norms and maternal expectations shape children's self-perceptions. Critically, while the egalitarian potential of sport is widely acknowledged, cultural and patriarchal norms actively restrict this potential. Reconstructing sport as an egalitarian domain requires systematic transformation of social norms, not only individual parental attitudes.

In elite-level sport discipline selection, parents prioritize the child's own desire and interest, maintaining motivation and happiness. Talent, physical suitability, infrastructure, and facility opportunities are also decisive factors. Laband and Lentz (1985) and Gao et al. (2024) confirm that genetic factors and parental attitudes shape motivational environments. Critically, elite sport branch selection gains meaning through the interaction of parental attitudes, genetic factors, and environmental conditions. Parents' evaluations of state sports infrastructure and policies are largely negative. Lack of early support and insufficient facility development from primary school are the most critical problems. Additionally, sports administrators often lack backgrounds in physical education, reducing policy effectiveness. Burke et al. (2024) and Hayre (2024) argue that parent education programmes and structured initiatives can reduce pressure and create healthier motivational environments. Critically, fundamental policy changes are needed for sport to be disseminated as an egalitarian and sustainable practice at the societal level.

The impact of sport during exam periods is multidimensional. Some parents stated that intensive training limits study time, pushing sport into the background. Others expressed that sport provides discipline and order, supporting exam preparation. Some noted both challenges and supportive effects. Thórsson and Ólafsdóttir (2024) and Zhang et al. (2022) confirm these contrasting effects. Critically, parents' attitudes and sports policies directly determine the impact of sport on students during exam periods. Based on these findings, the following practical implications are proposed. State sports policies should prioritize facility development and infrastructure investments from primary school level, with sports administrators selected from experts in physical education. Structured parental education programmes should reduce coercive attitudes and strengthen autonomy-supportive practices. Policies aimed at transforming cultural norms are necessary to eliminate gender discrimination, guaranteeing equal access for both girls and boys. Local-level facilities and qualified coaching support should be expanded. Flexible training programmes and time management strategies should be developed to balance sport with academic success during exam periods.

This study has several limitations. The research was conducted with only 15 parents, limiting generalizability; future research should use larger and more diverse samples. The qualitative design lacked quantitative measurements; future studies should adopt mixed methods. The study was conducted solely in Turkey without cross-cultural comparisons; future research should

examine different countries. The cross-sectional design did not assess long-term effects; longitudinal designs are needed. Parents' perceptions of sports policies were revealed but policy implementation effectiveness was not analysed; future studies should empirically investigate these factors.

Conclusion

This study reveals that sport is perceived not merely as a physical activity but as a tool for discipline, self-confidence, socialization, and quality of life. The relationship between academic achievement and sport is not unidirectional; during exam periods, sport can exert both supportive and challenging effects. Parents' approaches to professional athletic careers vary some prioritize happiness and talent, while others emphasize balancing sport with academic success. The egalitarian nature of sport is widely recognized, yet cultural and patriarchal norms limit this potential, particularly in girls' discipline choices. Elite discipline selection requires joint evaluation of the child's desire, talent, physical suitability, and available infrastructure. In conclusion, sport plays a central role in children's personal development and social value production. Future longitudinal and cross-cultural research is needed to clarify how parental support interacts with diverse cultural and policy environments over time.

Declarations

Ethical Declaration and Informed Consent:

This study was conducted with the necessary permissions from relevant authorities, and all procedures adhered to the Helsinki Declaration and international ethical standards. Participants' rights, safety, and confidentiality were protected, and data were used solely for academic purposes. Before participation, individuals were fully informed about the study's objectives, scope, and procedures through written and verbal explanations. Participation was voluntary, with no pressure applied. All participants signed informed consent forms prior to interviews, agreeing to take part. Their identities were kept confidential and represented only through codes (e.g., P1, P2…). Data were restricted to academic use, and participants retained the right to withdraw at any time. Interviews lasted approximately 30–35 minutes, and audio recordings were used exclusively by the research team for analysis. Researchers ensured privacy by securely storing data and preventing third-party access. Participants were informed that findings might be published in academic outlets, with explicit assurance that personal identities would not be disclosed.

Conflicts of interest:

The authors report no personal, academic, or financial conflicts that may have impacted this publication.

Funding declaration:

This research received no external funding.

Data availability statement:

The qualitative data used in this study were obtained through semi-structured interviews conducted with participants. The data were collected solely for academic purposes and anonymized to protect participant confidentiality. Identity information was coded (e.g., P1, P2…) and no personal details were disclosed. Raw datasets used in the research were accessible only to the research team, within the framework of institutional permissions and informed consent. Due to the obligation to protect participant confidentiality, the data are not publicly shared. However, academics wishing to verify the findings or conduct re-analysis may request limited access by contacting the authors of the article, in accordance with ethical guidelines.

References

1. Babkes, M. L., & Weiss, M. R. (1999). Parental influence on children's cognitive and affective responses to competitive soccer participation. *Pediatric exercise science, 11*(1), 44-62.

2. Baker, J., Horton, S., Robertson-Wilson, J., & Wall, M. (2003). Nurturing sport expertise: factors influencing the development of elite athlete. *Journal of Sports Science & Medicine*, *2*(1), 1-9. https://pmc.ncbi.nlm.nih.gov/articles/PMC3937568/

3. Baxter-Jones, A. D. G., & Maffulli, N. (2003). Parental influence on sport participation in elite young athletes. *Journal of Sports Medicine and Physical Fitness*, *43*(2), 250-255.

4. Bois, J. E., Sarrazin, P. G., Brustad, R. J., Trouilloud, D. O., & Cury, F. (2002). Mothers' expectancies and young adolescents' perceived physical competence: A yearlong study. *The Journal of Early Adolescence, 22*(4), 384-406.

5. Bowker, A., Boeknoven, B., Nolan, A., Bauhaus, S., Glover, P., Powell, T., et al. (2009). Naturalistic observations of spectator behavior at youth hockey games. *The Sport Psychologist, 23*,301e316. https://doi.org/10.1123/tsp.23.3.301

6. Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qual Res Psychol, 3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

7. Burke, S., Sharp, L. A., Woods, D., & Paradis, K. F. (2024). Enhancing parental support through parent-education programs in youth sport: A systematic review. *International Review of Sport and Exercise Psychology, 17*(1), 208-235.

8. Creswell, J. W. (2018). *Qualitative ınquiry & esearch design choosing among five approach.* Sage Publications.

9. Darling, N., & Steinberg, L. (1993). Parenting style as context: An integrative model. *Psychological Bulletin, 113*(3), 487–496. https://doi.org/10.1037/0033-2909.113.3.487

10. Dorsch, T. E., Wright, E., Eckardt, V. C., Elliott, S., Thrower, S. N., & Knight, C. J. (2021). A history of parent involvement in organized youth sport: A scoping review. *Sport, Exercise, and performance psychology, 10*(4), 536.

11. Gao, Z., Chee, C. S., Norjali Wazir, M. R. W., Wang, J., Zheng, X., & Wang, T. (2024). The role of parents in the motivation of young athletes: a systematic review. *Frontiers in psychology*, *14*, 1291711.

12. Gould, D., Lauer, L., Rolo, C., Jannes, C., & Pennisi, N. (2008). The role of parents in tennis success: Focus group interviews with junior coaches. *The sport psychologist, 22*(1), 18-37. https://doi.org/10.1123/tsp.22.1.18

13. Görgüt, İ., & Köylü, D. (2023). Masa tenisi branşına karşı ebeveynlerin bakış açısı. *Spor Ve Performans Araştırmaları Dergisi*, *14*(3), 293-314. https://doi.org/10.17155/omuspd.1272353

14. Harwood, C., Drew, A., & Knight, C. J. (2010). Parental stressors in professional youth football academies: a qualitative investigation of specialising stage parents. *Qualitative Research in Sport and Exercise*, 2,39-55. https://doi.org/10.1080/19398440903510152

15. Harwood, C. G., & Knight, C. J. (2015). Parenting in youth sport: A position paper on parenting expertise. *Psychology of Sport and Exercise*, *16*, 24-35. https://doi.org/10.1016/j.psychsport.2014.03.001

16. Hayre, R. S. (2024). *The impact of parental involvement and perceived parental pressure on athletes: a meta-analytic review*. (PhD thesis), Simon Fraser University.

17. Horn, T. S. (2008). *Advances in sport psychology*. Human kinetics.

18. Holt, N., & Knight, C. (2014). *Parenting in youth sport: From Research to practice* (1st ed.). Routledge. https://doi.org/10.4324/9780203798553

19. Jowett, S., & Lavallee, D. (Eds.). (2007). *Social psychology in sport. Human Kinetics*.

20. Kidman, L., McKenzie, A., & McKenzie, B. (1999). The nature and target of parents' comments during youth sport competitions. *Journal of Sport Behavior*, *22*,54-68.

21. Knight, C. J., & Holt, N. L. (2014). Parenting in youth tennis: understanding and enhancing children's experiences. *Psychology of Sport and Exercise, 15*,155e164. https://doi.org/10.1016/j.psychsport.2013.10.010

22. Laband, D. N., & Lentz, B. F. (1985). *The roots of success: Why children follow in their parents' career footsteps*. New York: Praeger.

23. Lauer, L., Gould, D., Roman, N., Pierce, M. (2010). Parental behaviors that affect junior tennis player development. *Psychology of sport and exercise, 11*(6), 487-496. https://doi.org/10.1016/j.psychsport.2010.06.008

24. Lincoln, Y.S., & Guba, E.G. (1985). *Naturalistic inquiry*. Newbury Park (CA): Sage.

25. Merriam, S. B. (2009). *Qualitative research: A Guide to design and ımplementation*. Jossey-Bass.

26. Patton, M. Q. (2002). *Qualitative research & evaluation methods*. Thousand Oaks (CA): Sage Publications.

27. Rowe, D. C. (1994). The limits of family influence: Genes, experience, and behavior. New York: Guilford Press.

28. Schader, R. M. (2001). *Perceptions of elite female athletes regarding success attributions and the role of parental influence on talent development*. [Order No. 3038047]. University of Connecticut.

29. Smoll, F. L. and Smith, R. E. (2002). *Children and youth in sport: A biopsychosocial perspective*. Dubuque, IA: Kendall/Hunt.

30. Smith, A. L., & Biddle, S. J. (2008). *Youth physical activity and sedentary behavior: challenges and solutions*. Human Kinetics.

31. **Thórsson, B., & Ólafsdóttir, S. (2024).** *Parental involvement and its influence on academic achievement: A cross-cultural analysis. International Journal of Educational Development, 1(1), 16–20.*

32. Ullrich-French, S., & Smith, A. L. (2006). Perceptions of relationships with parents and peers in youth sport: Independent and combined prediction of motivational outcomes. *Psychology of sport and exercise, 7*(2), 193-214.

33. Wolfenden, L. E., & Holt, N. L. (2005). Talent development in elite junior tennis: Perceptions of players, parents, and coaches. *Journal of Applied Sport Psychology, 17*(2), 108-126. https://doi.org/10.1080/10413200590932416.

34. Yıldırım, A., & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri.* Seçkin Yayıncılık.

35. Zhang, D., Hong, J., Chen, S., & Liu, Y. (2022). Associations of physical activity with academic achievement and academic burden in Chinese children and adolescents: do gender and school grade matter? *BMC Public Health*,*22*(1), 1496.

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REVIEW

Traditional Fitness Gym Training Effects on Cardiovascular Parameters, Body Composition, and Posture in Adolescents: A 15-Year Review

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Abstract

Adolescence represents a critical developmental period for the maturation of cardiovascular, metabolic, and musculoskeletal systems. Declining physical activity and increasing sedentary behaviour during this stage are associated with cardiometabolic risk, body composition changes, and postural deviations. Traditional fitness gym training combining aerobic and resistance exercise performed on machines in supervised indoor environments may simultaneously target these health domains. This review aimed to identify and synthesize evidence on the effects of gym-based aerobic and resistance exercise on cardiovascular parameters, body composition, and posture in adolescents. Materials and Methods: A structured literature search was conducted in PubMed, PubMed Central (PMC), and HINARI databases to identify intervention studies published between 2009 and 2025. Eligible studies included adolescents aged 10 to 19 years engaged in supervised gym or indoor facility programs using aerobic and/or resistance equipment. Outcomes included cardiorespiratory fitness, cardiometabolic indicators, body composition, and postural assessments. Randomized controlled trials, non-randomized controlled trials, and quasi-experimental studies were included. Results: A total of ten analytical units fulfilled the inclusion criteria. Interventions generally spanned 8 to 22 weeks, with 2 to 4 sessions weekly. Combined aerobic and resistance training was associated with improvements in cardiorespiratory fitness (VO_2peak), reductions in body fat, and increases in lean mass. Resistance-focused interventions were associated with improvements in blood pressure and body composition. Three studies evaluated postural outcomes, suggesting potential improvements in trunk endurance and postural alignment. Conclusions: Supervised gym-based aerobic and resistance training is associated with improvements in cardiovascular fitness and body composition in adolescents and may contribute to postural improvements, although current evidence for posture remains limited. These findings suggest that structured gym-based programs may represent a useful strategy for adolescent health promotion; however, further high-quality research is needed.

Keywords: adolescents, gym-based training, resistance training, aerobic exercise, cardiovascular fitness, body composition, posture.

1. Introduction

Adolescence represents a critical developmental phase for establishing cardiovascular, metabolic, and musculoskeletal health trajectories that extend into adulthood. Cardiorespiratory fitness during youth is a strong predictor of future cardiovascular morbidity and mortality (Ortega et al., 2008). However, global trends indicate a decline in physical activity levels alongside an increase in sedentary behaviors among adolescents, contributing to the rising prevalence of cardiometabolic risk factors, unfavorable body composition, and postural abnormalities (WHO, 2020). These patterns highlight the need for structured and effective exercise interventions targeting multiple health domains in this population.

Traditional fitness gym environments provide a controlled and adaptable setting in which adolescents can engage in both aerobic and resistance training using machines or free weights. Aerobic exercise, such as treadmill or cycle ergometer training, enhances cardiovascular function through central and peripheral adaptations, including increased stroke volume and improved oxygen transport capacity. In contrast, resistance training promotes skeletal muscle hypertrophy, metabolic regulation, and musculoskeletal stability (Faigenbaum et al., 2013). Evidence suggests that combining aerobic and resistance training may lead to significant improvements in cardiorespiratory fitness and reductions in adiposity among adolescents (Mendonça et al., 2022; Sigal et al., 2014).

During adolescence, body composition is particularly responsive to resistance-based exercise due to rapid hormonal and musculoskeletal development. Supervised strength training in gym settings has been shown to increase lean body mass and reduce fat mass, contributing to improved metabolic profiles and a lower risk of cardiovascular disease and type 2 diabetes (Santos et al., 2020). Moreover, multimodal training approaches that integrate different exercise types appear to be more effective in improving overall fitness and body composition compared to single-modality interventions (Cohen et al., 2021).

In addition to cardiovascular and metabolic benefits, resistance-based gym training may positively influence postural health. Strengthening the trunk and scapular stabilizing muscles enhances neuromuscular control and spinal alignment, thereby reducing common postural deviations in adolescents, such as forward head posture and shoulder protraction (Ruivo et al., 2017). Although posture is less frequently assessed in exercise research, existing evidence suggests that structured resistance and flexibility programs can improve musculoskeletal alignment during this critical developmental stage.

Despite these documented benefits, most research on adolescent exercise interventions has been conducted in school or sports-specific settings rather than in conventional fitness facilities. Consequently, the specific effects of supervised, machine-based indoor gym training on cardiovascular parameters, body composition, and postural outcomes in adolescents have not been comprehensively synthesized. Furthermore, the limited availability of randomized controlled trials in healthy adolescent populations necessitates the inclusion of non-randomized and quasi-

experimental studies to better reflect real-world training environments. Therefore, the purpose of this review is to identify and synthesize existing evidence on the effects of supervised conventional fitness facility training incorporating aerobic and resistance machine-based exercises on cardiovascular parameters, body composition, and postural outcomes in adolescent populations.

2. Materials and Methods

This study was conducted as a structured narrative review with a systematic search strategy examining the effects of supervised gym-based aerobic and resistance training on cardiovascular parameters, body composition, and posture in adolescents.

Search strategy

A comprehensive literature search was performed across electronic databases including PubMed, PubMed Central (PMC), and HINARI to identify relevant studies published between January 2009 and January 2025. Additional records were screened from reference lists of eligible articles to ensure completeness. Although supplementary sources such as journal publisher platforms were consulted for full-text access, they were not used as primary search databases.

The search strategy combined keywords and Boolean operators related to the population, intervention, and outcomes of interest. Search terms included "adolescent" OR "youth" AND "resistance training" OR "strength training" OR "aerobic training" OR "gym-based" OR "machine-based exercise" AND "cardiovascular" OR "VO_2peak" OR "blood pressure" OR "body composition" OR "posture." The search strategy was adapted as necessary for each database.

Study selection process

All identified records were imported and screened in a two-stage process. First, titles and abstracts were reviewed to exclude clearly irrelevant studies. Subsequently, full-text articles were assessed for eligibility based on the predefined inclusion criteria. The screening process was conducted independently by two reviewers, and any discrepancies were resolved through discussion and consensus.

Eligibility criteria

Studies were considered eligible if they included adolescent participants aged between 10 and 19 years and investigated supervised exercise interventions conducted in gym or indoor fitness facilities. Eligible interventions included aerobic training, resistance training, or a combination of both, performed using machines or structured equipment. Studies were required to report at least one of the following outcomes: cardiovascular parameters (such as VO_2peak or blood pressure), body composition, or postural measures. Both randomized controlled trials and non-randomized intervention studies with pre–post or controlled designs were included. Only full-text articles published in peer-reviewed journals and written in English were considered. Traditional fitness gym training was defined as supervised exercise performed in indoor fitness or school-based

facilities using resistance machines and/or aerobic equipment (e.g., treadmill, cycle ergometer). Studies including minor complementary components (e.g., plyometric or bodyweight exercises) were included only if the primary intervention consisted of supervised machine-based resistance or aerobic training.

Data extraction

Data from the included studies were systematically extracted using a standardized approach. Extracted information included study design, sample characteristics, intervention type and duration, training frequency, and reported outcomes related to cardiovascular health, body composition, and posture. The extraction process was performed independently by the reviewers to ensure accuracy.

Quality assessment and risk of bias

The methodological quality of the included studies was evaluated using appropriate criteria based on study design. Randomized controlled trials were assessed for potential sources of bias including randomization procedures, allocation concealment, and outcome reporting, while non-randomized studies were evaluated for selection bias, intervention consistency, and outcome measurement reliability. Given the heterogeneity of study designs and outcome measures, a qualitative assessment of methodological quality was conducted rather than a quantitative scoring system.

Data synthesis

Due to the variability in study designs, intervention protocols, and outcome measures, a meta-analysis was not feasible. Therefore, a narrative synthesis approach was used to summarize the findings. Results were grouped according to the primary outcomes of interest, including cardiovascular parameters, body composition, and postural adaptations. In cases where multiple studies shared highly similar intervention characteristics and outcomes, they were grouped and analyzed as a single analytical unit to facilitate synthesis. The review protocol was not registered (e.g., PROSPERO), which represents a potential limitation.

3. Results

Study selection and characteristics

The database search identified a total of 120 records. After the removal of 20 duplicate records, 100 studies remained for title and abstract screening. Of these, 75 were excluded based on irrelevance to the topic.

A total of 25 full-text articles were assessed for eligibility. Fifteen studies were excluded due to not meeting the inclusion criteria, including non-gym-based interventions, absence of relevant outcomes, or inappropriate population.

Finally, 10 studies met the inclusion criteria and were included in the qualitative synthesis (Figure 1).

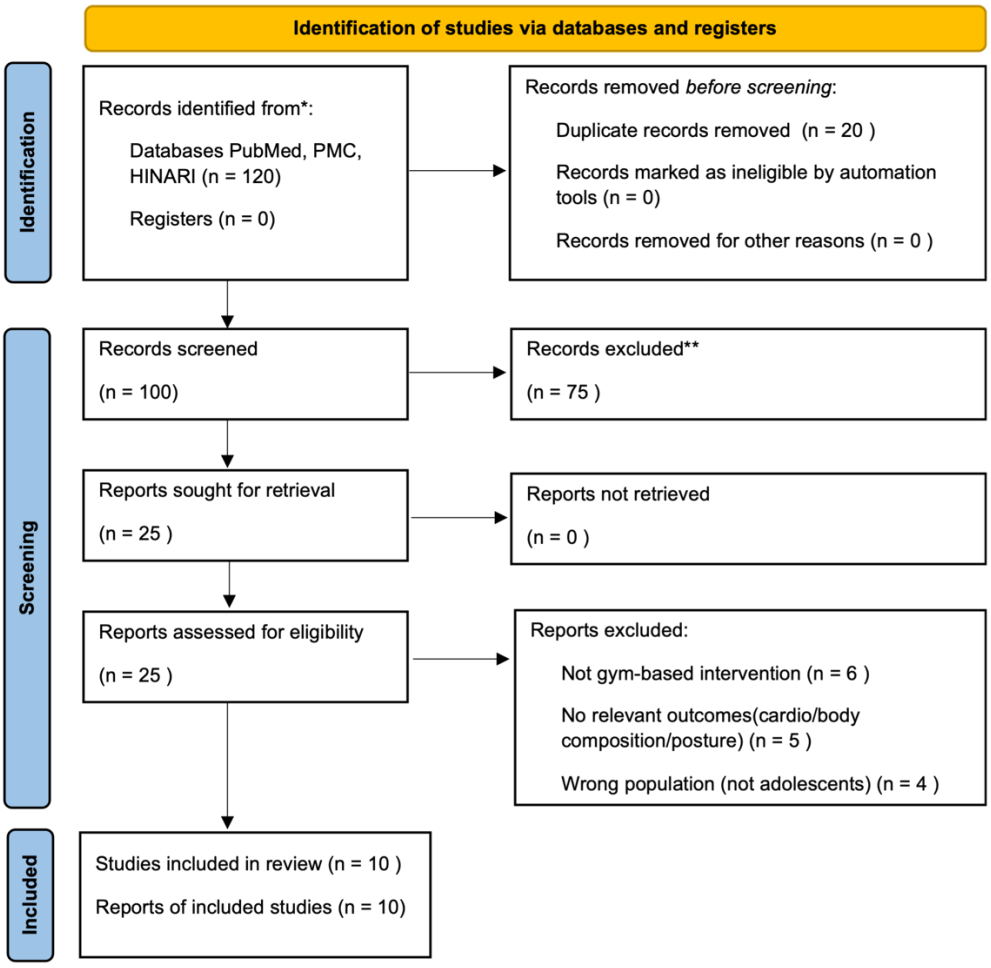

Figure 1. PRISMA flow diagram of study selection

Study characteristics

A total of 10 analytical units were included in this review. One category represents a synthesis of multiple school-based resistance training studies conducted between 2009 and 2015, which were grouped due to their methodological and intervention similarities.

The sample sizes ranged from 40 to 96 participants, with ages between 12 and 17 years. Six studies implemented combined aerobic and resistance training in school gyms or fitness centers, while four focused primarily on resistance-based programs. Intervention durations ranged from 8 to 22 weeks, with training frequencies of 2 to 4 sessions per week.

Cardiorespiratory fitness consistently improved in studies involving combined training protocols (Tjønna et al., 2009; Sigal et al., 2014; Cohen et al., 2021; Mendonça et al., 2022), with reported

increases in VO_2peak and reductions in blood pressure. Resistance-focused interventions demonstrated significant improvements in body composition, including reductions in fat mass and increases in lean mass (Lubans et al., 2012; Santos et al., 2020; Wan et al., 2025).

Additionally, resistance-machine training programs conducted in school settings showed consistent improvements in muscular strength and reductions in adiposity. Three studies assessed postural outcomes, all reporting improvements in trunk endurance and reductions in forward head posture or shoulder protraction (Ruivo et al., 2017; Cohen et al., 2021; Mendonça et al., 2022), although these findings are based on a limited number of studies.

Overall, the evidence suggests that supervised gym-based aerobic and resistance training contributes to improvements in cardiovascular fitness, body composition, and postural stability in adolescents. All of these details are summarized in Table 1.

Table 1. Summary of Included Gym-Based Training Studies in Adolescents (2009–2025)

Authors	Year	Sample (age)	Design	Intervention	Duration	Outcomes
Tjønna et al.	2009	51 overweight (14–16 y)	RCT	Aerobic interval + resistance	12 weeks, 3 sessions/week	↑VO_2peak, ↓BP, ↓fat %, ↑insulin sensitivity
School-based resistance training programs (multiple studies)	2010-2015	30–70 (12–17 y)	Pre–post	Resistance machines (school gyms)	8–12 weeks	↑strength, ↓fat mass
Lubans et al.	2012	60 (13–15 y)	Quasi-experimental	Resistance machines	8 weeks, 2 sessions/week	↓fat %, ↑lean mass
Sigal et al. (HEARTY trial)	2014	96 (13–17 y)	RCT	Aerobic vs resistance vs combined training	22 weeks, 4 sessions/week	↑VO_2peak, ↓BP, ↓fat %, ↓waist circumference
Ruivo et al.	2017	45 (14–16 y)	Quasi-experimental	Resistance training + trunk/scapular exercises	12 weeks, 2 sessions/week	↓forward head posture, ↑trunk endurance
Santos et al.	2020	52 (13–16 y)	RCT	Resistance machines	12 weeks, 2–3 sessions/week	↓SBP, ↓fat %, ↑lean mass
Cohen et al. (SIMAC trial)	2021	56 (14–16 y)	RCT	Combined aerobic and resistance training vs PE	16 weeks, 3 sessions/week	↑VO_2peak, ↑lean mass, ↑trunk endurance
Mendonça et al.	2022	48 (13–16 y)	RCT	Aerobic + resistance machines	12 weeks, 2 sessions/week	↑VO_2peak, ↓fat %, ↑lean mass

Wan et al.	2025	40 girls (12–15 y)	RCT	Resistance + plyometric training	12 weeks, 2–3 sessions /week	↑lean mass, ↓fat %, ↑strength

Notes. Abbreviations: RCT = randomized controlled trial; BP = blood pressure; SBP = systolic blood pressure; VO_2peak = peak oxygen uptake; PE = physical education. Symbols: ↑ indicates a significant increase or improvement; ↓ indicates a significant decrease or reduction. The category "School-based resistance training programs (multiple studies)" represents four individual studies (Faigenbaum et al., 2010; Granacher et al., 2011; Santos et al., 2012; Lubans et al., 2012), which were grouped and analyzed as a single analytical unit due to similarities in intervention design, population, and outcomes.

The included studies demonstrate a consistent pattern of positive adaptations following supervised gym-based training interventions in adolescents. Despite variations in study design, intervention duration, and training protocols, most studies reported improvements in cardiovascular fitness, body composition, and, where assessed, postural outcomes. Combined aerobic and resistance training interventions appeared to yield the most comprehensive benefits, particularly in terms of VO_2peak and cardiometabolic markers. Resistance-focused programs were especially effective in improving body composition by increasing lean mass and reducing fat mass.

Notably, school-based resistance training interventions showed comparable effectiveness to structured gym-based programs, suggesting that supervised machine-based training can be successfully implemented in both educational and fitness facility settings. Although fewer studies evaluated postural outcomes, available evidence indicates that targeted resistance training may contribute to improvements in trunk stability and postural alignment.

Discussion

This review synthesized 15 years of evidence examining the effects of supervised traditional fitness-facility training characterized as structured aerobic and resistance exercises conducted on machines in indoor gym settings on cardiovascular health, body composition, and postural outcomes in healthy adolescents. Randomized controlled trials, quasi-experimental studies, and controlled pre–post designs generally indicate that gym-based training improves cardiorespiratory fitness, resting cardiovascular parameters, and body composition, while emerging evidence suggests potential postural adaptations (Tjønna et al., 2009; Faigenbaum et al., 2010; Sigal et al., 2014).

The most consistent finding was an improvement in cardiorespiratory fitness, often assessed by VO_2peak or shuttle-run performance. Improvements were observed in both machine-based aerobic training (e.g., treadmill or cycle ergometer) and combined aerobic–resistance programs relative to control groups (Ortega et al., 2008; Cohen et al., 2021). Similar patterns were observed in school-based resistance-training interventions; however, aerobic adaptations tended to be more pronounced in programs incorporating higher-intensity components (Lubans et al., 2012; Santos et al., 2020). These findings are consistent with known physiological adaptations to endurance training during adolescence.

Resistance-training interventions were also associated with improvements in cardiometabolic markers, including reductions in resting blood pressure and improvements in body composition. Evidence suggests that increases in skeletal muscle mass may contribute to improved metabolic regulation and vascular function (Faigenbaum et al., 2013; Ortega et al., 2008). Combined aerobic and resistance training approaches appeared to provide broader benefits across multiple outcomes compared to single-modality interventions (Sigal et al., 2014; Cohen et al., 2021).

Body composition outcomes were relatively consistent across studies, with resistance-based training associated with increases in lean mass and reductions in fat mass. Interventions lasting at least 12 weeks and conducted 2–3 times per week appeared to be associated with more pronounced effects, suggesting a potential dose–response relationship (Tjønna et al., 2009; Santos et al., 2020; Wan et al., 2025).

Fewer studies examined postural outcomes; however, some improvements in spinal alignment, trunk stability, and shoulder positioning were reported following resistance training programs targeting core and scapular musculature (Ruivo et al., 2017; Mendonça et al., 2022). These findings should be interpreted with caution, as they are based on a limited number of studies and heterogeneous assessment methods. It is possible that improvements in neuromuscular control and reductions in adiposity contribute indirectly to postural adaptations.

Overall, the available evidence suggests potential effectiveness of supervised gym-based training for adolescents across multiple health domains, although findings should be interpreted with caution due to study heterogeneity and methodological limitations.

Limitations

This review has several limitations that should be acknowledged. First, the number of included studies was relatively small, and the interventions varied considerably in terms of duration, frequency, and training modalities, which limits comparability across studies. Second, outcome measures were heterogeneous, particularly for cardiovascular and postural assessments, reducing the ability to draw consistent conclusions. Third, only a limited number of studies evaluated postural outcomes, and these findings should therefore be considered preliminary. Additionally, most studies lacked long-term follow-up, making it difficult to assess the sustainability of observed benefits into adulthood. The absence of a formal quantitative risk-of-bias assessment and the lack of protocol registration may also affect the methodological robustness of the review. Finally, the possibility of publication bias cannot be excluded.

Conclusion

This review suggests that supervised traditional gym-based training using aerobic and resistance equipment in indoor fitness settings may provide beneficial effects on cardiovascular fitness and body composition in adolescents. Resistance-based interventions appear to be associated with increases in lean mass and reductions in fat mass, while combined training approaches may offer broader cardiometabolic benefits.

Evidence related to postural outcomes remains limited; however, preliminary findings indicate that targeted resistance training may contribute to improvements in trunk stability and postural alignment. These findings should be interpreted with caution due to the small number of available studies.

Overall, current evidence tentatively supports the inclusion of supervised gym-based training as a component of adolescent health promotion programs. Nevertheless, further high-quality randomized controlled trials using standardized outcome measures and long-term follow-up are needed to strengthen the evidence base. Future research should prioritize the use of standardized and validated postural assessment tools to strengthen the evidence base in this area.

References

1. Cohen, D. D., Gómez-Arbeláez, D., Camacho, P. A., Pinzón, S., Hormiga, C., Trejos-Suárez, J., & Lopez-Jaramillo, P. (2021). Effects of a school-based combined aerobic and resistance training program on physical fitness, body composition, and posture in adolescents: The SIMAC randomized controlled trial. *Journal of Strength and Conditioning Research, 35*(8), 2208–2216. https://doi.org/10.1519/JSC.0000000000003123
2. Faigenbaum, A. D., Myer, G. D., Farrell, A., Radler, T., Fabiano, M., Kang, J., Ratamess, N., & Hewett, T. E. (2010). Integrative neuromuscular training and resistance exercise in adolescents: Effects on fitness and body composition. *Pediatric Exercise Science, 22*(2), 240–253. https://doi.org/10.1123/pes.22.2.240
3. Faigenbaum, A. D., Kraemer, W. J., Blimkie, C. J. R., Jeffreys, I., Micheli, L. J., Nitka, M., & Rowland, T. W. (2013). Youth resistance training: Updated position statement paper from the National Strength and Conditioning Association. *Journal of Strength and Conditioning Research, 27*(Supplement 1), S1–S50. https://doi.org/10.1519/JSC.0b013e31829a63b0
4. Granacher, U., Schellbach, J., Klein, K., Prieske, O., Baeyens, J.-P., & Muehlbauer, T. (2011). Effects of core strength training using stable and unstable surfaces on physical fitness and trunk strength in adolescents. *Journal of Strength and Conditioning Research, 25*(11), 311–318. https://doi.org/10.1519/JSC.0b013e3181fefb0c
5. Lubans, D. R., Smith, J. J., Harries, S. K., Barnett, L. M., & Faigenbaum, A. D. (2012). School-based resistance training for adolescents: Effects on muscular fitness and body composition. *Medicine & Science in Sports & Exercise, 44*(10), 1921–1927. https://doi.org/10.1249/MSS.0b013e31825f7e1c
6. Mendonça, G. V., Nunes, J. P., Oliveira, A. C., Cyrino, E. S., & Sardinha, L. B. (2022). Effects of combined aerobic and resistance exercise training on cardiometabolic health and physical fitness in adolescents: A randomized controlled trial. *Pediatric Exercise Science, 34*(3), 157–165. https://doi.org/10.1123/pes.2021-0123
7. Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity, 32*(1), 1–11. https://doi.org/10.1038/sj.ijo.0803774

8. Ruivo, R. M., Pezarat-Correia, P., & Carita, A. I. (2017). Effects of resistance training on forward head posture and shoulder alignment in adolescents. *Journal of Bodywork and Movement Therapies, 21*(2), 347–352. https://doi.org/10.1016/j.jbmt.2016.06.005
9. Santos, F. R., Silva, A. M., Minderico, C. S., & Sardinha, L. B. (2012). Effects of resistance circuit training on body composition and muscular fitness in adolescents. *European Journal of Sport Science, 12*(6), 497–504. https://doi.org/10.1080/17461391.2011.566363
10. Santos, F. R., Minderico, C. S., & Sardinha, L. B. (2020). Resistance training improves blood pressure and body composition in adolescents: A randomized controlled trial. *BMC Pediatrics, 20*, 200. https://doi.org/10.1186/s12887-020-02114-9
11. Sigal, R. J., Alberga, A. S., Goldfield, G. S., Prud'homme, D., Hadjiyannakis, S., Gougeon, R., Phillips, P., Tulloch, H., Doucette, S., Ma, J., & Kenny, G. P. (2014). Effects of aerobic training, resistance training, or both on body composition and cardiometabolic risk in obese adolescents: The HEARTY randomized trial. *JAMA Pediatrics, 168*(11), 1006–1014. https://doi.org/10.1001/jamapediatrics.2014.1462
12. Tjønna, A. E., Stølen, T. O., Bye, A., Volden, M., Slørdahl, S. A., Ødegård, R., Skogvoll, E., & Wisløff, U. (2009). Aerobic interval training reduces cardiovascular risk factors more than a multitreatment approach in overweight adolescents. *Clinical Science*, 116(4), 317–326. https://doi.org/10.1042/CS20080249
13. Wan, X., Li, Y., Chen, J., & Zhang, H. (2025). Effects of resistance and plyometric training on body composition and muscular fitness in pubertal girls. *Pediatric Exercise Science, 37*(1), 45–53. https://doi.org/10.1123/pes.2024-0087
14. Welk, G. J., Saint-Maurice, P. F., Laurson, K. R., & Kline, C. E. (2011). The relationship of physical activity and cardiorespiratory fitness to health outcomes in adolescents. *Journal of Physical Activity & Health, 8*(5), 659–667. https://doi.org/10.1123/jpah.8.5.659
15. WHO (World Health Organization). (2020). *Guidelines on physical activity and sedentary behaviour*. World Health Organization. https://doi.org/10.2471/9789240015128

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REVIEW

Video Modeling, Video Feedback, and Observational Learning in Basketball Free-Throw Performance: A Systematic Mini-Review

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Abstract

Free-throw performance represents a critical component of scoring efficiency in basketball and has been widely investigated in motor learning research. In recent years, video-based instructional strategies such as video modeling, observational learning, and video feedback have gained increasing attention as tools for enhancing sport skill acquisition. The aim of this systematic mini-review was to synthesize empirical evidence regarding the effectiveness of video-based observational interventions on basketball free-throw performance. A systematic search was conducted in Scopus, Web of Science, and Google Scholar for peer-reviewed studies published between 2000 and 2025. Following duplicate removal and PRISMA 2020 screening procedures, eight studies met the predefined inclusion criteria and were included in the qualitative synthesis, highlighting the still limited evidence base in this specific domain. The methodological quality of the selected studies was evaluated using a five-criterion appraisal checklist adapted from the PEDro framework (Maher et al., 2003). Overall, the findings indicate that video-based observational interventions are generally associated with improvements in free-throw accuracy, movement consistency, and retention compared with traditional practice conditions. These outcomes are consistent with theoretical perspectives from observational learning theory, schema theory, the mirror neuron system, and the OPTIMAL theory of motor learning. Although the current body of evidence remains relatively limited, the results suggest that structured video modeling and observational learning strategies may represent effective pedagogical tools for improving free-throw performance in basketball training contexts.

Keywords: basketball, free-throw, video modeling, observational learning, motor learning, skill acquisition

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1. Introduction

Free-throw shooting is one of the most fundamental technical skills in basketball and often represents a decisive factor in game outcomes (Nakai et al., 2018). Because free-throws are executed without defensive interference, they provide players with uncontested scoring opportunities and are frequently considered an indicator of individual shooting proficiency (Cabarkapa et al., 2023; Han et al., 2026). Despite the relatively stable conditions under which the skill is performed, successful free-throw execution requires precise biomechanical coordination, consistent motor control, and effective perceptual–cognitive regulation (Amaro et al., 2025; Okazaki et al., 2015). As a result, even experienced basketball players may demonstrate variability in free-throw accuracy.

From a motor learning perspective, the free-throw is typically classified as a closed motor skill, performed in a stable and predictable environment where movement execution depends largely on the performer's ability to reproduce a consistent motor pattern (Schmidt, 1975). Closed skills are particularly suitable for investigating instructional strategies designed to improve movement consistency and technical precision. Traditional coaching approaches for developing shooting skills generally rely on verbal instruction, repetitive practice, and occasional demonstrations of proper technique (Smith et al., 2023). While these methods remain widely used, they may not fully exploit the visual and cognitive processes involved in observational learning and motor skill acquisition.

Advances in digital technology have increasingly enabled the integration of video-based instructional strategies in sport training (Mičiak et al., 2026). Techniques such as video modeling, observational learning, and video feedback allow athletes to repeatedly observe skilled movement patterns and analyze the technical components of performance (Tannoubi et al., 2023; Trabelsi et al., 2025). These visual learning approaches can facilitate the development of internal representations of movement, which may enhance motor planning and execution during practice (Tannoubi et al., 2026; Williams & Hodges, 2005). In sport settings, video-based learning tools have therefore become widely used to support skill acquisition and performance analysis.

The theoretical foundation for video-based instructional strategies draws upon several complementary frameworks in motor learning. Because free-throw performance requires the integration of cognitive, perceptual, motivational, and neuromuscular processes, no single theory fully explains the potential benefits of observational interventions. Accordingly, the following perspectives collectively provide a multidimensional explanation of how video-based learning may enhance shooting performance (Williams & Hodges, 2005). Observational learning theory proposes that individuals can acquire new behaviors by observing and imitating others (Bandura, 1986). According to this framework, observing a model performing a motor task enables learners to encode relevant visual information and construct cognitive representations of the movement. These representations subsequently guide motor execution when the learner attempts to reproduce the skill.

Complementing this framework, schema theory posits that motor learning involves the formation of generalized motor programs abstract internal rules that guide movement across varied contexts (Schmidt, 1975; Schmidt & Lee, 2019). Repeated exposure to skilled demonstrations through video modeling may enrich the learner's motor schema for the free-throw by providing multiple exemplars of successful movement coordination. This enriched schema may support the adaptability and consistency of shooting performance under varying practice conditions.

Neuroscientific research provides additional support for the effectiveness of observational learning. Studies on the mirror neuron system indicate that observing an action activates neural networks like those engaged during physical execution of the same action (Rizzolatti & Craighero, 2004). This motor resonance may promote neural simulation processes that facilitate the acquisition and refinement of movement patterns prior to physical practice. Consequently, observing skilled free-throw performances may prime motor pathways and subsequently enhance physical practice efficiency.

A further relevant perspective is the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016), which emphasizes the joint contributions of an external focus of attention, enhanced expectancies of success, and learner autonomy in optimizing motor performance and learning. Video-based instructional strategies may align with these conditions by directing athletes' attention toward task-relevant performance cues, by highlighting successful movement executions that strengthen self-efficacy, and by offering athletes some control over when and how they review their performance.

In basketball, several experimental studies have examined the effects of video modeling and observational learning on shooting performance, particularly in relation to free-throw execution. Self-modeling and video feedback interventions have demonstrated improvements in shooting accuracy and motor learning outcomes (Aiken et al., 2012; Sheikhzadeh et al., 2025). More recent investigations have explored how observational modeling combined with attentional focus instructions or gaze training can influence both perceptual processes and shooting accuracy (Asadi et al., 2023; Nasri et al., 2025; Rezaei et al., 2023). Additional research has examined video-based instructional approaches within structured basketball training programs, reporting improvements in technical skill acquisition among novice players (Tannoubi et al., 2023). Experimental studies on free-throw learning have also highlighted the role of feedback and reinforcement mechanisms in supporting skill (Rafiee et al., 2019).

Despite the increasing interest in video-based instructional methods in basketball, evidence focusing specifically on free-throw performance remains limited and dispersed across studies using different intervention designs and participant populations. The free-throw represents a particularly meaningful unit of analysis because it is performed under standardized and repeatable conditions, minimizes defensive and contextual variability, and contributes directly to match outcomes. These characteristics make the free-throw especially suitable for evaluating instructional strategies aimed

at improving technical consistency and motor learning (Choo et al., 2024; Han et al., 2022; Law & Hall, 2009).

Therefore, the purpose of this systematic mini-review was to synthesize empirical evidence on the effectiveness of video modeling, video feedback, and observational learning interventions for improving basketball free-throw performance. By reviewing experimental studies published between 2000 and 2025, this review aims to provide a clearer understanding of how video-based instructional strategies influence shooting accuracy and motor learning in basketball, and to identify practical implications for coaches and future research directions.

2. Methods

2.1 Literature Search

A systematic literature search was conducted to identify empirical studies examining the effects of video-based observational interventions on basketball shooting performance. The search was performed in three electronic databases: Scopus, Web of Science, and Google Scholar. Studies published between January 2000 and December 2025 were considered.

The search strategy combined keywords related to video-based instructional approaches and basketball shooting performance. Boolean operators were used to structure the search strings. The primary search string used in Scopus and Web of Science was: ("video modeling" OR "video modelling" OR "observational learning" OR "video feedback" OR "self-modeling" OR "self modelling") AND basketball AND ("free-throw" OR "free-throw" OR shooting). Minor adaptations of this syntax were applied to meet the indexing requirements of each database. For Google Scholar, the first 200 records sorted by relevance were screened for each search string. This cutoff was selected to balance search comprehensiveness with feasibility, as relevance-ranked results beyond this range typically show substantial declines in pertinence and increased duplication. Nevertheless, potentially eligible studies beyond this threshold may have been missed. The review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines.

2.2 Inclusion Criteria

Studies were included if they met the following criteria: (a) published in a peer-reviewed journal between 2000 and 2025, (b) written in English, (c) investigated basketball shooting performance, with a primary focus on free-throw outcomes or standardized shooting tasks closely related to the free-throw, (d) implemented a video modeling, video feedback, or observational learning intervention, and (e) reported quantitative performance outcomes such as accuracy, success rate, kinematic consistency, or retention. Experimental and quasi-experimental designs with pre- and post-intervention measures and, where possible, comparison groups were eligible. A small number of studies from closely related sport contexts were considered only when they provided directly transferable evidence regarding video-based motor-skill learning mechanisms. These were used

primarily to illustrate underlying mechanisms rather than to define basketball-specific effect magnitudes.

2.3 Exclusion Criteria

Studies were excluded if they: (a) were review articles, theoretical papers, conference abstracts, or dissertations; (b) did not investigate basketball skills or did not report outcomes relevant to shooting performance; (c) provided purely biomechanical or descriptive analyses without an intervention or without quantitative performance outcomes; or (d) used video only for purposes unrelated to motor-skill instruction (e.g., match broadcasting without feedback).

2.4 Study Selection, PRISMA Flow Diagram, and Data Extraction

Study selection was conducted in two stages. First, titles and abstracts of all retrieved records were screened to determine potential eligibility according to the predefined inclusion and exclusion criteria. In the second stage, the full texts of potentially relevant articles were assessed for final inclusion.

The screening process was conducted independently by two reviewers. Disagreements were resolved through discussion until consensus was achieved. Inter-rater agreement for full-text eligibility decisions was high (Cohen's $\kappa = 0.85$), indicating substantial agreement.

The initial database search yielded 186 records. After removing 32 duplicate entries, 154 records remained for title and abstract screening. During this stage, 100 studies were excluded because they did not meet the inclusion criteria. The full texts of 54 articles were subsequently assessed for eligibility. Following full-text evaluation, 46 studies were excluded, primarily because they did not examine basketball shooting performance or did not implement a video-based observational intervention.

A total of eight studies met all inclusion criteria and were included in the qualitative synthesis. The study selection process is illustrated in the PRISMA flow diagram (Figure 1).

For each included study, the following information was extracted: (a) authors and publication year, (b) participant characteristics (age, skill level, and sample size), (c) type of observational or video-based intervention, (d) intervention duration and training structure, (e) comparison or control conditions, (f) main outcome variables related to shooting performance, and (g) statistical results and key findings.

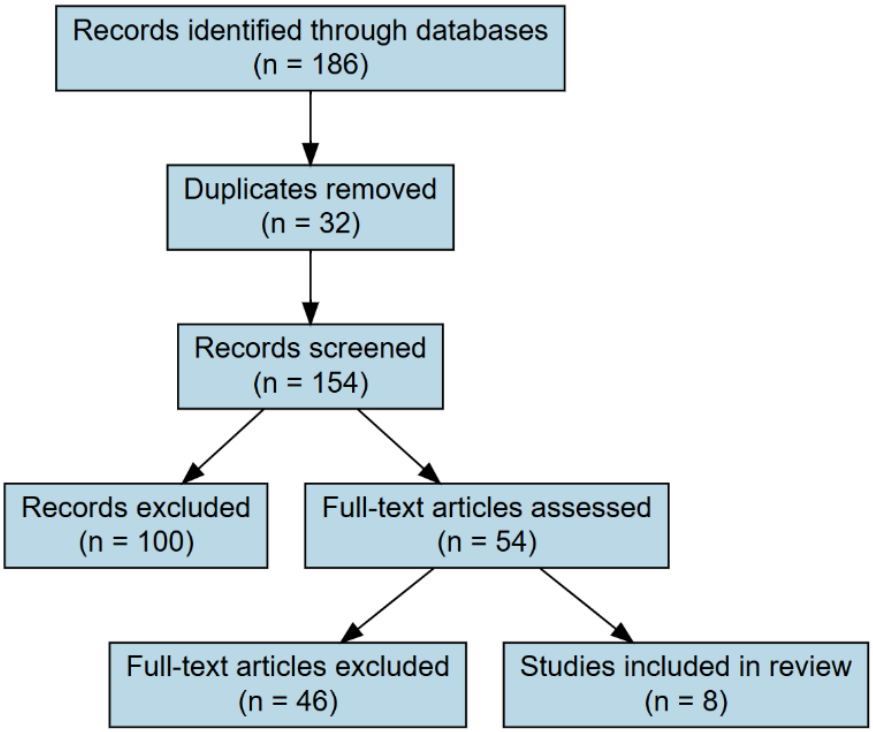

Figure 1. PRISMA 2020 flow diagram of the study selection process

2.5 Methodological Quality Appraisal

The methodological quality of the included studies was independently assessed by two reviewers using a five-criterion checklist adapted from the PEDro scale (Maher et al., 2003) and simplified for experimental sport-science interventions. The retained and adapted criteria focused on: (1) clear study design and objectives, (2) presence of a comparison or control condition, (3) standardized and reproducible intervention procedures, (4) valid and objective outcome measures, and (5) adequate statistical reporting of results.

Each criterion was rated as "Yes" (Y) when the criterion was clearly met, "No" (N) when the criterion was not met, and "Unclear" (U) when insufficient methodological detail was reported. Studies meeting four or five criteria were classified as high methodological quality, those meeting two or three criteria as moderate quality, and those meeting zero or one criterion as low quality. Discrepancies in quality ratings between reviewers were resolved through discussion and consensus. Inter-rater agreement for methodological appraisal was high (Cohen's $\kappa = 0.82$).

3. Results

3.1 Overview of Included Studies

Across the eight included studies, the overall direction of evidence was favorable to video-based observational interventions. Improvements were reported most for shooting accuracy, with

several studies also describing benefits in confidence, technical consistency, retention, attentional control, or quiet-eye behavior. However, the magnitude and specific form of improvement varied across studies as a function of participant level, intervention format, and outcome definition.

Sample sizes ranged from 24 to 60 participants, including youth players, university students, and novice basketball players. Several forms of observational interventions were implemented. Self-modeling approaches were used in studies where athletes viewed edited videos of their own successful performances. Other studies employed expert video modeling, where participants observed demonstrations of correct shooting technique before or during practice sessions. More recent studies incorporated attentional focus cues and gaze-based modeling strategies, emphasizing perceptual components of free-throw performance.

Overall, the included studies consistently reported positive effects of observational and video-based interventions, including improvements in shooting accuracy, movement consistency, and motor skill retention. The characteristics of the eight included studies are summarized in Table 1.

Table 1. Characteristics of the studies included in the systematic mini-review examining the effects of video modeling and observational learning interventions on basketball free-throw performance.

Study	**N ; Skill Level**	**Intervention Type**	**Intervention Description**	**Comparison/Control**	**Key Outcome**
Ste-Marie et al. (2012)	N = 48 ; basketball players	Self-modeling	Participants viewed edited videos of own successful free-throw attempts	Practice without self-modeling	Improved shooting accuracy and self-confidence; moderate performance gains reported relative to practice-only condition (p > 0.05)
Aiken et al. (2012)	N = 28; novice women (SC n=14, YK n=14)	Self-controlled video feedback	Participants chose when to view own shooting form videos during acquisition; yoked group received matched feedback schedule	Yoked (YK) video feedback group	SC group: higher form scores at transfer, F(1,26) = 4.67, p = 0.040, η^2 = .153; no significant accuracy difference at transfer, F(1,26) =

					1.57, p = 0.221.
Sheikhzadeh et al. (2025)	N = 30; female high school students, age 16–18 (*M*_age Concurrent = 14.17 ± 1.08; Delayed = 14.82 ± 1.10; Control = 14.45 ± 1.06)	Concurrent video feedback (active video game) vs. delayed video feedback of own performance	Concurrent group: X-box 360 Kinect virtual free-throw simulation, 50 trials/session × 4 sessions, real-time avatar feedback, no real ball or basket. Delayed group: real free-throws (4.5 m from hoop), watched own performance video after each 10-trial block	No-feedback, no-acquisition control group	Significant post-test and retention improvements vs control (η^2=.23–.33); ($p < 0.05$).
Asadi et al. (2023)	N = 40; novice basketball players (*M*_age = 21.77 ± 1.40)	Observational modeling with attentional focus + gaze instruction	Observed model performing free-throws under external attentional-focus cueing and/or gaze instruction	Internal attentional-focus group ; verbal instruction control	External-focus and gaze-instructed groups outperformed internal-focus and control in accuracy and quiet-eye duration, $p <$ 0.05.
Rezaei et al. (2023)	N = 45; female beginners (*M*_age = 21.62 ± 3.08; BMI = 23.48 ± 0.99 kg/m²)	Observational learning + attentional focus (internal vs. external)	Video modeling with internal vs. external focus strategy; 6 sessions × 2 × 10 attempts	Control (skilled model only, no attention strategy)	Immediate recall: $F(2,42)$ = 4.96, p = 0.012. Delayed recall: between-group differences, $p \leq 0.05$. Internal-focus

					> external-focus and control at delayed recall ($p \leq 0.05$); external-focus vs. control: $p > 0.05$.
Rafiee et al. (2019)	N = 60; mixed skill	Observational demonstration + feedback (expert vs. beginner model)	Expert/beginner demonstrations with reinforcement feedback; role of imagery examined	Practice-only control	Significant accuracy improvement ($p < 0.05$).
Tannoubi et al. (2023) N = 24	N = 20; novice players (VMG: *n*=10, *M*_age = 12.5 ± 0.5; CG: *n*=10, *M*_age = 12 ± 0.7)	Video modeling	Video demonstrations before each practice session, 4-week program	Traditional instruction control	Efficiency index: VMG post > pre, $p = 0.013$, $d = 1.24$; Attack balls index VMG vs CG: $p = 0.001$, $d = 0.28$; Losing ball index VMG vs CG: $p < 0.001$, $d = -3.23$.
Nasri et al. (2025)	N = 48; novice students	Observational modeling (quiet-eye gaze)	Expert free-throw models emphasizing quiet-eye gaze behaviour	Standard observation control	Significantly increased quiet-eye duration and free-throw accuracy, $p < 0.05$.

3.2 Methodological Quality of Included Studies

The results of the methodological quality appraisal are presented in Table 2. Overall, the quality of included studies was moderate to high. All eight studies met Criterion 1 (clear research design) and Criterion 4 (valid and objective outcome measures). Six of the eight studies reported an explicit comparison or control condition (Criterion 2), while two studies used a single-group pre–post design without a concurrent comparison group. Standardized intervention protocols were clearly described in six studies (Criterion 3), with two studies providing insufficient methodological

detail to confirm reproducibility. All studies reported between-group or pre–post statistical comparisons with appropriate descriptive statistics (Criterion 5). Based on this appraisal, six studies were classified as high quality and two as moderate quality. No studies were classified as low quality.

Table 2. Methodological quality appraisal of included studies (Y = Met; N = Not Met; U = Unclear).

Study	C1: Clear Design	C2: Comp. Group	C3: Stand. Protocol	C4: Valid Outcomes	C5: Stats Reported	Overall Quality
Ste-Marie et al. (2012)	Y	Y	Y	Y	Y	High (5/5)
Aiken et al. (2012)	Y	Y	Y	Y	Y	High (5/5)
Sheikhzadeh et al. (2025)	Y	Y	Y	Y	Y	High (5/5)
Asadi et al. (2023)	Y	Y	Y	Y	Y	High (5/5)
Rezaei et al. (2023)	Y	Y	Y	Y	Y	High (5/5)
Rafiee et al. (2019)	Y	U	U	Y	Y	Moderate (3/5)
Tannoubi et al. (2023)	Y	Y	Y	Y	Y	High (5/5)
Nasri et al. (2025)	Y	Y	U	Y	Y	Moderate (3/5)

Note. C1 = Clear research design; C2 = Comparison/control group allocation; C3 = Standardized and reproducible intervention protocol; C4 = Valid and objective outcome measures; C5 = Statistical comparisons and descriptive statistics reported. Quality ratings: High = 4–5 criteria met; Moderate = 2–3 criteria met; Low = 0–1 criteria met.

4. Discussion

The purpose of this systematic mini-review was to synthesize empirical evidence regarding the effectiveness of video modeling, video feedback, and observational learning interventions for improving basketball free-throw performance. Overall, the available evidence suggests that observational and video-based instructional strategies may facilitate improvements in shooting performance, particularly among novice and intermediate players.

However, the current body of research remains relatively limited, and the included studies differ considerably in terms of intervention structure, participant characteristics, and outcome

measures. Consequently, the findings should be interpreted with caution, and further research using larger samples and standardized methodologies is required to strengthen the evidence base.

Importantly, the heterogeneity was not random. Studies involving novice or less experienced participants generally reported stronger gains than those involving mixed or more experienced samples, suggesting greater responsiveness among developing players. Likewise, interventions combining observation with feedback or attentional-focus cues appeared more effective than passive observation alone.

4.1 Effects of Video Modeling on Free-Throw Performance

A central finding of the present review is that video modeling interventions are frequently associated with improvements in free-throw performance, particularly in terms of shooting accuracy and technical execution. Several studies reported that observing demonstrations of correct shooting technique before or during practice sessions helped participants develop more consistent movement patterns and achieve higher shooting success rates (Sheikhzadeh et al., 2025). These findings suggest that visual observation of skilled performance may provide athletes with clearer references for the coordination and sequencing of movements required for accurate shooting.

Self-modeling interventions also demonstrated positive effects in several of the reviewed studies. In these approaches, athletes observed edited recordings of their own successful free-throw attempts, reinforcing effective movement patterns and strengthening confidence in their ability to perform the skill successfully (Aiken et al., 2012). Self-modeling may be particularly beneficial for novice or intermediate players because it highlights successful executions that the learner is already capable of performing, thereby increasing self-efficacy and facilitating more consistent motor performance.

4.2 Role of Attentional Focus and Perceptual Processes

Recent research included in this review highlights the importance of attentional focus and perceptual cognitive processes in observational learning. Studies examining observational modeling combined with attentional focus instructions demonstrated improvements in both shooting accuracy and visual attention control (Asadi et al., 2023; Rezaei et al., 2023). These findings suggest that directing athletes' attention toward task-relevant cues during model observation may enhance the effectiveness of video-based instructional interventions.

Gaze-based modeling interventions have further shown that observing expert performers' visual fixation patterns can improve perceptual control during free-throw execution. Research examining quiet-eye behavior demonstrated that observational modeling could increase visual fixation duration on the target and subsequently improve shooting accuracy (Nasri et al., 2025). These findings support the growing body of literature emphasizing the importance of perceptual processes in skilled sport performance.

4.3 Practical Implications for Basketball Coaching

The findings of this review have several practical implications for coaches and practitioners working in basketball training environments. First, incorporating video modeling sessions into regular practice routines may help players develop a clearer understanding of correct free-throw mechanics. Observing expert demonstrations can provide athletes with visual references for important technical elements such as body alignment, shooting rhythm, elbow positioning, and follow-through.

Second, the use of self-modeling and video feedback may allow athletes to analyze their own performances and identify areas for technical improvement. With the widespread availability of smartphones and video analysis applications, coaches can easily record athletes' shooting performances and provide immediate visual feedback during training sessions. Finally, integrating attentional focus cues and perceptual training strategies within video modeling interventions may further enhance their effectiveness. Encouraging athletes to focus on key task-relevant cues such as the target or ball trajectory may improve shooting consistency and attentional control during free-throw execution.

However, practical implementation may be influenced by contextual barriers such as limited training time, restricted access to recording devices or analysis software, and coaches' familiarity with evidence-based feedback methods. Simple smartphone-based approaches may help overcome many of these constraints.

4.4 Theoretical Interpretation of Findings

The findings of this review align with several complementary theoretical frameworks that explain how observational experiences facilitate motor learning.

Observational learning theory (Bandura, 1986) provides the most direct explanatory framework. Observing a skilled performer helps learners form cognitive representations of movement patterns that can subsequently guide physical practice (Williams & Hodges, 2005). Prior studies on self-modeling such as those by (Ste-Marie et al., 2012) have reported that participants who observed expert models or edited recordings of their own successful performances demonstrated improvements in shooting accuracy and technical consistency. These observations align with the broader pattern of positive findings reported across the studies included in this review.

Schema theory (Schmidt, 1975; Schmidt & Lee, 2019) further contextualizes these results by explaining how repeated video observation may strengthen generalized motor programs for the free-throw. Each exposure to a skilled model demonstration provides additional information about the relationship between movement parameters and successful outcomes, enriching the learner's internal movement template and supporting adaptability and retention.

The mirror neuron system (Rizzolatti & Craighero, 2004) offers a neuroscientific account of why observation alone produces motor learning benefits. Motor resonance during video observation may prime the neural pathways associated with executing the free-throw, so that subsequent physical practice builds upon already-activated motor representations. This

mechanism may help explain when observational learning can be active when combined with limited physical practice.

Finally, the OPTIMAL theory of motor learning (Wulf & Lewthwaite, 2016) provides a motivational and attentional perspective. Video modeling interventions may naturally satisfy the three conditions the theory identifies as critical for learning: an external attention focus (directed toward the target or ball trajectory), enhanced expectations of success (through viewing successful performance models), and autonomy support (as in self-controlled feedback paradigms). The improvements in attentional control and shooting accuracy observed in studies using combined observational and attentional focus approaches (Asadi et al., 2023; Rezaei et al., 2023) are consistent with this theoretical account.

4.5 Limitations and Future Research Directions

Several limitations should be considered when interpreting the findings of this review. First, the number of studies meeting the inclusion criteria was relatively small, which limits the generalizability of the conclusions. Second, substantial heterogeneity was observed across studies in participant characteristics, intervention duration, and outcome measures, making direct comparisons difficult. Third, effect sizes were not consistently reported, preventing formal meta-analysis. Fourth, although study selection was conducted by two reviewers, data extraction was primarily performed by one reviewer, which may introduce a small risk of extraction bias. Fifth, the review was restricted to English-language publications and may therefore have excluded relevant evidence published in other languages.

5. Conclusion

This systematic mini-review examined the effects of video modeling, video feedback, and observational learning interventions on basketball free-throw performance. Across the eight included studies, observational and video-based instructional strategies appear to represent promising tools for improving basketball free-throw performance, particularly in novice and developing players.

These findings support theoretical perspectives from observational learning theory, schema theory, and the OPTIMAL theory of motor learning, suggesting that observing skilled performance can facilitate the development of effective motor representations and enhance subsequent physical practice.

From a practical perspective, the integration of video modeling and self-observation into basketball training may represent a valuable tool for coaches seeking to improve shooting performance. Nevertheless, further high-quality experimental research is needed to better understand the long-term effectiveness and optimal implementation of these instructional approaches.

References

1. Aiken, C. A., Fairbrother, J. T., & Post, P. G. (2012). The effects of self-controlled video feedback on the learning of the basketball set shot. *Frontiers in psychology*, *3*, 338.

2. Amaro, C. M., Castro, M. A., Mendes, R., Rice, H., & Gomes, B. B. (2025). Influence of Jump and Ball Release Parameters on Shooting Accuracy in Basketball Under Varying Constraints. *Journal of Functional Morphology and Kinesiology*, *10*(4), 459.

3. Asadi, A., Daneshfar, A., Maleki, B., & Aiken, C. (2023). Effects of attentional focus and gaze instruction during observational learning of a basketball free-throw. *Human movement science*, *87*, 103038.

4. Bandura, A. (1986). Social foundations of thought and action. *Englewood Cliffs, NJ*, *1986*(23-28), 2.

5. Cabarkapa, D., Cabarkapa, D. V., Miller, J. D., Templin, T. T., Frazer, L. L., Nicolella, D. P., & Fry, A. C. (2023). Biomechanical characteristics of proficient free-throw shooters—markerless motion capture analysis. *Frontiers in Sports and Active Living*, *5*, 1208915.

6. Choo, L., Novak, A., Impellizzeri, F. M., Porter, C., & Fransen, J. (2024). Skill acquisition interventions for the learning of sports-related skills: A scoping review of randomised controlled trials. *Psychology of sport and exercise*, *72*, 102615.

7. Han, M., Gómez-Carmona, C. D., Conte, D., & Calvo, J. L. (2026). Developmental Differences in Gaze Behaviors and Performance During Basketball Free Throws in Youth Athletes. *Sports*, *14*(3), 105.

8. Han, Y., Syed Ali, S. K. B., & Ji, L. (2022). Use of observational learning to promote motor skill learning in physical education: A systematic review. *International Journal of Environmental Research and Public Health*, *19*(16), 10109.

9. Law, B., & Hall, C. (2009). Observational learning use and self-efficacy beliefs in adult sport novices. *Psychology of sport and exercise*, *10*(2), 263–270.

10. Maher, C. G., Sherrington, C., Herbert, R. D., Moseley, A. M., & Elkins, M. (2003). Reliability of the PEDro scale for rating quality of randomized controlled trials. *Physical therapy*, *83*(8), 713–721.

11. Mičiak, M., Toman, D., Kubina, M., Poljaková, T., Ivanovič, K., Šimová, K., Majchráková, A., Bystrická, I., Kováčik, L., & Furmánek, T. (2026). Modern ICT Tools and Video Content in Athletes' Education—Inspiration from Corporate Learning and Development. *Big Data and Cognitive Computing*, *10*(2), 53.

12. Nakai, M., Tsunoda, Y., Hayashi, H., & Murakoshi, H. (2018). Prediction of basketball free throw shooting by openpose. JSAI International symposium on artificial intelligence,

13. Nasri, A., Farsi, A., Pineda-Hernandez, S., & Alboghebeish, S. (2025). Impact of observational modeling on quiet eye duration and free-throw performance in basketball. *Learning and Motivation*, *89*, 102070.

14. Okazaki, V. H., Rodacki, A. L., & Satern, M. N. (2015). A review on the basketball jump shot. *Sports biomechanics*, *14*(2), 190–205.

15. Rafiee, S., MehrPour, M., & Kashi, A. (2019). Effect of observational expert and beginner model on learning of basketball free throw: the role of imagination capability. *Iranian Journal of Learning & Memory*, *2*(5), 27–35.

16. Rezaei, M., Hatami, F., & Lotfi, G. (2023). The impact of different attentional focus strategies during modeling on the acquisition and retention of free throws in basketball. *International Journal of Sport Studies for Health*, *6*(1). https://doi.org/https://doi.org/10.61838/kman.intjssh.6.1.6

17. Rizzolatti, G., & Craighero, L. (2004). THE MIRROR-NEURON SYSTEM. *Annual Review of Neuroscience*, *27*(2004), 169–192.

18. Schmidt, R. A. (1975). A schema theory of discrete motor skill learning. *Psychological review*, *82*(4), 225.

19. Schmidt, R. A., & Lee, T. D. (2019). *Motor learning and performance 6th edition with web study guide-loose-leaf edition: From principles to application*. Human Kinetics Publishers.

20. Sheikhzadeh, F., Abedanzadeh, R., & Hazeltine, E. (2025). Real Practice and Virtual Practice Improve Basketball Free Throwing Skill Learning in Female Students: Examining the Role of Concurrent and Delayed Feedback. *Journal of Computer Assisted Learning*, *41*(3), e70034.

21. Smith, K., Burns, C., O'Neill, C., Duggan, J. D., Winkelman, N., Wilkie, M., & Coughlan, E. K. (2023). How to coach: A review of theoretical approaches for the development of a novel coach education framework. *International Journal of Sports Science & Coaching*, *18*(2), 594–608.

22. Ste-Marie, D. M., Law, B., Rymal, A. M., Jenny, O., Hall, C., & McCullagh, P. (2012). Observation interventions for motor skill learning and performance: an applied model for the use of observation. *International Review of Sport and Exercise Psychology*, *5*(2), 145–176. https://doi.org/https://doi.org/10.1080/1750984X.2012.665076

23. Tannoubi, A., Geantă, V. A., Ursu, V. E., & Azaiez, F. (2026). Self-video modeling combined with self-feedback in youth sport: an opinion on cognitive load, attention, and learning design [Opinion]. *Frontiers in psychology*, *Volume 17 - 2026*. https://doi.org/10.3389/fpsyg.2026.1775088

24. Tannoubi, A., Ouergui, I., Srem-Sai, M., Hagan, J. E., Quansah, F., & Azaiez, F. (2023). Effectiveness of video modeling in improving technical skills in young novice basketball players: A quasi-experimental study. *Children*, *10*(4), 687. https://doi.org/https://doi.org/10.3390/children10040687

25. Trabelsi, O., Romdhani, A., Ghorbel, A., Bouchiba, M., Souissi, M. A., Scharenberg, S., & Gharbi, A. (2025). A review of best practices in video modeling for sport pedagogues. *International Journal of Sports Science & Coaching*, 17479541251335611. https://doi.org/https://doi.org/10.1177/17479541251335611

26. Williams, A. M., & Hodges, N. J. (2005). Practice, instruction and skill acquisition in soccer: challenging tradition. *J Sports Sci*, *23*(6), 637–650. https://doi.org/10.1080/02640410400021328

27. Wulf, G., & Lewthwaite, R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic bulletin & review*, *23*(5), 1382–1414.

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ORIGINAL SCIENTIFIC PAPER

How Much Does Physical Condition Affect Volleyball Technique? A Case Study of High School Students in Padang City

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Abstract

This study aims to identify the influence of physical condition on volleyball technique mastery among players at Padang State High School. The main objective of this study is to explore the relationship between various physical components such as leg muscle strength, arm muscle strength, agility, hand-eye coordination, flexibility, and aerobic endurance on basic volleyball techniques such as underhand passing, overhand passing, smashing, and overhand serving. Physical condition measurements were conducted using the vertical jump test, two-hand medicine ball put, Illinois Agility Test, tennis ball throw and catch test, flexibility test using a flexiometer, and the bleep test. The basic volleyball techniques measured included underhand passing, overhand passing, spiking (also known as smashing), and overhand serving. The research involved 30 volleyball players, selected using purposive sampling and analyzed using Structural Equation Modeling (SEM). The results showed significant correlations between physical conditions and volleyball techniques, particularly in underhand and overhand passing. However, physical conditions had a weaker influence on smashing and overhand serving. The SEM analysis revealed that flexibility, leg muscle power, and agility significantly contributed to better technique execution, with hand-eye coordination having a minor influence. The findings suggest that physical conditions, particularly leg muscle power, flexibility, and agility, play a significant role in mastering basic volleyball techniques. It is recommended that coaches develop training programs that integrate physical conditioning with technical skill development to optimize player performance.

Keywords: Physical, condition, volleyball, technique, agility.

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1. Introduction

Volleyball is one of the most popular and beloved sports among high school students (Ismailova, 2022). The popularity of this sport stems from its dynamic, competitive, and challenging nature, both physically and mentally (Furley, 2019; Martín-Rodríguez et al., 2024). To play well, a player must master various fundamental techniques, including underhand passing, overhand passing, serving, and smashing. These techniques form the foundation of volleyball, determining a team's success in both defense and attack (Deda, 2024).

However, mastering these basic techniques alone is insufficient without optimal physical condition (Stănciulescu, 2016). Good technical skills without adequate physical ability will make it difficult for players to maintain their performance throughout the game (Farley, Stein, Keogh, Woods, & Milne, 2020; Francesco Sgrò, Salvatore Bracco, Salvatore Pignato, & Mario Lipoma, 2018). In volleyball, physical aspects such as strength, speed, agility, flexibility, endurance, and coordination are crucial because the sport demands quick responses, agile position changes, and the ability to perform explosive movements repeatedly within a short time frame.

Observations at several schools, including a state high school in Padang City, reveal that many volleyball players experience a decline in technical performance, particularly towards the middle to end of the match. This often occurs due to physical fatigue, which leads to decreased serving accuracy, less synchronized movement coordination, and reduced jumping power for smashes or blocks. This phenomenon indicates that technical training alone is insufficient. A structured physical training program is necessary to maintain and optimally apply technical skills on the court.

Previous studies have confirmed that physical conditioning components significantly contribute to mastering basic volleyball techniques (Rebelo et al., 2025). For example, lower limb muscle power, measured through vertical jumps, is closely related to the ability to perform effective smashes and blocks (Berriel et al., 2021; Marpaung & Priyonoadi, 2019). Similarly, upper limb strength, assessed using the two-hand medicine ball throw, plays a crucial role in generating powerful serves and smashes (Pajar Juanda, Iyakrus, & Ahmad Richard Victorian, 2024). However, strength alone is insufficient without good eye-hand coordination (Mueangson et al., 2025; Setiawan & Mukarohim, 2024). This skill can be measured using the tennis ball catch-and-throw test and is essential for making precise movements and quick decisions on the court.

Additionally, agility, as measured by the Illinois Agility Test, is crucial for making lateral movements and executing position changes during both defense and attack (Söyler, 2022; Young, Dos'Santos, Harper, Jefferys, & Talpey, 2022). Flexibility, as measured by a flexometer, supports the range of body movement, enabling the performance of passing and ball return techniques more efficiently and safely (Bajić, Veljović, & Bulajić, 2023). Meanwhile, aerobic endurance, often overlooked, plays a crucial role in maintaining performance stability during matches, especially in high-intensity and long-duration matches (Hulton, Malone, Clarke, & MacLaren, 2022; Lv, Yang, Suo, & Han, 2025). This ability can be assessed through the bleep test.

Based on this background, a player's success in mastering basic volleyball techniques is determined not only by how often they practice the techniques but also by how well they develop their physical condition. Therefore, this study aims to empirically examine the extent to which physical components such as agility, muscle strength, coordination, flexibility, and aerobic endurance influence basic volleyball technique ability among high school students in Padang City. The results of this study are expected to provide tangible contributions to the field of coaching, particularly in designing training programs that not only focus on technical aspects but also consider physical aspects holistically and measurably, thereby producing competent, resilient, and high-performing student-athletes.

Based on the theoretical framework, physical condition is conceptualized as a latent construct comprising aerobic endurance, agility, muscle strength, flexibility, and hand-eye coordination, which are hypothesized to influence performance in volleyball technique.

2. Methods

This study involved 30 high school volleyball players selected through purposive sampling. The participants were aged 14-18 and were actively involved in regular volleyball training and school competitions. All participants had prior experience in organized volleyball activities. The participants were players who actively trained and regularly participated in school volleyball competitions. The inclusion criteria for participation in this study were students who were registered as regular players on the school volleyball team and who were willing to undergo a series of physical and technical tests. There were no specific exclusion criteria. Specifically, players who were injured at the time of data collection were excluded to maintain the validity of the results.

Although the sample size in this study was relatively small (n = 30), the use of Partial Least Squares Structural Equation Modeling (PLS-SEM) is considered appropriate. PLS-SEM is suitable for exploratory research and can be applied to small sample sizes, particularly when the research model is relatively simple and prediction-oriented. According to Hair et al. (2019), PLS-SEM can be used with small samples as long as the minimum sample size follows the "10-times rule," which states that the sample size should be at least ten times the maximum number of structural paths directed at any latent construct. In this study, the model meets this requirement. The model in this study is specified as a reflective measurement model, where all observed variables are assumed to reflect the underlying latent construct of physical condition.

This study used a quantitative approach with a correlational descriptive design. The purpose of this study was to investigate the impact of physical condition on the mastery of basic volleyball techniques. Data collection involved various physical condition tests and basic technique tests.

1. Physical condition tests:
a. Vertical Jump Test to measure lower limb muscle power.
b. Two-hand medicine Ball Throw to measure upper limb muscle power.
c. Illinois Agility Test to measure agility.
d. Tennis ball throw-catch test against a wall to measure hand-eye coordination.
e. Flexometer to measure flexibility.

f. Bleep Test to measure aerobic endurance.

2. Basic volleyball technique tests:

a. Underhand pass

b. Overhand pass.

c. Smash.

d. Overhand serve.

These instruments were selected due to their relevance to measuring physical and technical abilities in the sport of volleyball. Data collection was conducted under controlled conditions in a school environment, supervised by coaches and researchers. Each participant took all tests in turn, and the results were recorded for further analysis.

The collected data were analyzed using Structural Equation Modelling (SEM) with the assistance of SmartPLS software. SEM was chosen because it can analyze complex relationships between physical condition variables and mastery of basic techniques simultaneously. The data analysis stages included:

1. Model Validity Test

This test was conducted using several indices, including the Chi-Square, Root Mean Square Error of Approximation (RMSEA), Goodness-of-Fit Index (GFI), and Comparative Fit Index (CFI). An RMSEA value below 0.08, along with GFI and CFI values above 0.90, indicates a good model.

2. Reliability and Construct Validity Test

Average Variance Extracted (AVE) is used to measure validity, where a value above 0.50 indicates adequate validity. Composite Reliability (CR) is used to measure construct reliability, with a value above 0.70 indicating good reliability.

3. Hypothesis Test

This test is conducted by examining path coefficients to assess the direct effects between variables. A T-statistic value above 1.96 at a 95% confidence level and a p-value below 0.05 indicate a significant relationship between variables.

4. Multicollinearity Evaluation

Multicollinearity among independent variables is evaluated using the Variance Inflation Factor (VIF), where a VIF value below 5 indicates no multicollinearity issues.

5. R-Square (R^2) and Adjusted R-Square

The R^2 value is used to measure the extent to which the independent variables (physical conditions) explain the variance in the dependent variable (volleyball technique). An R^2 value above 0.25 is considered adequate, while the adjusted R^2 is used to account for the number of variables used in the model.

6. Confidence Intervals:

Confidence intervals that do not include zero indicate a significant relationship between variables. Narrower intervals provide more precise estimates of the influence of variables.

By using this analysis, the study aims to provide a clear understanding of the relationship between physical condition and basic volleyball techniques, enabling coaches to design effective training programs for their players.

3. Results

A correlation analysis was conducted to identify the relationships between physical condition components and basic volleyball skills. Physical condition variables consisted of aerobic endurance, agility, arm muscle power, flexibility, hand-eye coordination, and leg muscle power. Meanwhile, volleyball skill variables included lower passing, smash, upper passing, and upper serve. The correlation coefficient values for each variable indicator are presented in the following table 1.

Table 1. Outer Loadings (Matrix)

Variable	Physical Condition (X)	Volleyball Technique (Y)
Aerobic Endurance	0.690	
Agility	0.517	
Arm Muscle Explosiveness	0.594	
Flexibility	0.729	
Hand Eye Coordination	0.135	
Limb Muscle Explosiveness	0.617	
Lower Passing		0.735
Smash		0.442
Upper Passing		0.912
Upper Serve		0.075

From the outer loadings table 1, it can be seen that physical condition variables (X) have different contributions to volleyball techniques (Y). Outer loadings indicate the extent to which each indicator reflects its respective latent construct. In this study, most indicators of physical condition showed acceptable loadings (above 0.50), suggesting they adequately represent the underlying construct. Specifically, aerobic endurance (0.690), agility (0.517), arm muscle power (0.594), flexibility (0.729), and leg muscle power (0.617) demonstrate sufficient contributions as reflective indicators. However, hand-eye coordination shows a relatively low loading (0.135), suggesting it may not strongly reflect the physical condition construct in this model. This result

suggests that hand-eye coordination may function better as a separate construct rather than as a component of general physical condition.

Contributes significantly to volleyball technique with a path coefficient of 0.502, indicating a moderate relationship between physical condition and volleyball technique. Furthermore, the contribution of physical condition to several volleyball techniques, such as Lower Passing (0.735) and Upper Passing (0.912), is relatively high, indicating that basic passing ability in volleyball is highly dependent on the player's physical condition. However, the Smash (0.442) and Upper Serve (0.075) techniques have a weaker relationship with physical condition, which may indicate that these two techniques are influenced by factors other than physical condition, such as technical skills or playing experience.

Table 2. R-square – Summary

Volleyball Technique	R-square	Adjusted R-square
(Y)	0.252	0.225

In terms of R-square, the value for volleyball technique (Y) is 0.252, indicating that approximately 25.2% of the variance in volleyball technique can be explained by physical condition. This suggests a moderate level of explanatory power, meaning that other factors beyond physical condition also play a substantial role in influencing volleyball technique. The adjusted R-square value (0.225), which is slightly lower, further indicates that the model remains relatively simple and may be improved by incorporating additional relevant variables. Therefore, the findings should be interpreted with caution, considering the relatively limited explanatory power of the model.

Table 3. Multicollinearity Statistics (VIF) - Outer Model - List

Variable	VIF
Aerobic Endurance	1.468
Agility	1.246
Arm Muscle Explosiveness	1.317
Flexibility	1.610
Hand Eye Coordination	1.143
Limb Muscle Explosiveness	1.237
Lower Passing	1.269

Smash	1.081
Upper Passing	1.315
Upper Serve	1.011

In the VIF (Variance Inflation Factor), all variables have low values, well below the threshold of 5, indicating that there are no multicollinearity issues in this model. This means that the independent variables in physical condition do not significantly influence each other, and each contributes uniquely to the technical volleyball results.

Overall, this model provides insight into the importance of physical condition in supporting volleyball technique. However, it also suggests that many other factors may be more significant, particularly in techniques such as the smash and serve. This opens the door for further research to identify additional variables that could explain more variation in volleyball technique performance.

Table 4. Path Coefficients - Mean, STDEV, T-Values, P-Values

Variable	Original sample (O)	Sample average (M)	Standard deviation (STDEV)	T-statistics (O/STDEV)	P values
Physical Condition (X) - Volleyball Technique (Y)	0.502	0.633	0.143	3.513	0.000

From the results of the path coefficient between Physical Condition (X) and Volleyball Technique (Y), we see a coefficient value of 0.502. This indicates that physical condition has a significant influence on volleyball technique. With a T-statistic value of 3.513 and a highly significant p-value of 0.000, we can conclude that this influence is significant at a 95% confidence level. This means that physical condition indeed has a moderate relationship with influencing the quality of volleyball playing technique.

Table 5. Path Coefficients - Confidence Intervals

Path	Original Sample (O)	Sample Mean (M)	2.5%	97.5%
Physical Condition - Technique	0.520	0.057	-0.750	

The confidence interval provides a range of possible values for the path coefficient. In the case of Physical Condition → Volleyball Technique, the confidence interval of 2.5% to 97.5% is between

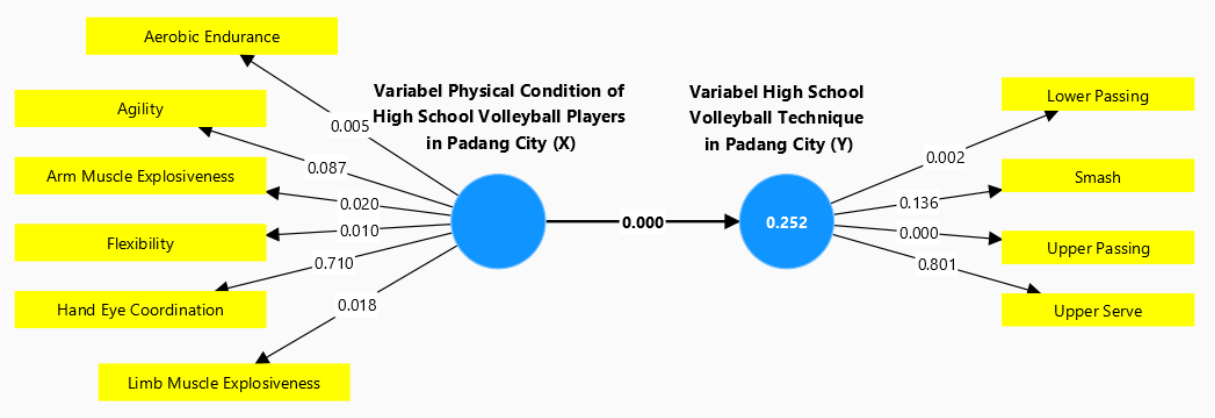
0.468 and 0.805, which does not include zero, thus confirming that this relationship is significant. This supports the previous conclusion that physical condition consistently affects volleyball technique.

Table 6. Path Coefficients - Confidence Intervals

Path	Original Sample (O)	Sample Mean (M)	2.5%	97.5%
Physical Condition (X) - Volleyball Technique (Y)	0.502	0.633	0.468	0.805

From the more detailed graph, it can be seen that other independent variables, such as Aerobic Endurance (0.005), Flexibility (0.020), and Limb Muscle Explosiveness (0.018), also have low coefficient values related to physical condition. However, even though these values are low, they still have a positive contribution. Meanwhile, other factors, such as Hand-Eye Coordination, show smaller values (0.010), indicating that the role of hand-eye coordination is less significant in influencing physical condition.

In volleyball techniques, such as Lower Passing (0.002) and Upper Passing (0.136), there is a more significant influence of physical condition compared to other techniques, like Smash (0.801) and Upper Serve (0.136), which show a weaker relationship.



Overall, these results suggest that physical condition generally contributes significantly to improvements in volleyball playing techniques, particularly in basic skills such as passing. However, there are variations in the influence of each technique, suggesting that specific techniques may also be influenced by factors other than physical condition, such as technical skills, strategy, or playing experience.

This data also supports the assertion that the independent variables used do not exhibit multicollinearity issues based on the low VIF values, which indicates that each variable contributes independently to the dependent variable.

4. Discussion

The results of this study indicate that physical condition has a significant influence on the mastery of basic volleyball techniques among students at High school in Padang City. Good physical condition, including aerobic endurance, flexibility, and lower limb muscle power, is a fundamental factor in supporting players' performance when executing basic techniques, particularly underhand and overhand passes. These findings are consistent with previous studies, which indicate that physical components, particularly aerobic endurance and flexibility, are crucial for enhancing athletes' performance in sports that require rapid and reactive movements (Akbar et al., 2022; Nuzzo, 2020; X. Wang et al., 2023). Arm muscle strength is also a dominant factor influencing smash accuracy, followed by eye-hand coordination and body flexibility (Ardianto Rifki Purnama, Yopi Kusdinar, Kardjono Kardjono, & Mulyana, 2024).

Specific physical training for volleyball players can help improve performance in countries like Romania, where training levels are often lower compared to stronger championships (Martin, Gavra, & Martin-Hadmaș, 2024). Optimal physical ability enables players to maintain sufficient stamina throughout the match and possess the body flexibility necessary to execute more effective playing techniques (Cao, Liu, Wang, & Geok, 2024; Luo et al., 2023). Unique physical demands based on playing position and situational variables also influence performance, emphasizing the importance of position-specific physical training (Sarmento et al., 2024).

Good flexibility allows players to move more freely when receiving the ball, enhancing passing effectiveness (Ilahi & Rasvid, 2020). Flexibility also increases the range of motion, which is crucial in both defensive and offensive positions, especially during blocking or spiking (Cakici, Alpay, & Soylu, 2026; Soylu & Altundag, 2024). Other research indicates that volleyball players with high flexibility levels exhibit better performance in agility, acceleration speed, and vertical jumps compared to those with low flexibility levels. These measurements use the 6x10 m shuttle run test, the countermovement jump test with arm swing, and the 20 m sprint test from a standing position.

Lower limb muscle power is also crucial, especially for jumping higher, which helps players achieve an ideal position when performing overhead passes or blocks (Mercado-Palomino, Aragón-Royón, Richards, Benítez, & Ureña Espa, 2021). Muscle strength is crucial for ensuring effective jumps in controlling the ball, which ultimately impacts the improvement of techniques such as smashes and blocks (Esposito, Altavilla, Giardullo, Ceruso, & D'Isanto, 2024; Tariq Ismael, 2024).

Aerobic endurance plays a significant role in maintaining stamina throughout the match, especially in high-intensity sports like volleyball (Rafi Tri Indarwan & Adi S, 2025; Wu, 2023). Maintaining stamina allows players to sustain optimal performance from the start to the end of

the match (Hostrup & Bangsbo, 2023; Ranchordas, Dawson, & Russell, 2017). Previous studies also emphasize the importance of aerobic endurance in maintaining athletic performance during prolonged matches (Skorski et al., 2019; Spiering, Mujika, Sharp, & Foulis, 2021).

However, the influence of physical condition components varies across techniques. Eye-hand coordination, for example, showed a lower influence in this study, suggesting that technical skills or playing experience may play a greater role in improving basic volleyball technique performance (Addivinola, Cereda, & Aliberti, 2021). Research on teaching methods for eye-hand coordination in volleyball shows that a mixed approach (cognitive and dynamic ecological) is more effective in improving eye-hand coordination than a single approach (SAPARİA, DLIS, & HANIF, 2020).

Although eye-hand coordination is important in catching and controlling the ball, its influence on overall volleyball performance is lower than that of muscle strength or agility (Ngadiyana, 2020). Another study also found that while eye-hand coordination is important, its impact on technical performance in volleyball is not as significant as other physical components (Jariono et al., 2023). Eye-hand coordination is a skill that can be improved through various training methods, such as the use of the FitLight Trainer and distance manipulation exercises. This coordination is critical in serving, passing, and smashing techniques in volleyball (Waryanti, Umar, Rifki, & Masrun, 2025). Concerning basic techniques, passing ability is highly dependent on physical condition (B. Wang et al., 2024). Underhand and overhand passing are significantly influenced by leg and arm muscle strength, as well as the agility required to move quickly to the correct position (Uly, Hudain, Adil, Kamaruddin, & Fahrizal, 2025). Studies indicate that upper body and arm muscle strength play a significant role in enhancing ball speed and accuracy during passing (Finlay, Bridge, Greig, & Page, 2022). Training focused on improving these muscle strengths can help players perform passing more effectively and consistently (Suchomel, Nimphius, Bellon, & Stone, 2018).

Passing requires high precision, and good physical strength helps players control and direct the ball better (Rein, Raabe, & Memmert, 2017). On the other hand, techniques such as smashes and overheads reveal a weaker relationship with physical condition, suggesting that technical skills, including ball control and hand speed, play a greater role in the execution of these techniques (Li, Li, Zhang, & Shan, 2023). This finding supports the notion that technical complexity influences the degree to which physical condition contributes to performance outcomes. Some studies also support these findings, showing that technical experience and ball control play a larger role in the success of smashes and overhead serves (Ramasamy et al., 2023).

The R-squared value from this analysis indicates that approximately a quarter of the variation in volleyball technique mastery can be explained by physical condition. This suggests that, in addition to physical condition, other factors such as playing experience, strategy, and motivation also play important roles in enhancing a player's technical ability (Wiemeyer, Nacke, Moser, & ‘Floyd’ Mueller, 2016). This study is consistent with findings stating that experience and technical skills are equally important as physical condition in determining athletic performance (Koopmann, Faber, Baker, & Schorer, 2020).

Low multicollinearity among physical condition variables indicates that each component contributes uniquely to the volleyball technique without interfering with one another (Musa et al., 2023). Physical conditions such as agility and aerobic endurance have a significant influence on improving overall player performance (Komarudin, Suharjana, Yudanto, & Kusuma, 2022). These variables function independently and make significant contributions to each technique, ensuring that no single variable dominates (Musall, Kaufman, Juavinett, Gluf, & Churchland, 2019).

Overall, this study demonstrates that physical condition plays a crucial role in supporting the mastery of basic volleyball techniques, particularly in passing techniques. Techniques such as smashes and overhead serves are more influenced by other factors like technical skills and playing experience. This study also opens opportunities for further exploration of non-physical factors that may influence volleyball technique performance, such as psychological aspects, strategy, or team dynamics.

Each physical component contributes differently to each technique in volleyball, and coaches need to understand the specific role of each variable to design more effective training programs. Thus, this study contributes not only to the development of volleyball performance at the student level but also to the scientific literature on the influence of physical condition on technical performance in the sport of volleyball.

5. Conclusions

This study concludes that physical condition has a moderate but significant influence on volleyball technique performance, particularly in passing skills. However, the relatively low explanatory power suggests that factors beyond physical condition also play a substantial role. Therefore, training programs should integrate both physical conditioning and technical skill development to achieve optimal performance.

Therefore, it is recommended that volleyball training programs not only focus on developing technical skills but also integrate physical training specifically designed to enhance relevant physical components. This is important for achieving optimal performance in volleyball matches, especially for techniques that require strength, flexibility, and high speed. Further research is needed to explore other factors that may influence volleyball techniques, such as psychological aspects, team dynamics, or tactical strategies, which can contribute to a player's success on the court.

Conflict of Interest

The authors declare that they have no conflicts interests.

References

1. Addivinola, S., Cereda, F., & Aliberti, S. (2021). Teaching method to improve eye-hand coordination in volleyball serve. *Journal of Human Sport and Exercise - 2021 - Spring Conferences of Sports Science*. Universidad de Alicante. https://doi.org/10.14198/jhse.2021.16.Proc4.18
2. Akbar, S., Soh, K. G., Jazaily Mohd Nasiruddin, N., Bashir, M., Cao, S., & Soh, K. L. (2022). Effects of neuromuscular training on athletes physical fitness in sports: A systematic review. *Frontiers in Physiology*, *13*. https://doi.org/10.3389/fphys.2022.939042
3. Ardianto Rifki Purnama, Yopi Kusdinar, Kardjono Kardjono, & Mulyana. (2024). The Relationship Between Wrist Flexibility and Arm Muscle Strength with the Accuracy and Speed of Smash for Badminton Athletes Universitas Pendidikan Indonesia (UPI). *Journal of Physical Education Health and Sport*, *11*(2), 75–78. https://doi.org/10.15294/jpehs.v11i2.18563
4. Bajić, S., Veljović, D., & Bulajić, B. Đ. (2023). Impact of Physical Fitness on Emergency Response: A Case Study of Factors That Influence Individual Responses to Emergencies among University Students. *Healthcare*, *11*(14), 2061. https://doi.org/10.3390/healthcare11142061
5. Berriel, G. P., Schons, P., Costa, R. R., Oses, V. H. S., Fischer, G., Pantoja, P. D., … Peyré-Tartaruga, L. A. (2021). Correlations Between Jump Performance in Block and Attack and the Performance in Official Games, Squat Jumps, and Countermovement Jumps of Professional Volleyball Players. *Journal of Strength and Conditioning Research*, *35*(12S), S64–S69. https://doi.org/10.1519/JSC.0000000000003858
6. Cakici, A. P., Alpay, N., & Soylu, C. (2026). Effects of an eight-week neuro-athletic training program on passing accuracy, shooting precision, flexibility, and isokinetic knee strength in male soccer players: A randomized controlled trial. *Journal of Science and Medicine in Sport*. https://doi.org/10.1016/j.jsams.2026.01.013
7. Cao, S., Liu, J., Wang, Z., & Geok, S. K. (2024). The effects of functional training on physical fitness and skill-related performance among basketball players: a systematic review. *Frontiers in Physiology*, *15*. https://doi.org/10.3389/fphys.2024.1391394
8. Deda, N. (2024). The Study of Technical-Tactical and Physical Parameters of Modern Volleyball Through Specific Models in the Defense Element. *Interdisciplinary Journal of Research and Development*, *11*(2), 44. https://doi.org/10.56345/ijrdv11n206
9. Esposito, G., Altavilla, G., Giardullo, G., Ceruso, R., & D'Isanto, T. (2024). The Effects of the Use of Plyometric Exercises with and without the Ball in the Development of Explosive Strength in Volleyball. *Journal of Functional Morphology and Kinesiology*, *9*(3), 126. https://doi.org/10.3390/jfmk9030126
10. Farley, J. B., Stein, J., Keogh, J. W. L., Woods, C. T., & Milne, N. (2020). The Relationship Between Physical Fitness Qualities and Sport-Specific Technical Skills in Female, Team-Based Ball Players: A Systematic Review. *Sports Medicine - Open*, *6*(1), 18. https://doi.org/10.1186/s40798-020-00245-y

11. Finlay, M. J., Bridge, C. A., Greig, M., & Page, R. M. (2022). Upper-Body Post-activation Performance Enhancement for Athletic Performance: A Systematic Review with Meta-analysis and Recommendations for Future Research. *Sports Medicine*, *52*(4), 847–871. https://doi.org/10.1007/s40279-021-01598-4
12. Francesco Sgrò, Salvatore Bracco, Salvatore Pignato, & Mario Lipoma. (2018). Small-Sided Games and Technical Skills in Soccer Training: Systematic Review and Implications for Sport and Physical Education Practitioners. *Journal of Sports Science*, *6*(1). https://doi.org/10.17265/2332-7839/2018.01.002
13. Furley, P. (2019). What Modern Sports Competitions Can Tell Us About Human Nature. *Perspectives on Psychological Science*, *14*(2), 138–155. https://doi.org/10.1177/1745691618794912
14. Hostrup, M., & Bangsbo, J. (2023). Performance Adaptations to Intensified Training in Top-Level Football. *Sports Medicine*, *53*(3), 577–594. https://doi.org/10.1007/s40279-022-01791-z
15. Hulton, A. T., Malone, J. J., Clarke, N. D., & MacLaren, D. P. M. (2022). Energy Requirements and Nutritional Strategies for Male Soccer Players: A Review and Suggestions for Practice. *Nutrients*, *14*(3), 657. https://doi.org/10.3390/nu14030657
16. Ilahi, R., & Rasvid, W. (2020). The Effect of Limb Muscle Explosive Power, Flexibility, and Confidence Toward Long Passing Ability of Football Players. *Proceedings of the 1st International Conference of Physical Education (ICPE 2019)*. Paris, France: Atlantis Press. https://doi.org/10.2991/assehr.k.200805.048
17. Ismailova, A. (2022). Volleyball is a popular game in many countries around the world. *ACADEMICIA: An International Multidisciplinary Research Journal*, *12*(10), 75–85. https://doi.org/10.5958/2249-7137.2022.00809.6
18. Jariono, G., Nurhidayat, Sudarmanto, E., Nugroho, H., Maslikah, U., & Budiman, I. A. (2023). Basic Volleyball Technical Skills for Students: Validity and Reliability. *Physical Education Theory and Methodology*, *23*(5), 747–753. https://doi.org/10.17309/tmfv.2023.5.13
19. Komarudin, K., Suharjana, S., Yudanto, Y., & Kusuma, M. N. H. (2022). The different influence of speed, agility and aerobic capacity toward soccer skills of youth player. *Pedagogy of Physical Culture and Sports*, *26*(6), 381–390. https://doi.org/10.15561/26649837.2022.0604
20. Koopmann, T., Faber, I., Baker, J., & Schorer, J. (2020). Assessing Technical Skills in Talented Youth Athletes: A Systematic Review. *Sports Medicine*, *50*(9), 1593–1611. https://doi.org/10.1007/s40279-020-01299-4
21. Li, F., Li, S., Zhang, X., & Shan, G. (2023). Biomechanical Insights for Developing Evidence-Based Training Programs: Unveiling the Kinematic Secrets of the Overhead Forehand Smash in Badminton through Novice-Skilled Player Comparison. *Applied Sciences*, *13*(22), 12488. https://doi.org/10.3390/app132212488
22. Luo, S., Soh, K. G., Zhang, L., Zhai, X., Sunardi, J., Gao, Y., & Sun, H. (2023). Effect of core training on skill-related physical fitness performance among soccer players: A

systematic review. *Frontiers in Public Health*, *10*. https://doi.org/10.3389/fpubh.2022.1046456

23. Lv, X., Yang, J., Suo, L., & Han, W. (2025). The role and application of internal and external load indicators in monitoring fatigue in rugby players—a narrative review. *Frontiers in Sports and Active Living*, *7*. https://doi.org/10.3389/fspor.2025.1654577
24. Marpaung, H. I., & Priyonoadi, B. (2019). The Correlation between Leg-arm Muscle Power and Volleyball Players' Open Smash Ability. *Proceedings of the 3rd Yogyakarta International Seminar on Health, Physical Education, and Sport Science in Conjunction with the 2nd Conference on Interdisciplinary Approach in Sports*, 379–385. SCITEPRESS - Science and Technology Publications. https://doi.org/10.5220/0009786803790385
25. Martin, Ștefan A., Gavra, M. G., & Martin-Hadmaș, R. M. (2024). Analyzing Targeted Muscle Strength: Impact on Speed, Endurance, and Performance in Female Volleyball. *Applied Sciences*, *14*(23), 10951. https://doi.org/10.3390/app142310951
26. Martín-Rodríguez, A., Gostian-Ropotin, L. A., Beltrán-Velasco, A. I., Belando-Pedreño, N., Simón, J. A., López-Mora, C., … Clemente-Suárez, V. J. (2024). Sporting Mind: The Interplay of Physical Activity and Psychological Health. *Sports*, *12*(1), 37. https://doi.org/10.3390/sports12010037
27. Mercado-Palomino, E., Aragón-Royón, F., Richards, J., Benítez, J. M., & Ureña Espa, A. (2021). The influence of limb role, direction of movement and limb dominance on movement strategies during block jump-landings in volleyball. *Scientific Reports*, *11*(1), 23668. https://doi.org/10.1038/s41598-021-03106-0
28. Mueangson, O., Keawmai, W., Pabbumnan, R., Chukaithai, A., Thongdonmuean, P., & Vongvaivanichakul, P. (2025). The Effects of Eye Exercises on Eye-Hand Coordination, Cognitive Functions and Balance Ability of the Elderly: A Randomized Controlled Trial. *International Journal of Environmental Research and Public Health*, *22*(10), 1564. https://doi.org/10.3390/ijerph22101564
29. Musa, R. M., Abdul Majeed, A. P. P., Suhaimi, M. Z., Abdullah, M. R., Mohd Razman, M. A., Abdelhakim, D., & Abu Osman, N. A. (2023). Identification of high-performance volleyball players from anthropometric variables and psychological readiness: A machine-learning approach. *Proceedings of the Institution of Mechanical Engineers, Part P: Journal of Sports Engineering and Technology*, *237*(4), 317–324. https://doi.org/10.1177/17543371211045451
30. Musall, S., Kaufman, M. T., Juavinett, A. L., Gluf, S., & Churchland, A. K. (2019). Single-trial neural dynamics are dominated by richly varied movements. *Nature Neuroscience*, *22*(10), 1677–1686. https://doi.org/10.1038/s41593-019-0502-4
31. Ngadiyana, H. (2020). The Effect of Eye-Hand Coordination Training on Accuracy of Service in Volleyball Players. *Proceedings of the 1st South Borneo International Conference on Sport Science and Education (SBICSSE 2019)*. Paris, France: Atlantis Press. https://doi.org/10.2991/assehr.k.200219.040
32. Nuzzo, J. L. (2020). The Case for Retiring Flexibility as a Major Component of Physical Fitness. *Sports Medicine*, *50*(5), 853–870. https://doi.org/10.1007/s40279-019-01248-w

33. Pajar Juanda, Iyakrus, & Ahmad Richard Victorian. (2024). The Relationship Between Arm Length and Arm Muscle Power with the Chest Pass Ability. *ACTIVE: Journal of Physical Education, Sport, Health and Recreation*, *13*(2), 390–396. https://doi.org/10.15294/peshr.v13i2.4910
34. Rafi Tri Indarwan, & Adi S. (2025). Analysis of Endurance Training in Volleyball: A Systematic Literature Review. *Indonesian Journal for Physical Education and Sport*, *6*(2), 56–66. https://doi.org/10.15294/inapes.v6i2.27083
35. Ramasamy, Y., Usman, J., Razman, R., Wei, Y. M., Towler, H., & King, M. (2023). A Systematic Review of the Biomechanical Studies on Shoulder Kinematics in Overhead Sporting Motions: Types of Analysis and Approaches. *Applied Sciences*, *13*(16), 9463. https://doi.org/10.3390/app13169463
36. Ranchordas, M. K., Dawson, J. T., & Russell, M. (2017). Practical nutritional recovery strategies for elite soccer players when limited time separates repeated matches. *Journal of the International Society of Sports Nutrition*, *14*(1). https://doi.org/10.1186/s12970-017-0193-8
37. Rebelo, A., Valente-dos-Santos, J., Pires, I. G., Arrais, I., Pereira, J. R., & Turner, A. N. (2025). Strength and Conditioning for Volleyball: A Review. *Strength & Conditioning Journal*, *47*(5), 499–517. https://doi.org/10.1519/SSC.0000000000000895
38. Rein, R., Raabe, D., & Memmert, D. (2017). "Which pass is better?" Novel approaches to assess passing effectiveness in elite soccer. *Human Movement Science*, *55*, 172–181. https://doi.org/10.1016/j.humov.2017.07.010
39. SAPARİA, A., DLIS, F., & HANIF, A. S. (2020). Plyometric Training Methods and Hand Eye Coordination on Volleyball Smash Skills in Sport Education Students, Tadulako University. *International E-Journal of Educational Studies*, *4*(8), 167–175. https://doi.org/10.31458/iejes.709841
40. Sarmento, H., Martinho, D. V., Gouveia, É. R., Afonso, J., Chmura, P., Field, A., … Clemente, F. M. (2024). The Influence of Playing Position on Physical, Physiological, and Technical Demands in Adult Male Soccer Matches: A Systematic Scoping Review with Evidence Gap Map. *Sports Medicine*, *54*(11), 2841–2864. https://doi.org/10.1007/s40279-024-02088-z
41. Setiawan, H., & Mukarohim, F. (2024). Contribution of Arm Muscle Strength and Hand Eye Coordination to the Lower Service Results of the Mts S Muaro Sijunjung Volleyball Extracurricular Team. *Eduvest - Journal of Universal Studies*, *4*(10), 9699–9714. https://doi.org/10.59188/eduvest.v4i10.43685
42. Skorski, S., Mujika, I., Bosquet, L., Meeusen, R., Coutts, A. J., & Meyer, T. (2019). The Temporal Relationship Between Exercise, Recovery Processes, and Changes in Performance. *International Journal of Sports Physiology and Performance*, *14*(8), 1015–1021. https://doi.org/10.1123/ijspp.2018-0668
43. Söyler, M. (2022). Examination of the effects of reactive agility and planned change of direction skills on Self Defense techniques in private security and protection program students. *Sportis. Scientific Journal of School Sport, Physical Education and Psychomotricity*, *8*(3), 309–328. https://doi.org/10.17979/sportis.2022.8.3.9008

44. Soylu, C., & Altundag, E. (2024). Rewiring for Victory: Neuro-Athletic Training Enhances Flexibility, Serve Speed, and Upper Limb Performance in Elite Volleyball Players—A Randomized Controlled Trial. *Applied Sciences*, *14*(23), 11102. https://doi.org/10.3390/app142311102
45. Spiering, B. A., Mujika, I., Sharp, M. A., & Foulis, S. A. (2021). Maintaining Physical Performance: The Minimal Dose of Exercise Needed to Preserve Endurance and Strength Over Time. *Journal of Strength & Conditioning Research*, *35*(5), 1449–1458. https://doi.org/10.1519/JSC.0000000000003964
46. Stănciulescu, R. (2016). Development of Basic Physical Qualities, Essential Condition for Creating a Competitive Physical Capacity. *Scientific Bulletin*, *21*(1), 54–60. https://doi.org/10.1515/bsaft-2016-0037
47. Suchomel, T. J., Nimphius, S., Bellon, C. R., & Stone, M. H. (2018). The Importance of Muscular Strength: Training Considerations. *Sports Medicine*, *48*(4), 765–785. https://doi.org/10.1007/s40279-018-0862-z
48. Tariq Ismael, A. (2024). Analysis of the Relationship between Certain Biokinematic and Goniometric Variables of the Linear Smash with Explosive Force Upwards, Forwards, and in Volleyball Shooting. *Ascarya: Journal of Islamic Science, Culture, and Social Studies*, *4*(1), 55–65. https://doi.org/10.53754/iscs.v4i1.667
49. Uly, A., Hudain, Muh. A., Adil, A., Kamaruddin, I., & Fahrizal, F. (2025). The Effect of Drill Training on Underhand Passing Ability in High School Students. *ETDC: Indonesian Journal of Research and Educational Review*, *4*(2), 420–432. https://doi.org/10.51574/ijrer.v4i2.3172
50. Wang, B., Wan, B., Chen, S., Zhang, Y., Bai, X., Xiao, W., … Long, B. (2024). A Systematic review of the factors that affect soccer players' short-passing ability—based on the Loughborough Soccer Passing Test. *BMC Sports Science, Medicine and Rehabilitation*, *16*(1), 96. https://doi.org/10.1186/s13102-024-00880-y
51. Wang, X., Soh, K. G., Samsudin, S., Deng, N., Liu, X., Zhao, Y., & Akbar, S. (2023). Effects of high-intensity functional training on physical fitness and sport-specific performance among the athletes: A systematic review with meta-analysis. *PLOS ONE*, *18*(12), e0295531. https://doi.org/10.1371/journal.pone.0295531
52. Waryanti, D., Umar, U., Rifki, M. S., & Masrun, M. (2025). LEARNING STRATEGIES INVOLVING PLAY AND COORDINATION: A PATHWAY TO IMPROVING MOTOR SKILLS. *Prima Magistra: Jurnal Ilmiah Kependidikan*, *6*(3), 355–362. https://doi.org/10.37478/jpm.v6i3.5053
53. Wiemeyer, J., Nacke, L., Moser, C., & 'Floyd' Mueller, F. (2016). Player Experience. In *Serious Games* (pp. 243–271). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-40612-1_9
54. Wu, X. (2023). HIGH-INTENSITY INTERVAL TRAINING IMPACTS ON ENDURANCE OF VOLLEYBALL PLAYERS. *Revista Brasileira de Medicina Do Esporte*, *29*. https://doi.org/10.1590/1517-8692202329012023_0047

55. Young, W., Dos'Santos, T., Harper, D., Jefferys, I., & Talpey, S. (2022). Agility in Invasion Sports: Position Stand of the IUSCA. *International Journal of Strength and Conditioning*, *2*(1). https://doi.org/10.47206/ijsc.v2i1.126

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ORIGINAL SCIENTIFIC PAPER

Rumination in Sports: A Pilot Study on Sports Science Students

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Abstract

The purpose of this study is to examine the rumination perception levels of faculty of sports science students. This study, which used the comparative survey model from quantitative research methods, included 253 university students who actively engage in sports, selected using a convenience sampling method. The Personal Information Form and the "Sports Competition Rumination Scale" were used as data collection tools. Independent groups t-test and one-way analysis of variance (ANOVA) were applied in the analysis of the data. According to the findings, there was no statistically significant difference in the rumination levels of the participants according to the variables of gender, age group, type of sport (individual or team), and department of study. However, post-hoc power analyses revealed that statistical power was low across all comparisons (range: .05–.34), and the findings should therefore be regarded as preliminary rather than conclusive evidence of an absence of demographic effects.

Keywords: *university student, rumination, sports, competitive*

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1. Introduction

Today, achieving athletic success involves more than physical skills. Athletes must also manage their mental and emotional states. In competitive settings, especially at high levels, an athlete's mindset and coping strategies for negative experiences are crucial for performance (Birrer et al., 2012). The tendency to dwell on mistakes or stress after competition is called "rumination" (Roy et al., 2016).

Rumination means focusing on certain thoughts multiple times (Joormann, 2005). It involves repetitively dwelling on negative thoughts (Kirkegaard-Thomsen, 2006). However, not all repetitive thoughts are negative; Watkins (2008) differentiates between unconstructive rumination, which is abstract and self-focused, and constructive repetitive thinking that can support problem-solving and improve performance. Rumination intersects with performance anxiety, motivation, and mental toughness, creating additional challenges in training and competition. Research indicates that when athletes dwell on past mistakes or future concerns, their stress levels increase, which in turn undermines motivation and impairs performance (Raedeke and Smith, 2004; Yılmaz and Mayda, 2024). This cycle of negative thinking constitutes a significant obstacle to athletic achievement (Michel-Kröhler et al., 2023). Identifying ruminative thoughts is key to protecting athletes' mental and physical health. It helps prevent burnout and improve overall performance (Caselli et al., 2008; Watson et al., 2012).

A review of the literature indicates that athletes who engage in ruminative thinking struggle to maintain focus during competition, which has a negative effect on their ability to choose appropriate tactical actions and influences their decision-making processes (Eskiyecek and Sezan, 2025; Kolman et al., 2022). Furthermore, researchers have found that as competition rumination increases, athletes' mental resilience, which refers to their ability to recover from difficulties, and their psychological (cognitive) flexibility, which facilitates their adaptation to changing situations, decrease (Akbulut, 2025; Yılmaz et al., 2024; Yılmaz et al., 2025). It has been noted that high levels of rumination can harm athletes' belief in their ability to succeed and their self-efficacy, and that an increase in athletes' self-efficacy beliefs leads to improved athletic performance (Korkmaz and Demir, 2025). Considering university students involved in sports, they encounter more complex triggers for this negative thought cycle. The university period is a challenging process in which individuals strive to meet academic expectations (exams, graduation, future concerns) while also engaging in intense training and competition to achieve their sporting goals.

Identifying ruminative thoughts is essential for safeguarding athletes' mental and physical health, preventing burnout, and improving performance (Watson et al., 2012; Karafil and Pehlivan, 2023). University student-athletes represent a particularly vulnerable group, as they must simultaneously cope with academic demands and competitive pressures.

Several theoretical grounds motivate the examination of demographic variables in relation to sports competition rumination. With respect to gender, emotion regulation research suggests that women may be more susceptible to ruminative thinking than men, potentially due to socialisation

patterns that encourage inward emotional processing (Nolen-Hoeksema et al., 2004). In sport-specific contexts, however, the shared demands of competitive environments may attenuate such gender differences. Regarding age, cognitive self-regulatory capacities tend to develop across early adulthood, raising the possibility that younger student-athletes may exhibit higher rumination levels than their older counterparts, who may have accumulated greater coping experience. In terms of sport type, athletes in individual sports bear exclusive personal responsibility for performance outcomes, which may intensify post-competition self-focused thinking relative to team sport athletes, who can distribute causal attributions across group members (Roy et al., 2016). Finally, the academic department of sport science students may be relevant insofar as programme-specific demands, occupational expectations, and training loads differ across departments such as coaching education, physical education teaching, sports management, and recreation, potentially creating distinct cognitive stress profiles. Despite these theoretical rationales, it remains unclear whether these factors translate into observable differences in ruminative responding when variance in academic and sport environment is constrained.

Although previous research has extensively examined the relationship between rumination and psychological variables such as mental resilience, cognitive flexibility, and self-efficacy, relatively limited attention has been given to its distribution across fundamental demographic characteristics such as gender, age, sport type, and academic department. Moreover, existing findings regarding these demographic differences are inconsistent and often based on heterogeneous samples, making it difficult to determine whether observed differences reflect true demographic effects or contextual variability.

Accordingly, the present study aims to address this gap by examining rumination levels within a relatively homogeneous group of sport science students, in order to better understand whether rumination is structured by demographic factors or primarily driven by individual cognitive processes.

2. Materials and Methods

The study population consists of individuals who are actively involved in sports and are continuing their education in Türkiye. The study sample includes a total of 253 participants, 129 female and 124 male, selected using convenience sampling. The demographic characteristics of the participants are presented in Table 1.

3. Results

Table 1. *Demographic Information About the Participants*

Variables	Sub-Group	N	%
Gender	Female	129	51.0%

	Male	124	49.0%
Age Group	18-20 Age	56	22.1%
	21-23 Age	138	54.5%
	24 Age and Above	59	23.3%
Department	Physical Education and Sports Teacher Department	43	17.0%
	Coaching Education Department	53	20.9%
	Sports Management Department	109	43.1%
	Recreation Department	48	19.0%
Sport Type	Individual Sports	137	54.2%
	Team Sports	116	45.8%

Research Design

This research is a quantitative study conducted using a comparative survey model, which is a sub-type of the general survey approach. The survey method aims to describe a past or current situation as it exists. Specifically, a descriptive-comparative design was employed to determine whether the independent variables—gender, age, department, and sport type—lead to significant differences in participants' levels of sports competition rumination. This design is particularly appropriate for exploring potential group differences in a natural setting where the independent variables are already present (Büyüköztürk,2018).

Data Collection Tools

The data collection tools used in the study were distributed to participants via Google Forms. In this context, a convenience sampling method was employed.

Personal Information Form

A personal information form consisting of six items was used to obtain detailed information about the participants. This form included questions about gender, age, university, department and sports type.

Sports Competition Rumination Scale

The Sports Competition Rumination Scale, developed by Michel-Kröhler, Krys, and Berti (2023) was adapted to Turkish by Karafil and Pehlivan (2023). The scale consists of six items grouped into a single factor. It uses a 5-point Likert-type rating. The Cronbach's alpha value calculated for the scale was 0.87. The value obtained in the current study was also 0.86.

Ethics Approval

Ethical approval for this research was obtained from the Yalova University Social and Human Sciences Scientific Research Ethics Committee with decision number 2025/223 dated 15.05.2025.

Statistical Analysis

The data obtained within the scope of the research were analyzed using the SPSS software package. The skewness and kurtosis values of the data were examined and found to be between -1 and +1. T-tests and ANOVA were applied to the normally distributed data in Table 2.

Table 2. *Scale Descriptive Statistics*

Scale	x	S.d.	Skewness	Kurtosis	Cronbach's Alpha
Sports Rumination	21.90	5.47	-.618	.225	.861

Results Table 3. *t- Test Results of Sports Competition Rumination According to Gender*

Gender	N	x	S.d.	t	p	Cohen's d
Female	129	22.33	4.86	.225	.822	.157
Male	124	21.47	6.05			

Table 3 shows the t-Test according to the gender variable. No significant difference was found according to the gender variable ($p>0.05$). The mean difference between female and male athletes was 0.86 points (95% CI: −0.50 to 2.22), and the effect size (Cohen's d = 0.157) indicates a small and practically negligible difference, suggesting that gender has minimal influence on sports competition rumination in this sample.

Table 4. *ANOVA Results of Sports Competition Rumination According to Age*

Age Group	N	x	S.d.	F	p	η²
18-20 Age	56	21.75	4.78	.043	.958	.000
21-23 Age	138	21.91	5.84			
24 Age and above	59	22.05	5.30			

Table 4 shows the ANOVA according to the age variable. No significant difference was found according to the age variable ($p>0.05$). Group means ranged narrowly from 21.75 (18–20 age group) to 22.05 (24 and above), with the overall spread suggesting minimal between-group variation. The effect size ($\eta^2 = 0.000$) indicates a negligible practical difference across age groups, suggesting that rumination levels are highly consistent regardless of age within this university student sample.

Table 5. *ANOVA Results of Sports Competition Rumination According to Department*

Department	N	x	S.d.	F	p	η²
Physical Education and Sports Teacher Department	43	20.95	5.68	.539	.656	.006
Coaching Education Department	53	22.26	4.44			
Sports Management Department	109	22.05	5.84			
Recreation Department	48	22.04	5.55			

Table 5 shows the ANOVA according to the department variable. No significant difference was found according to the department variable ($p>0.05$). The largest pairwise mean difference observed was between the Coaching Education Department and the Physical Education and Sports Teacher Department ($\Delta M = 1.31$, 95% CI: −0.77 to 3.39). The effect size ($\eta^2 = 0.006$) reflects a trivial magnitude of difference between departments, indicating that academic program has virtually no practical association with rumination levels among sports science students.

Table 6. *t- Test Results of Sports Competition Rumination According to Sport Type*

Sport Type	N	x	S.d.	t	p	Cohen's d
Individual Sports	137	21.68	5.60	-.713	.476	-0.090
Team Sports	116	22.17	5.35			

Table 6 shows the t-test according to the sport type variable. No significant difference was found according to the sport type variable ($p>0.05$). The mean difference between team and individual sport athletes was 0.49 points (95% CI: −0.86 to 1.84), and the effect size (Cohen's d = −0.090) indicates a negligible difference, suggesting that the structural differences between sport types do not translate into meaningfully different rumination experiences in this population.

4. Discussion

The present pilot study examined whether sports competition rumination differed across four demographic variables — gender, age group, sport type, and academic department — and found no statistically significant differences in any of the comparisons conducted. While this consistent null pattern is noteworthy, it should be interpreted in light of the study's limited statistical power (range: .05–.34), which was insufficient to detect small-to-medium effects. Accordingly, the absence of significant differences does not constitute evidence that demographic group differences are absent in the broader athlete population; rather, these findings are best understood as preliminary observations that warrant replication in adequately powered and more heterogeneous samples. Taken cautiously, the results are nonetheless consistent with theoretical perspectives that position rumination as a cognitive process shaped primarily by individual psychological mechanisms — such as emotion regulation and self-regulatory capacity — rather than by demographic group membership (Nolen-Hoeksema et al., 2004; Michel-Kröhler et al., 2023).

One possible explanation for the observed null pattern could be the characteristics of the study sample. All participants were from sport science faculties, sharing a similar academic background, sport training, and competition experiences. This similarity may limit group differences, masking potential demographic impacts. Studies with more diverse samples have found that factors like gender and sport type can affect psychological outcomes in sports (Nixdorf et al., 2016). Therefore, these findings should be viewed with this limitation in mind, which may have hidden

demographic effects on rumination. The effect sizes across all analyses were small (Cohen's d: -0.090 to 0.157; η^2: 0.000 to 0.006). This indicates that while group differences were not statistically significant, they were also minimal—common in samples with limited variance. Overall, these results are consistent with much research on demographic factors related to sports competition rumination.

Yılmaz et al. (2025), Eskiyecek and Sezan (2025), Akbulut (2025), and Korkmaz and Demir (2025) also found no significant differences in rumination based on gender, age, or sport type, which supports the null pattern in this study. However, Yılmaz and Mayda (2024) found that female athletes had higher rumination levels than male athletes, which is not in line with our findings. This difference is likely due to differences in the study context and methods rather than a direct contradiction. Yılmaz and Mayda (2024) included university students who were active in sports, but not limited to sport science students, which resulted in a more varied sample in terms of training background, academic pressure, and exposure to sport culture. Such differences in sample composition can affect psychological outcomes in sport research (Nixdorf et al., 2016), which may explain the different gender effects found in different studies. A similar explanation applies to comparisons involving age, department, and sport type: studies that found significant differences often had samples with a wider age range, more diverse academic backgrounds, or different competitive levels. Notably, Cevahircioğlu et al. (2023) also found no significant differences in rumination across fields of study, which aligns with our results and suggests that the shared training environment in sport science may reduce differences in rumination between departments. These differences between studies suggest that demographic factors may not have a fixed influence on rumination in sport, but may be affected by the specific cognitive and stress-related demands of athletes' training and competition contexts. The lack of significant differences in rumination across gender, age group, sport type, and academic department is in line with theoretical perspectives that view rumination as a cognitive process influenced by individual psychological mechanisms, such as emotion regulation strategies and self-regulatory capacity, rather than by group characteristics (Nolen-Hoeksema et al., 2004; Michel-Kröhler et al., 2023). In sport-specific frameworks, factors like mental resilience, cognitive flexibility, and self-efficacy have been identified as key determinants of ruminative responses to competition outcomes (Akbulut, 2025; Yılmaz et al., 2024; Korkmaz and Demir, 2025). While the current data do not allow for a direct examination of these psychological variables, they are consistent with this perspective: the similar rumination levels across different demographic subgroups suggest that the cognitive processes underlying post-competition rumination are not organized along demographic lines. Future research that combines demographic and psychological predictors would be better equipped to clarify the relative contributions of each variable to sports competition rumination. The findings of this study, along with existing literature, suggest that future research on sports competition rumination may yield more meaningful insights by focusing on psychological predictors rather than demographic factors.

Limitations

This study has three key limitations that warrant acknowledgment. The homogeneity of the sample constrains the interpretability of the results. All participants were drawn from sport science faculties with comparable academic environments, training regimens, and competition levels. While this consistency supports internal validity, it restricts between-group variability, thereby reducing the sample's sensitivity to demographic differences in rumination. Accordingly, the null

findings should be understood as specific to this population and cannot be taken to imply an absence of demographic effects in more heterogeneous athlete samples.

The study used a cross-sectional design, which involved measuring rumination at one point in time. This limits our ability to draw causal conclusions about the relationship between rumination and demographic factors. We cannot determine if demographic factors influence rumination, or if rumination affects how athletes perceive their demographics, or if other factors such as competitive history, injury, or training load shape both. A longitudinal or experience-sampling design would be better suited to address these issues.

Additionally, a power analysis was not conducted prior to data collection. Post-hoc calculations based on the observed effects revealed that the statistical power was lower than the desired level of .80 for all comparisons: .24 for gender, .11 for sport type, .34 for department, and approximately .05 for age. This means that the design was only capable of detecting larger effects, specifically those with Cohen's $d \geq 0.35$ or $\eta^2 \geq 0.009$, which is higher than what is typically considered a small effect. As a result, the lack of significant findings should not be taken to mean that group differences are small in the broader population. Instead, it highlights the design's limited ability to detect smaller yet meaningful effects. In light of these power limitations, the present study should be interpreted as a pilot investigation, and the null findings regarding demographic variables cannot be taken as evidence of true absence of group differences in the broader population. Future studies should perform power analyses before beginning data collection, aiming for a minimum power of .80 at $\alpha = .05$ to ensure they can detect demographic differences in rumination among athletes.

Future Directions

Building on the present pilot findings, subsequent studies are recommended to examine the associations between sports competition rumination and psychological variables — including mental resilience, cognitive flexibility, and self-efficacy — in order to identify the individual-level mechanisms that may account for variation in ruminative responses to competition.

To identify the situational triggers of rumination in competitive sport — such as coach-related pressure, audience effects, and fear of injury — future research may benefit from qualitative or mixed-method designs incorporating in-depth interviews alongside quantitative measures.

Future studies conducted with more diverse samples, extending beyond sport science populations, would enable a more precise examination of the boundary conditions under which demographic variables relate to sports competition rumination.

5. Conclusions

The findings of the present pilot study indicate that sports competition rumination levels did not differ significantly across gender, age group, sport type, or academic department among sport science students. Given the limited statistical power of the study (range: .05–.34) and the homogeneity of the sample, these results should be regarded as preliminary and context-specific rather than as evidence of a true absence of demographic effects in broader athlete populations. The within-sample uniformity is more plausibly attributed to the shared academic and competitive environment of sport science students than to the irrelevance of demographic factors per se. With respect to practical implications, the present findings do not provide sufficient grounds for recommending uniform or differentiated psychological support programs across demographic subgroups; rather, they suggest that support efforts may be more effectively guided by individual-level psychological assessment than by demographic categorisation. Specifically, given that

rumination levels were similarly distributed across gender, age, sport type, and department, practitioners working with competitive sport science students may find it more productive to screen for individual differences in mental resilience, cognitive flexibility, and self-efficacy — factors that existing literature identifies as meaningful correlates of ruminative responding — rather than assuming that demographic group membership predicts support needs. Such recommendations should, however, be treated as tentative pending replication in adequately powered studies with more heterogeneous samples. Taken together, this study contributes a methodologically transparent pilot investigation to the emerging literature on sports competition rumination, and underscores the need for future research to examine psychological determinants — including mental resilience, cognitive flexibility, and self-efficacy — alongside demographic variables in order to develop a more complete understanding of ruminative processes in competitive sport contexts.

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References

1. Akbulut, V. (2025). Karate sporcularında müsabaka ruminasyonu, psikolojik esneklik ve zihinsel dayanıklılık arasındaki ilişki. *Gümüşhane Üniversitesi Sağlık Bilimleri Dergisi, 14*(3), 954-964.
2. Birrer, D., Röthlin, P., & Morgan, G. (2012). Mindfulness to enhance athletic performance: Theoretical considerations and possible impact mechanisms. *Mindfulness, 3*(4), 235-246.
3. Büyüköztürk, Ş. (2018). Sosyal bilimler için veri analizi el kitabı. Pegem Atıf İndeksi, 1-214
4. Caselli, G., Bortolai, C., Leoni, M., Rovetto, F., & Spada, M. M. (2008). Rumination in problem drinkers. *Addiction Research & Theory, 16*(6), 564-571.
5. Cevahircioğlu, B., Karakuş, K., & Şenel, E. (2023). Sporcularda zihinsel antrenman ile müsabaka ruminasyonu arasındaki ilişki. *Kilis 7 Aralık Üniversitesi Beden Eğitimi ve Spor Bilimleri Dergisi, 7*(2), 292-305.
6. Eskiyecek, C. G., & Sezan, T. (2025). Çim hokeycilerde ruminatif düşüncelerin taktiksel becerilere etkisi: Kesitsel bir araştırma. *SPORMETRE Beden Eğitimi ve Spor Bilimleri Dergisi, 23*(1), 139-153.
7. Joormann, J. (2005). Inhibition, rumination, and mood regulation in depression. R. W. Engle, G. Sedek, U. von Hecker, & D. N. McIntosh (Eds.), *Cognitive limitations in aging and psychopathology* içinde (ss. 275–312). Cambridge: Cambridge University Press.
8. Karafil, A. Y., & Pehlivan, E. (2023). Spor müsabakaları ruminasyon ölçeğinin Türkçeye uyarlanması geçerlik ve güvenirlik çalışması. *Gazi Beden Eğitimi ve Spor Bilimleri Dergisi, 28*(1), 8-15. https://doi.org/10.53434/Gbesbd.1158522
9. Kirkegaard-Thomsen, D. (2006). The association between rumination and negative affect: A review. *Cognition and Emotion, 20*(8), 1216-1235.
10. Kolman, N. S., Huijgen, B. C., van Heuvelen, M. J., Visscher, C., & Elferink-Gemser, M. T. (2022). Self-assessed tactical skills in tennis players: Psychometric evaluation of the

Tactical Skills Questionnaire in Tennis. *Frontiers in Sports and Active Living, 4*, 988595. https://doi.org/10.3389/fspor.2022.988595

11. Korkmaz, C., & Demir, D. (2025). Yüzücülerde müsabaka ruminasyonu ve öz yeterlik düzeylerinin incelenmesi. *Dede Korkut Spor Bilimleri Dergisi, 3*(1), 129-140. https://doi.org/10.71243/dksbd.1682416
12. Michel-Kröhler, A., Krys, S., & Berti, S. (2023). Development and preliminary validation of the sports competition rumination scale (SCRS). *Journal of Applied Sport Psychology, 35*(2), 265–283. https://doi.org/10.1080/10413200.2021.1961921
13. Nixdorf, I., Frank, R., & Beckmann, J. (2016). Comparison of athletes' proneness to depressive symptoms in individual and team sports: Research on psychological mediators in junior elite athletes. *Frontiers in psychology*, *7*, 893.
14. Nolen-Hoeksema, S., Corte, C., & Vohs, K. (2004). Gender and self-regulation. In R. F. Baumeister & K. D. Vohs (Eds.), Handbook of self-regulation: Research, theory, and application (pp. 412–420). The Guilford Press.
15. Raedeke, T. D., & Smith, A. L. (2004). Development of the Athlete Burnout Questionnaire. *The Sport Psychologist, 18*(1), 49-68.
16. Roy, M. M., Memmert, D., Frees, A., Radzevick, J., Pretz, J., & Noël, B. (2016). Rumination and performance in dynamic, team sport. *Frontiers in Psychology, 6*, 2038.
17. Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychological Bulletin, 134*(2), 163–206. https://doi.org/10.1037/0033-2909.134.2.163
18. Watson, L. A., Berntsen, D., Kuyken, W., & Watkins, E. R. (2012). The characteristics of involuntary and voluntary autobiographical memories in depressed and never depressed individuals. *Consciousness and Cognition, 21*(3), 1382-1392.
19. Yılmaz, B. H., Kılınç, A., İlhan, E. L., Eski, T., & Bayrakdar, A. (2025). The relationship between mental toughness and rumination in athletes. *Physical Education of Students, 29*(6), 446-456.
20. Yılmaz, B. H., Yetim, D., Özdemir, M., Üzer, Y., & Gül, E. (2024). Sporcularda ruminasyon ile bilişsel esneklik arasındaki ilişki. *Yalova Üniversitesi Spor Bilimleri Dergisi, 3*(1), 127-139.
21. Yılmaz, T., & Mayda, M. H. (2024). Aktif spor yapan üniversite öğrencilerinin ruminasyon düzeylerinin incelenmesi. *Gaziantep Üniversitesi Spor Bilimleri Dergisi, 9*(2), 194-205.

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ORIGINAL SCIENTIFIC PAPER

Effectiveness of a Monitored and Individualized Physiotherapy Program on Gait Recovery in Post-Stroke Patients: A Comparative Experimental Study

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Abstract

Gait impairment is one of the most common and disabling consequences of stroke, significantly affecting functional independence and quality of life. Optimizing rehabilitation strategies remains a key objective in neurorehabilitation. This study aimed to evaluate the effectiveness of a monitored and individualized physiotherapy program compared to a conventional rehabilitation protocol in improving gait performance in post-stroke patients. A randomized controlled study was conducted on 48 post-stroke patients aged 40–50 years, allocated into a control group (n = 24) and an experimental group (n = 24). Both groups underwent a 9 weeks rehabilitation program. The experimental group received a monitored, individualized physiotherapy intervention, while the control group followed a conventional protocol. Gait performance was assessed pre- and post-intervention using the Dynamic Gait Index (DGI) and Lower Extremity Functional Scale (LEFS). Both groups showed significant improvements over time ($p < .001$). However, the experimental group demonstrated greater improvements in walking speed, dynamic balance, and lower limb functional capacity ($p < .05$). The interaction effect between time and group was statistically significant, indicating superior outcomes associated with the monitored intervention. The findings suggest that a monitored and individualized physiotherapy program may be more effective than conventional rehabilitation in improving gait parameters in post-stroke patients. Further studies with larger samples are needed to confirm these results.

Keywords: *stroke rehabilitation, gait recovery, physiotherapy, randomized controlled study*

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1. Introduction

Gait impairment is one of the most frequent and disabling consequences of stroke, significantly reducing patients' functional independence and quality of life.

Stroke results in neurological dysfunction that leads to hemiplegia, representing one of the most severe motor impairments, commonly characterized by deficits in voluntary motor control. Among these, impaired ankle dorsiflexion is particularly significant, as it disrupts normal gait biomechanics and compromises functional ambulation.

Hemiplegia is frequently associated with hypertonia and spasticity of the flexor muscle groups. The upper limb is typically positioned in shoulder abduction with forearm pronation and flexion of the wrist and fingers. Similarly, the lower limb on the affected side demonstrates abnormal motor patterns, with reduced knee extension during the stance phase of gait and a persistent plantarflexed foot posture, contributing to compensatory and inefficient gait patterns.

As a result of post-stroke neuromotor impairment, gait velocity is markedly reduced, accompanied by increased spatial-temporal asymmetry and an enlarged, unstable base of support. Locomotion is frequently characterized by circumduction of the paretic lower limb, reflecting compensatory movement strategies secondary to impaired ankle dorsiflexion and reduced distal motor control (Pirker, 2017). Post stroke gait typically exhibits disrupted intersegmental coordination, abnormal muscle activation timing, and reliance on compensatory kinematic adjustments involving the non affected limb and trunk to maintain functional ambulation (Lofrumento et al., 2021). A hallmark of hemiplegic gait is the absence of physiological heel strike during initial contact on the affected side. Instead, weight acceptance is achieved through excessive hip flexion and altered swing-to-stance transition mechanics, reflecting impaired central motor planning and defective neuromuscular synergy organization during the gait cycle (Simonsen, 2014).

Restoration of gait function represents a central objective of neurorehabilitation, where structured physiotherapy interventions play a pivotal role in promoting locomotor recovery. Targeted therapeutic exercise programs are designed to optimize neuromuscular performance by enhancing muscle strength, improving postural stability, and restoring temporal spatial coordination of the gait cycle.

Contemporary evidence supports the clinical utility of spatiotemporal gait parameters as reliable quantitative biomarkers of functional recovery. Parameters such as gait velocity, step length, and step symmetry provide objective insights into motor performance and rehabilitation progress. The systematic integration of these measures into individualized rehabilitation protocols facilitates precision-based therapeutic modulation and improves functional recovery outcomes.

Therefore, this article aims to present contemporary kinesiological strategies to improve gait in individuals with disabling conditions, emphasizing physiotherapy interventions and gait parameter monitoring as tools to optimize rehabilitation.

This approach integrates theoretical and practical aspects of physiotherapy with modern objective assessment technologies, supporting the development of effective, individualized post-stroke rehabilitation protocols.

2. Materials and Methods

Recovery of gait function is a priority objective of post-stroke rehabilitation programs, since gait independence significantly influences patient autonomy, social reintegration, and quality of life. We aim to evaluate the impact of a complex rehabilitation program, structured and adapted to each patient's individual characteristics, on walking speed, dynamic balance, and lower limb functional level.

It was hypothesized that a monitored and individualized physiotherapy program would lead to greater improvements in gait-related functional outcomes compared to conventional rehabilitation in post-stroke patients.

Experimental Design

The present study is motivated by the need to optimize physiotherapy interventions for gait rehabilitation following stroke, considering the high prevalence of locomotor disabilities and their major impact on functional independence. Since conventional rehabilitation programs demonstrate variable effectiveness, a comparative evaluation of a monitored protocol is required, as it may allow superior individualization and progressive adaptation of therapy.

By employing a standardized assessment battery and an experimental design with a control group, the study aims to objectively determine the differences between the applied interventions and to support the development of optimized therapeutic strategies.

The main objective of this study is to evaluate the effectiveness of a monitored physiotherapy program for gait rehabilitation in post-stroke patients. The research aims to compare the outcomes obtained after applying the experimental program with those recorded under a conventional rehabilitation protocol, using a standardized battery of two functional tests.

The present study was designed as a randomized controlled experimental study with two parallel groups, aiming to evaluate the effectiveness of a monitored physiotherapy program compared to a conventional rehabilitation protocol in post-stroke patients.

Participants were randomly allocated into either the control group or the experimental group using a simple randomization procedure (computer-generated random numbers). Allocation was performed by an independent researcher not involved in the intervention process. Due to the nature of the intervention, blinding of participants and therapists was not feasible. However, outcome assessment was conducted by an independent evaluator, blinded to group allocation.

Participants

The study comprised a total of 48 patients diagnosed with stroke within the previous six months, aged between 40 and 50 years. Participants were allocated into two groups: a control group (n = 24) and an experimental group (n = 24). The age range was deliberately restricted to minimize variability and to focus on younger stroke survivors, a population characterized by a rising incidence and a considerable potential for functional recovery. Ethical considerations were strictly observed throughout the study. All participants were informed about the purpose and procedures of the research and provided written informed consent prior to their inclusion in the study.

Eligibility was established based on the following criteria: a confirmed diagnosis of stroke, inclusion in the post-acute phase, age between 40 and 50 years, the ability to ambulate with or without assistive devices, the presence of gait impairments, and clinically evident foot drop.

The selection of the 40–50 year age interval was intentional, aiming to ensure cohort homogeneity with respect to neuroplastic potential, functional recovery capacity, and neuromuscular responsiveness to rehabilitation interventions. Individuals within this age range are less likely to present confounding factors such as advanced degenerative changes, multimorbidity, or age-related sarcopenia, which could independently influence gait patterns and rehabilitation outcomes.

At the same time, this group frequently exhibits persistent post-stroke locomotor deficits, including dorsiflexor weakness associated with foot drop, making it particularly relevant for targeted gait rehabilitation strategies.

Although participants did not exhibit severe balance impairments, they demonstrated measurable functional gait deficits identifiable through dynamic assessment instruments such as the Dynamic Gait Index. Gait performance was evaluated pre- and post-intervention using the Dynamic Gait Index (DGI) and the Lower Extremity Functional Scale (LEFS), allowing for a comprehensive assessment of both dynamic balance during ambulation and lower limb functional capacity.

Intervention

The study was based on the hypothesis that the monitored intervention would generate significantly superior improvements in gait parameters compared to the conventional therapeutic approach. The research adopted a parallel-group experimental design, with two study arms (control and experimental), each comprising 24 subjects, enabling a comparative analysis of functional progression and supporting the validation of the effectiveness of the proposed rehabilitation protocol. The intervention was conducted over a period of 9 weeks, with a frequency of three sessions per week. Each session lasted approximately 45–60 minutes and was administered by licensed physiotherapists with experience in neurorehabilitation.

The experimental group followed a monitored and individualized physiotherapy program based on neurorehabilitation principles, including task-oriented training, progressive loading, movement repetition, and proprioceptive and balance training. Exercise intensity and complexity were progressively adjusted based on individual patient performance and tolerance.

The rehabilitation protocol included proximal stability exercises, gait phase training, ankle mobility and dorsiflexion facilitation, and coordination tasks. An ankle–foot orthosis (AFO) was used consistently during the intervention period. The control group followed a conventional rehabilitation program consisting of general mobility exercises, muscle strengthening, and standard gait training, without individualized progression or systematic monitoring.

Presentation of the Test Battery

To assess gait parameters, a structured battery of two standardized tests was employed to evaluate the functional capacity of the paretic lower limb, the ability to adapt gait to varying environmental demands, and the extent to which participants could approximate a physiological gait pattern.

Functional gait assessment was conducted at baseline (pre-intervention) and repeated at the end of the rehabilitation period (post-intervention), ensuring consistency through the use of a standardized evaluation protocol.

To objectively determine the effectiveness of the intervention on gait performance, two validated and reliable clinical instruments were utilized. These measures are widely recognized for their applicability in neurological populations and provide complementary insights into dynamic balance, gait adaptability, and lower limb functional performance.

1. The Dynamic Gait Index (DGI) is an assessment tool designed to evaluate the ability to adapt gait to varying environmental and functional demands, such as changes in direction, obstacle negotiation, and speed modulation, making it particularly useful for assessing fall risk. The test consists of 8 items with different task requirements. The evaluated abilities include steady-state walking, walking at variable speeds, walking while performing head movements in different directions, walking over and around obstacles, turning during gait, and stair climbing (Herman et al., 2009; Shumway-Cook et al., 2013);

2. The Lower Extremity Functional Scale (LEFS) is a functional self-report questionnaire used to assess patient autonomy and perceived lower limb functional capacity during activities of daily living. The LEFS consists of 20 items evaluating the individual's ability to perform fundamental functional tasks, including walking, stair climbing, and transferring from sitting to standing positions. Research evidence has demonstrated that the LEFS is a reliable and valid clinical tool for assessing the impact of various pathological conditions on lower limb function (Mehta et al., 2016).

The selection of this test battery enables a comprehensive assessment of gait performance by integrating both objective parameters (such as walking speed and dynamic balance) and the functional as well as subjective dimensions of recovery. Based on the initial evaluation and the identified functional characteristics of the patients, a therapeutic intervention program was designed and implemented, aiming to optimize gait parameters with an emphasis on progressive loading, individualized adaptation, and systematic monitoring of functional improvement throughout the rehabilitation process.

Rehabilitation intervention proposal

The intervention was implemented over a nine-week period, with participants engaging in three sessions per week. Each session lasted approximately 45 to 60 minutes and was delivered by licensed physiotherapists specialized in neurorehabilitation. The structured frequency and duration of the sessions were designed to ensure consistent therapeutic exposure while allowing adequate recovery time between sessions. Furthermore, the involvement of experienced clinicians ensured the standardized application of intervention protocols, as well as the adaptation of exercises to

individual patient needs and functional capacities, thereby optimizing the overall effectiveness of the rehabilitation process.

A key component of the rehabilitation program was the integration of an ankle–foot orthosis (AFO) as an assistive device to enhance gait mechanics. The orthosis was consistently utilized throughout the intervention period to augment proprioceptive input, reinforce kinesthetic memory, and support motor relearning processes associated with post-stroke gait recovery.

The structure of the intervention was individualized based on the initial assessment, taking into account the severity of motor deficit, degree of spasticity, level of postural control, and baseline functional performance. The therapeutic program aimed to restore the physiological motor pattern of gait through interventions targeting both proximal control (postural control and trunk stability) and distal control (selective control of the affected lower limb).

The neuromotor facilitation component incorporated principles of the Bobath concept, with an emphasis on postural tone normalization, inhibition of pathological motor patterns, and facilitation of balance reactions, as well as Proprioceptive Neuromuscular Facilitation (PNF) techniques, used to promote selective recruitment of motor units and improve intersegmental coordination.

Proximal stability training included exercises targeting activation of the abdominal and paravertebral musculature, controlled trunk rotation movements, and postural alignment exercises in standing position, with the aim of optimizing center of gravity control and facilitating efficient load transfer during gait. Gait re-education was structured according to the analysis of the gait cycle phases. During the stance phase, the focus was on improving hip extension, ensuring pelvic stabilization in the frontal plane, and enhancing knee joint control. During the swing phase, interventions were directed toward facilitating knee flexion and ankle dorsiflexion in order to minimize circumduction and other compensatory movement strategies. The intervention also incorporated specific exercises to improve ankle joint mobility and distal neuromuscular control.

Balance and coordination training was performed through proprioceptive exercises, controlled weight-shifting activities, variations in gait speed and direction and gait adaptation to changing environmental conditions, in accordance with the principles of progressive functional training. Intervention monitoring was conducted through periodic functional assessments, qualitative observation of gait parameters (including symmetry, step length, and postural stability), and progressive adjustment of task complexity and exercise intensity. This approach allowed continuous adaptation of the therapeutic program to individual patient responses, thereby optimizing functional recovery outcomes.

Through its structured, progressive, and individualized design, the proposed intervention aimed to improve the temporospatial parameters of gait, enhance neuromuscular control, and increase the level of functional independence in post-stroke patients. The combination of different kinetic strategies was intended to optimize gait biomechanics and increase the effectiveness of physiotherapy intervention. Continuous monitoring of patient progress allowed for the permanent adjustment of the rehabilitation program in order to maximize functional outcomes. In this context, the therapeutic intervention was oriented toward facilitating motor recovery, improving postural control, and increasing independence in activities of daily living, thereby contributing to the

improvement of patients' quality of life. Furthermore, the therapeutic approach aimed to stimulate neuroplasticity and reinforce correct movement patterns through repetitive, task-specific training.

The proposed rehabilitation program is structured in progressive stages and incorporates a combination of passive, active-assisted, and active exercises, targeting both joint mobility and the re-education of neuromuscular control and gait patterns. The initial stage is predominantly analytical, focusing on stretching the musculotendinous structures that limit hip mobility and on improving the range of motion at the hip and knee joints. Subsequently, the program integrates exercises aimed at facilitating muscle activation and selectively strengthening the main muscle groups involved in gait, particularly the hip flexors, extensors, abductors, and adductors, as well as the quadriceps and hamstrings.

The final stage of the program is functional and task-specific, focusing on gait re-education under progressively challenging conditions. This includes variations in movement planes, obstacle negotiation, unsupported walking, the use of added resistance, and walking on unstable or inclined surfaces. Exercise progression is achieved through increasing motor task complexity, reducing external support, and introducing temporal and biomechanical constraints, with the goal of stimulating neuromotor adaptation, intersegmental coordination, and postural control.

Overall, the program is characterized by a systematic, individualized, and progressive approach that combines principles of neuromotor re-education with functional gait-specific exercises, thereby supporting the optimization of gait parameters and enhancing functional independence in post-stroke patients.

The proposed gait rehabilitation program differs from standardized rehabilitation protocols through its individualized, deficit-oriented approach. While conventional protocols typically rely on fixed exercise sequences and progression criteria applied uniformly across patients, the present program was specifically tailored to each participant based on their functional impairments, particularly gait asymmetry and the presence of foot drop.

Unlike standardized interventions that emphasize general motor recovery, the developed program integrates task-specific and context-dependent gait training, with a focus on improving dorsiflexor activation, dynamic balance, and adaptability to environmental challenges. Exercise selection, intensity, and progression were continuously adjusted according to each participant's performance and response to therapy, allowing for a more targeted and responsive rehabilitation process. Furthermore, the program places greater emphasis on the restoration of a near-physiological gait pattern, rather than solely improving mobility or independence. This includes specific strategies aimed at correcting compensatory mechanisms commonly observed in post-stroke gait. In contrast, standardized approaches often prioritize functional ambulation without systematically addressing underlying biomechanical deficits.

Statistical Analysis

Statistical analysis was performed using a mixed-design ANOVA (2×2), with group (control vs. experimental) as the between-subject factor and time (pre- vs. post-intervention) as the within-subject factor. Prior to analysis, the assumptions of normality and homogeneity of variance were assessed. Statistical significance was set at $p < .05$, while effect sizes (η^2) and confidence intervals were also calculated to provide a more comprehensive interpretation of the results.

3. Results

In order to test the formulated hypotheses, statistical analysis was performed on the data obtained following the application of the functional test battery. The results are presented comparatively for the two groups, highlighting within-group progression and between-group differences recorded after the 9-week intervention period. Statistical analysis was conducted using a mixed-design ANOVA model (2×2), with the between-subjects factor representing the type of intervention (control group vs. experimental group) and the within-subjects factor representing the evaluation moment (pre- and post-intervention).

Results of gait parameter assessment using the Dynamic Gait Index

The results demonstrated superior functional improvement in the experimental group compared to the control group. At baseline, the control group obtained a mean Dynamic Gait Index score of 11.50, which increased to 18.62 following the intervention, corresponding to a 61.91% improvement.

Despite this progress, the final mean score remained within a range associated with persistent gait impairment and elevated fall risk. In the experimental group, the baseline mean score was 10.95, increasing to 20.70 post-intervention, representing an 89.04% improvement. This result indicates a substantial functional gain, placing participants within a range associated with improved gait performance and reduced fall risk. Overall, the experimental group demonstrated greater improvement than the control group, with a 27.13 percentage point difference between groups. These findings indicate superior functional recovery in the experimental group, as shown in Table 1, which presents baseline and post-intervention Dynamic Gait Index scores and improvement rates for both groups.

Table 1. *Results obtained for the Dynamic Gait Index*

	Results obtained for the Dynamic Gait Index		
	Initial assessment	**Final assessment**	**Progress rate**
Mean of the control group	***11.5***	***18.62***	***61.91%***
Mean of the experimental group	***10.95***	***20.70***	***89.04 %***

As shown in figure 1, both groups demonstrated improvements in Dynamic Gait Index scores from baseline to post-intervention. However, a greater increase was observed in the experimental group. Similarly, figure 2 indicates that the experimental group exhibited a substantially higher percentage improvement in Dynamic Gait Index scores compared with the control group.

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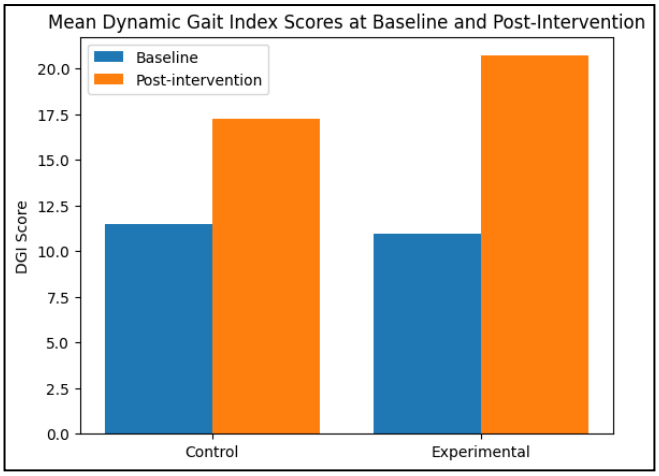

Figure 1. *Mean Dynamic Gait Index scores at baseline and post-intervention for both groups*

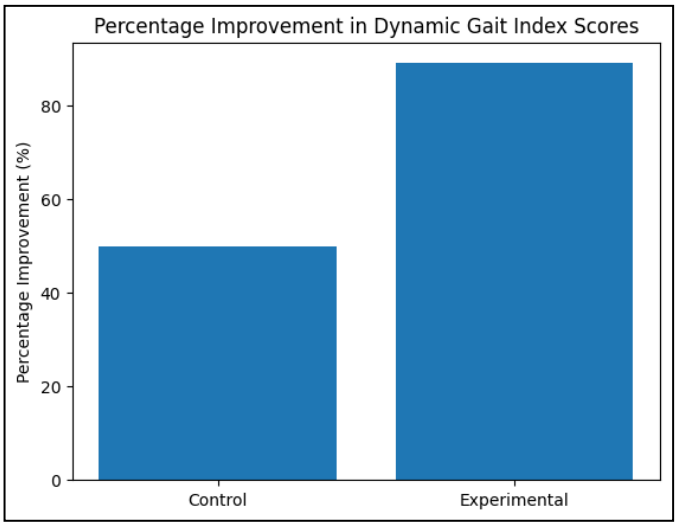

Figure 2*. Percentage improvement in Dynamic Gait Index scores for both groups*

A mixed-design ANOVA (2 × 2) was conducted to examine the effects of TIME (initial vs. final assessment) and GROUP (control vs. experimental) on Dynamic Gait Index scores.

The results indicated a significant main effect of TIME, $F(1, 46) = 1339.58$, $p < .001$, $\eta^2 = .97$, suggesting a substantial overall improvement in Dynamic Gait Index scores from the initial to the final assessment across both groups.

A significant main effect of GROUP was also observed, $F(1, 46) = 51.39$, $p < .001$, $\eta^2 = .10$, indicating differences between the control and experimental groups regardless of measurement time. In addition, the interaction between TIME and GROUP was significant, $F(1, 46) = 51.39$, $p < .001$, $\eta^2 = .10$, showing that the experimental group demonstrated a significantly greater improvement over time compared to the control group. Post-hoc comparisons confirmed that participants in the experimental group achieved higher Dynamic Gait Index scores at the final assessment ($M = 20.70$) compared to the control group ($M = 18.62$), $p < .05$. Overall, the results demonstrate that both groups improved in gait performance following the intervention period; however, the experimental group showed significantly greater gains. These findings suggest that

the applied intervention was more effective in enhancing dynamic gait parameters and reducing fall risk compared to the standard condition.

As illustrated in **figure 3**, a clear time × group interaction is observed, with both groups improving over time, but with a more pronounced increase in the experimental group compared to the control group.

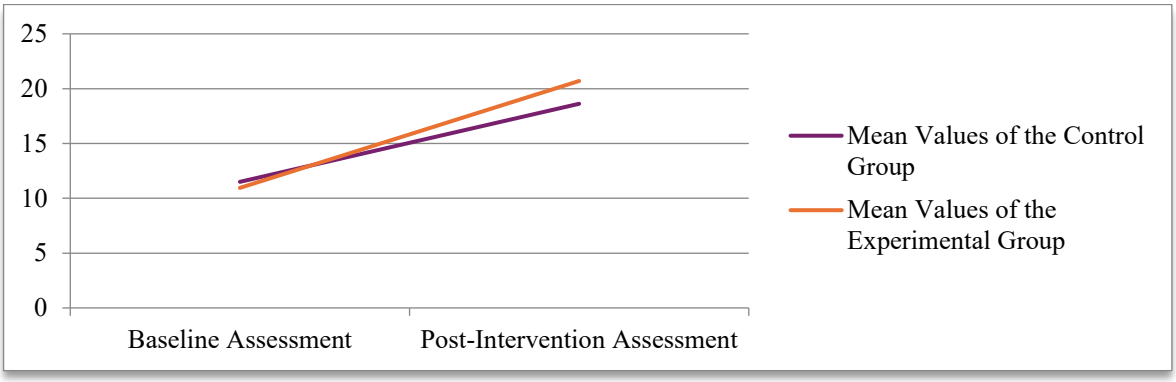

Figure 3. *Interaction effect of time and group on mean Dynamic Gait Index scores.*

Results of gait parameter assessment using the Lower Extremity Functional Scale

Results of gait parameter assessment using the Lower Extremity Functional Scale (LEFS) demonstrated marked functional improvement in both groups. At baseline, the control group recorded a mean score of 18.58 points, corresponding to severe functional limitation, while the experimental group had a comparable baseline value of 17.45 points.

Following intervention, the control group showed an increase to a mean LEFS score of 49.79 points, with improvement reaching 168%, indicating a transition toward mild functional limitation. In contrast, the experimental group demonstrated a greater increase, reaching a post-intervention mean score of 64.95 points, corresponding to a functional gain of 272.2%.

Overall, the experimental group exhibited superior functional recovery compared to the control group, suggesting greater effectiveness of the applied intervention protocol. Detailed results are presented in table 2, which summarizes baseline and post-intervention LEFS mean scores and the calculated percentage improvement for both groups. As shown in figure 4, both groups improved in Lower Extremity Functional Scale (LEFS) scores from baseline to post-intervention, with a greater increase in the experimental group. Figure 5 similarly shows a higher percentage improvement in LEFS scores for the experimental group compared with the control group.

Table.2. *Results obtained from the LEFS scale*

	Results obtained from the LEFS scale		
	Initial assessment	**Final assessment**	**Progress rate**
Mean of the control group	***18.58***	***49.79***	***168.00%***
Mean of the experimental group	***17.45***	***64.95***	***272.20%***

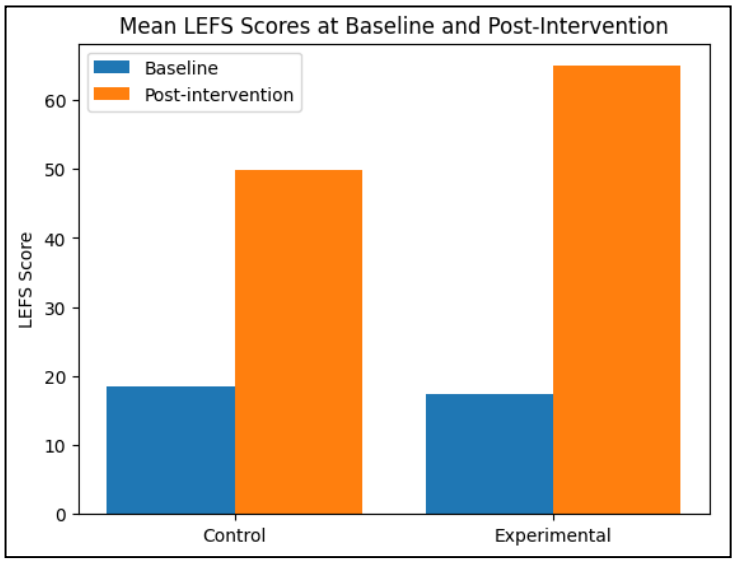

Figure 4. *Mean LEFS Scale scores at baseline and post-intervention for both groups*

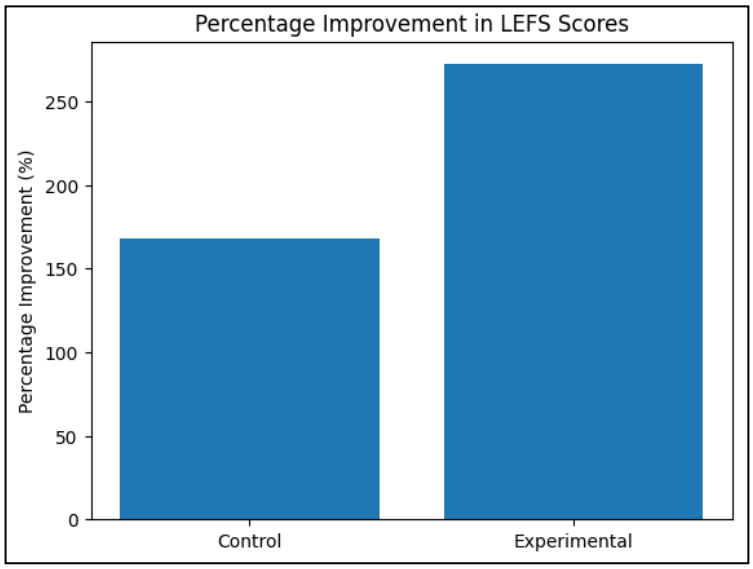

Figure 5. *Percentage improvement in LEFS Scale for both groups*

According to the recorded data, there was a significant main effect of the ***TIME*** variable on LEFS scores, **F (1, 46) = 1807.46, p < .001, η^2 = .98**. Additionally, mean LEFS scores were significantly higher at the final assessment (**M = 57.37; SD = 9.66**) compared to the initial assessment (**M = 18.02; SD = 2.77**), with **p < .001**. There was also a significant main effect of the ***GROUP*** variable (the two treatment categories) on LEFS scores, **F (1, 46) = 53.31, p = .001, η^2 = .54**. Participants in the experimental group achieved a higher mean LEFS score (**M = 41.21**) compared to the control group (**M = 34.19**), **p = .001**, as measured using the Lower Extremity Functional Scale (LEFS).

For LEFS functional scores, all statistical test results indicated rejection of the null hypotheses. Therefore, the working hypothesis stating that the application of specific intervention strategies

leads to significantly greater improvements compared to standard rehabilitation is supported by the presented data.

Figure 6 illustrates the changes in mean LEFS scores from baseline to post-intervention in both groups, showing improvements in both the control and experimental groups, with a greater increase observed in the experimental group.

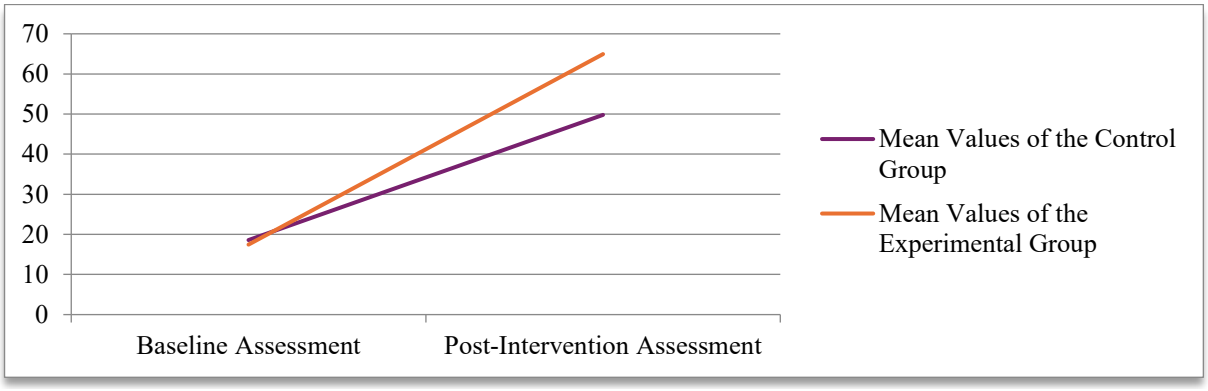

Figure 6. *Interaction effect of time and group on mean* ***Lower Extremity Functional Scale***

4. Discussion

The study hypothesis stated that a monitored physiotherapy program would lead to superior improvements in gait parameters compared to conventional rehabilitation in post-stroke patients. The findings of the present study support this hypothesis, as a significant interaction effect between time and intervention group was observed, indicating greater functional improvement in the experimental group.

Participants who underwent the monitored physiotherapy program demonstrated better outcomes in walking speed, dynamic balance, and lower limb functional performance compared to those receiving conventional rehabilitation. Improvements in the Dynamic Gait Index suggest enhanced postural control and better adaptability during gait, while gains in the Lower Extremity Functional Scale indicate improved functional use of the affected limb.

The rehabilitation protocol also included the use of an ankle–foot orthosis (AFO), aimed at improving ankle stability and facilitating a more efficient gait pattern in participants with foot drop. The observed outcomes therefore reflect the combined effect of orthotic support and task-specific physiotherapy, although the independent contribution of the AFO cannot be determined within this study design.

The improvements observed in the Dynamic Gait Index indicate an increased capacity to adapt to variable environmental conditions and enhanced postural stability during walking. This aspect is particularly important from a clinical perspective, as dynamic balance represents a key determinant in fall prevention among neurological patients. The results suggest that the integration of proprioceptive exercises and progressive functional training contributed to the improvement of postural control.

Furthermore, the results obtained from the Lower Extremity Functional Scale highlight superior recovery of the functional capacity of the affected lower limb within the experimental group. This improvement may be explained by the complex therapeutic approach, which combined neuromotor facilitation, gait phase training, and proximal stability exercises. Improved proximal control biomechanically facilitates distal segment performance, contributing to more efficient gait patterns.

From a clinical perspective, the functional improvements may be associated with task-oriented training and progressive rehabilitation strategies commonly used in neurorehabilitation practice. These approaches support motor relearning and functional recovery following stroke. Methodological limitations, including the relatively small sample size and restricted age range, should be considered when interpreting the results.

5. Conclusions

The monitored and individualized physiotherapy program demonstrated superior effectiveness compared to conventional rehabilitation in improving functional gait outcomes in post-stroke patients.

Participants in the experimental group achieved significantly better results in dynamic balance and lower limb functional capacity, as evidenced by the improvements in the Dynamic Gait Index and the Lower Extremity Functional Scale. These outcomes indicate enhanced postural control, improved functional mobility, and greater independence in lower limb use during gait-related activities.

The findings confirm the study hypothesis, supporting the advantage of a structured, continuously monitored rehabilitation approach in post-stroke functional recovery.

However, the interpretation of these results should take into account methodological limitations, including the relatively small sample size and the specific clinical characteristics of the study population, which may influence the generalizability of the findings. Further research involving larger cohorts, more diverse populations, and long-term follow-up assessments is necessary to validate these results and to better establish the clinical effectiveness of this rehabilitation approach.

References

1. Chan, W. L. S., Pin, T. W. (2019). Reliability, validity and minimal detectable change of 2-minute walk test, 6-minute walk test and 10-meter walk test in frail older adults with dementia. Experimental Gerontology, 115, 9–18. https://doi.org/10.1016/j.exger.2018.11.001.

2. Herman, T., Inbar-Borovsky, N., Brozgol, M., Giladi, N., Hausdorff, J. M. (2009). The Dynamic Gait Index in healthy older adults: the role of stair climbing, fear of falling and gender. Gait & Posture, 29(2), 237–241. https://doi.org/10.1016/j.gaitpost.2008.08.013.

3. Lofrumento, M., Tropea, P., Picardi, M., Antoniotti, P., Micera, S., Corbo, M., Monaco, V. (2021). Effects of gait rehabilitation on motor coordination in stroke survivors: an UCM-based approach. Experimental Brain Research, 239(7), 2107–2118. https://doi.org/10.1007/s00221-021-06117-5.

4. Mehta, S. P., Fulton, A., Quach, C., Thistle, M., Toledo, C., Evans, N. A. (2016). Measurement properties of the Lower Extremity Functional Scale: A systematic review. Journal of Orthopaedic & Sports Physical Therapy, 46(3), 200–216. https://doi.org/10.2519/jospt.2016.6165.

5. Miyagawa, D., Matsushima, A., Maruyama, Y., Mizukami, N., Matsushima, T., Hashimoto, M., Yoshida, K. (2023). Gait training with a wearable powered robot during stroke rehabilitation: a randomized parallel-group trial. Journal of NeuroEngineering and Rehabilitation, 20(1), 54. https://doi.org/10.1186/s12984-023-01168-x.

6. Moore, J. L., Potter, K., Blankshain, K., Kaplan, S. L., O'Dwyer, L. C., Sullivan, J. E. (2018). A core set of outcome measures for adults with neurologic conditions undergoing rehabilitation: A clinical practice guideline. Journal of Neurologic Physical Therapy, 42(3), 174–220. https://doi.org/10.1097/NPT.0000000000000229.

7. Nicolescu, L., Prală, A., Codreanu, A., Pișoș, L., Boru, C. (2024). Kinetoterapia specifică îmbunătățirii calității vieții la vârsta a III-a. Arad: Vasile Goldiș University Press.

8. Nabi, S. (2017). Gait Disorders: When the Patient Can't Walk the Walk. Medscape. https://reference.medscape.com/slideshow/gait-disorders-6003199#23.

9. Peters, D. M., Fritz, S. L., Krotish, D. E. (2013). Assessing the reliability and validity of a shorter walk test compared with the 10-Meter Walk Test. Journal of Geriatric Physical Therapy, 36(1), 24–30. https://doi.org/10.1519/JPT.0b013e318248e20d.

10. Pirker, W., Katzenschlager, R. (2017). Gait disorders in adults and the elderly. Wiener Klinische Wochenschrift, 129, 81–95. https://doi.org/10.1007/s00508-016-1096-4.

11. Popescu, B. O., Băjenaru, O. (2009). Elemente esențiale de neurologie clinică. București: Editura Amaltea.

12. Pritchett, J. W., Porembski, M. A. (2022). Foot drop. Medscape – Orthopedic Surgery. https://emedicine.medscape.com/article/1234607-overview.

13. Shumway-Cook, A., Taylor, C. S., Matsuda, P. N., Studer, M. T., Whetten, B. K. (2013). Expanding the scoring system for the Dynamic Gait Index. Physical Therapy, 93(11), 1493–1506. https://doi.org/10.2522/ptj.20130035.

14. Simonsen, E. B. (2014). Contributions to the understanding of gait control. Danish Medical Journal, 61(4), B4823. https://pubmed.ncbi.nlm.nih.gov/24814597/.

15. Talaty, M., Esquenazi, A. (2023). Feasibility and outcomes of supplemental gait training by robotic and conventional means in acute stroke rehabilitation. Journal of NeuroEngineering and Rehabilitation, 20(1), 134. https://doi.org/10.1186/s12984-023-01243-3.

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ORIGINAL SCIENTIFIC PAPER

Determination of Ecorecreative Attitudes of University Students

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Abstract

The purpose of this study is to determine the ecorecreative attitude levels of university students and to examine these attitudes according to selected demographic variables. The study was conducted using a quantitative research approach and was designed based on a cross-sectional survey model. The study was conducted with a sample of 309 university students. The Ecorecreative Attitude Scale (EAS) was administered as the data collection instrument. The scale consists of three subdimensions: affective attitude, cognitive attitude, and behavioral attitude, and aims to measure the importance that participants attach to ecological sustainability in their participation in recreational activities. In the data analysis process, the Cronbach Alpha coefficient was calculated to determine the reliability of the measurement tool. Skewness and kurtosis values were examined to evaluate the distributional characteristics of the data set. For the data set that met the assumption of normal distribution, the Independent Samples t-test was used for comparisons between two groups. According to the findings, when the subdimensions were examined, the highest mean score was observed in the cognitive attitude dimension (M =3.66), while the lowest mean score was found in the affective attitude dimension (M =3.34). It was determined that students who were members of university nature sports clubs had significantly higher ecorecreative attitude scores in all subdimensions and in the total scale score compared to those who were not members (for total score, $t=2.767$, $p<0.05$, $d=0.33$). Similarly, students who evaluated their leisure actively had significantly higher ecorecreative attitude levels than those who evaluated their leisure passively (for total score, $t=3.362$, $p<0.05$, $d=0.43$). In this context, increasing nature-based recreational activities at universities and supporting student nature sports clubs are considered important factors that may contribute to the development of students' ecorecreational awareness.

Keywords: leisure, ecorecreation, outdoor, nature-sports, sustainability

1. Introduction

Today environmental problems occurring on a global scale have made it necessary to reconsider the relationship between humans and the natural environment. Industrialization, rapid urbanization and increasing population pressure cause serious damage to natural ecosystems and

bring about problems such as biodiversity loss, environmental pollution, climate change and the depletion of natural resources. Environmental pressures emerging particularly from industrial activities lead to ecosystem degradation, habitat loss and the threat to the sustainability of natural resources (Berdenov et al., 2025). Moreover, recreational activities carried out in natural areas may also create various environmental impacts when they are not properly planned. It has been reported that nature-based recreational activities can result in environmental consequences such as habitat degradation, vegetation damage and ecosystem pressure (Pickering and Hill, 2007). Therefore, planning recreational activities in line with sustainability principles and increasing environmental awareness have become necessary.

Urbanization and technological developments brought about by modern life have significantly reduced individuals' contact with the natural environment (Louv, 2006). In particular, the decreasing opportunities for young individuals to interact with nature may negatively affect the development of environmental awareness and attitudes toward nature (Soga and Gaston, 2016). Research indicates that young people's interactions with nature and rural environments are not merely recreational experiences but also play an important role in the formation of individual identity and the development of lifestyle patterns (King and Church, 2013). However, with the increasing level of urbanization, the connection individuals establish with nature in their daily lives has weakened, and opportunities for nature experiences have become increasingly limited (Miller, 2005). Indeed, it has been suggested that urbanization causes significant changes in individuals' lifestyles and by reducing interaction with the natural environment, brings about various environmental and social problems (Kaynak et al., 2025).

At this point, nature-based recreational activities are considered one of the important tools that enable individuals to reconnect with the natural environment (Bratman et al., 2019). Outdoor recreational activities allow individuals to spend time in natural settings and provide significant benefits both physically and psychologically (Pretty et al., 2005). Nature-based activities such as mountaineering, hiking, camping and water sports enable individuals to experience nature while also contributing to the development of their environmental awareness (Jenkins and Pigram, 2006). However, a critical distinction must be drawn between general outdoor recreation and the specific paradigm of ecorecreation (Fennell, 2015). While outdoor recreation encompasses a broad spectrum of leisure pursuits situated in natural settings (Thapa, 2010), ecorecreation places a distinct emphasis on environmentally responsible participation that actively aligns with ecological

sustainability (Weaver, 2008). Consequently, ecorecreation transcends mere physical presence in nature; it reflects a deliberate, conscious orientation aimed at minimizing environmental impacts while actively fostering pro-environmental attitudes and conservation behaviors (Ewert et al., 2005; Larson et al., 2011). Establishing this conceptual boundary at an early stage is imperative to clarify the theoretical scope of the study and to accurately contextualize the psychological and behavioral dimensions of ecorecreational engagement (Vaske and Kobrin, 2001).

The implementation of nature-based recreational activities in line with environmental protection principles has brought the concept of ecorecreation to the forefront. Ecorecreation refers to recreational activities that support environmental sustainability while increasing individuals' interaction with the natural environment (Karaküçük and Akgül, 2016). These activities enable individuals to establish contact with nature and contribute to the development of environmental awareness and a sense of environmental responsibility (Hungerford and Volk, 1990). Participation in nature-based activities has been shown to improve individuals' physical health, enhance psychological well-being and positively influence life satisfaction (Pritchard et al., 2020). In addition, it has been emphasized that the sustainable planning of recreational areas is important both for environmental conservation and for public health (Manning, 1999).

The literature indicates that the relationship established with nature has a significant effect on individuals' environmental attitudes (Mayer and Frantz, 2004; Schultz, 2001). Individuals who develop a strong connection with nature tend to exhibit more environmentally responsible and sensitive behaviors (Wells and Lekies, 2006). In particular participation in outdoor recreational activities has been reported to increase individuals' level of interaction with nature and contribute to the development of ecological attitudes (Thapa, 2010; Nisbet et al., 2009). Strengthening the emotional and psychological connection with nature may increase individuals' sensitivity toward environmental problems and contribute to the adoption of sustainable behaviors.

Recent research has increasingly emphasized the role of nature-based recreation in shaping environmental attitudes among university students (Uygur et al., 2025; Durhan and Karaküçük, 2020). Studies have shown that stronger connection to nature is associated with greater preference for outdoor environments and more frequent participation in nature-based recreational activities (Rosa et al., 2023; Martin et al., 2020). In addition, interaction with natural environments has been linked to improved psychological well-being and cognitive restoration during emerging adulthood (Puhakka et al., 2021). Furthermore, evidence from sport sciences

contexts suggests that individuals who actively engage in nature-based and ecorecreational activities tend to exhibit higher levels of environmental awareness and more positive sustainability-related attitudes. These findings highlight that environmental attitudes among university students are closely associated with experiential aspects of leisure and remain a relevant area for further investigation.

University students represent an important life period in which environmental awareness and sustainable behaviors develop. The university years can be considered a critical stage during which individuals' value systems and attitudes toward the environment are shaped. For this reason determining university students' attitudes toward ecorecreation is considered important for increasing environmental awareness and promoting a sustainable understanding of recreation. In this context the aim of the study is to determine university students' attitudes toward ecorecreation and to examine these attitudes in terms of various variables. Based on the literature, the following hypotheses were formulated:

- H1: Ecorecreative attitude levels differ according to gender.
- H2: Ecorecreative attitude levels differ according to recreational opportunities.
- H3: Ecorecreative attitude levels differ according to nature sports club membership.
- H4: Ecorecreative attitude levels differ according to leisure type (active vs. passive).

2. Materials and Methods

Research model

This study was designed using the general survey model, one of the quantitative research methods, in order to determine the ecorecreative attitude levels of university students and to examine whether these attitudes differ according to various demographic variables. The survey model is a research approach that aims to reveal the existing situation as it is and allows the examination of relationships between variables. Within this framework relational survey approaches were used in the study.

Population and sample

The population of the study consists of undergraduate students studying at Yalova University. The sample of the study consists of a total of 309 volunteer university students selected using the convenience sampling method. Of the participants 45.3% were female (n = 140) and

54.7% were male (n = 169). Convenience sampling is a widely used approach that allows researchers to collect data from easily accessible participants. However, this method may limit the representativeness of the sample and, therefore, the generalizability of the findings to the broader population.

Research publication ethics

Ethical approval required for the conduct of the study was obtained from the Yalova University Human Research Ethics Committee. The ethics committee approved the study as ethically appropriate with the decision dated 10.03.2023 and protocol number 2023/38. Before the data collection process participants were informed about the purpose and scope of the study and it was stated that participation was based on voluntary consent. Participants were also informed that they could withdraw from the study at any time and that all data would be used only for scientific purposes.

Data collection tools

In the study the Demographic Information Form and the Ecorecreative Attitude Scale were used as data collection instruments.

Ecorecreative attitude scale

The Ecorecreative Attitude Scale (EAS) was developed by Kement et al. (2021) to assess individuals' attitudes toward ecorecreation. The scale was developed through a comprehensive multi-stage process including the Delphi technique, focus group interviews, item purification, and validation procedures. In the scale development phase, data were collected from participants in Turkey and both exploratory and confirmatory analyses were conducted to establish its validity and reliability.

The final scale consists of three subdimensions: affective (5 items), cognitive (7 items), and behavioral (10 items), reflecting the multidimensional structure of ecorecreative attitudes. Given that the present study was conducted with a university student sample within a similar cultural context, the use of the scale was considered appropriate without requiring further cross-cultural adaptation. The scale was rated on a five-point Likert-type format, and higher scores indicate higher levels of ecorecreative attitudes.

Data collection

The data of the study were collected through an online questionnaire form. During the data collection process participants were informed about the purpose of the study and were asked to complete the questionnaire voluntarily.

Data analysis

The data obtained from the study were analyzed using the SPSS 23.0 statistical software package. Frequency and percentage distributions were calculated to determine the demographic characteristics of the participants. Cronbach's alpha reliability coefficient was calculated to determine the internal consistency of the scale. The normality of the data set was evaluated by examining skewness and kurtosis values. Parametric test techniques were used for variables that met the assumption of normal distribution.

Skewness and kurtosis values were examined to evaluate the normality of the data distribution. In line with Tabachnick and Fidell (2013) values within the range of ±1.5 were considered indicative of normal distribution. For variables meeting this assumption, parametric tests were applied. The assumption of homogeneity of variances was tested using Levene's test. In cases where the assumption of equal variances was violated, Welch's t-test was used as a more robust alternative. Accordingly, Welch-adjusted degrees of freedom were reported in the relevant analyses.

3. Results

Table 1. Descriptive statistics

Variables		N	%	Total	Min.	Max.	Mean	s.d.
Gender	Female	140	45,3	309				
	Male	169	54,7					
Recreational Opportunities	Sufficient	110	35,6					
	Insufficient	199	64,4					
Nature Sports Club Membership	Yes	141	45,6					
	No	168	54,4					
Leisure Type	Active	207	67,0					
	Passive	102	33,0					
Age					18	34	21,23	2,44

Note: Mean, standard deviation, minimum and maximum values are not reported for nominal variables.

Table 1 presents the findings related to some demographic characteristics of the participants included in the study. According to the frequency results a total of 309 individuals participated in the study including 169 males (54.7%) and 140 females (45.3%). When participants' perceptions of recreational opportunities were examined 110 participants (35.6%) evaluated these opportunities as sufficient whereas 199 participants (64.4%) considered them insufficient. Regarding nature sports club membership 141 participants (45.6%) reported that they were members of a club while 168 participants (54.4%) stated that they were not members. In terms of the way participants spent their leisure time 207 participants (67.0%) reported that they spent their leisure time actively while 102 participants (33.0%) stated that they spent it passively. Finally the ages of the participants ranged between 18 and 34 and the mean age was 21.23 ± 2.44.

Table 2. Distribution of measurement scores

Dependent Variables	Number of Items	N	Mean	Skewness	Kurtosis	Cronbach's Alpha
Affective Attitude Subdimension	5	309	3,34	-,224	,059	,808
Cognitive Attitude Subdimension	7		3,66	-,474	,251	,846
Behavioral Attitude Subdimension	10		3,55	-,519	,694	,888
Total Score of the Ecorecreative Attitude Scale	22		3,54	-,422	,905	,933

When table 2 is examined descriptive statistics related to the scores obtained by 309 students participating in the study from the Ecorecreative Attitude Scale (EAS) are presented. When evaluated in terms of the subdimensions of the scale participants obtained a mean score of 3.34 from the affective attitude subdimension 3.66 from the cognitive attitude subdimension and 3.55 from the behavioral attitude subdimension. The total mean score of the scale was determined as 3.54. The skewness and kurtosis values related to the subdimensions and the total score ranged between ±1.5 indicating that the data set showed a normal distribution (Tabachnick and Fidell

2013). According to the reliability analysis results Cronbach's alpha coefficients were .808 for the affective attitude subdimension .846 for the cognitive attitude subdimension .888 for the behavioral attitude subdimension and .933 for the total score of the scale. These findings indicate that the subdimensions and the total score of the scale have a high level of internal consistency and that the scale is a reliable measurement tool.

Table 3. Independent samples t test results according to the gender variable

Dependent Variables	Gender	N	Mean	s.d.	t	df	p	Cohen's d
Affective Attitude	Female	140	3,39	,851	,759	307	,449	0.08
	Male	169	3,32	,855				
Cognitive Attitude	Female	140	3,75	,826	1,517	307	,130	0.18
	Male	169	3,60	,844				
Behavioral Attitude	Female	140	3,60	,855	,885	307	,377	0.11
	Male	169	3,51	,802				
Total Score of the Ecorecreative Attitude Scale	Female	140	3,60	,759	1,182	307	,238	0.13
	Male	169	3,50	,738				

Table 3 presents the results of the independent samples t-test according to the gender variable. When the findings are examined it is seen that the mean scores of female participants in the affective cognitive and behavioral attitude subdimensions as well as the total score of the Ecorecreative Attitude Scale are higher than those of male participants. However the results of the analysis indicated that these differences were not statistically significant ($p > 0.05$). This finding shows that participants' ecorecreative attitude levels do not differ significantly according to the gender variable. No statistically significant differences were observed according to gender. Furthermore, effect size estimates (Cohen's d) indicated negligible differences, suggesting that gender does not play a meaningful role in shaping ecorecreative attitudes.

Table 4. Independent samples t test results according to the recreational opportunities variable

Dependent Variables	Recreational Opportunities	N	Mean	s.d.	t	df	p	Cohen's d
Affective Attitude	Sufficient	110	3,43	,937	1,276	307	,203	0.15
	Insufficient	199	3,30	,802				
Cognitive Attitude	Sufficient	110	3,70	,864	,565	307	,572	0.06
	Insufficient	199	3,65	,826				
Behavioral Attitude	Sufficient	110	3,59	,883	,613	307	,540	0.07
	Insufficient	199	3,53	,795				

Total Score of the Ecorecreative Attitude Scale	Sufficient	110	3,59	,800	,840	307	,402	0.10
	Insufficient	199	3,52	,719				

Table 4 presents the results of the independent samples t-test according to the recreational opportunities variable. When the findings are examined it is observed that the mean scores of participants who evaluated recreational opportunities as sufficient in the affective cognitive and behavioral attitude subdimensions as well as in the total ecorecreative attitude score were higher than those of participants who evaluated these opportunities as insufficient. However the results of the analysis indicated that these differences were not statistically significant ($p > 0.05$). This finding shows that participants' ecorecreative attitude levels do not differ significantly according to whether they perceive recreational opportunities as sufficient or insufficient. No statistically significant differences were found based on perceived recreational opportunities. Consistent with this, effect size estimates (Cohen's d) were small, indicating that perceived opportunities have limited practical influence on ecorecreative attitudes.

Table 5. *Independent samples t test results according to the nature sports club membership variable*

Dependent Variables	**Nature Sports Club Membership**	**N**	**Mean**	**s.d.**	**t**	**df**	**p**	**Cohen's d**
Affective Attitude	Yes	141	3,48	,970	2,493	255,308	,013	0.28
	No	168	3,24	,726				
Cognitive Attitude	Yes	141	3,81	,881	2,815	307	,005	0.31
	No	168	3,55	,783				
Behavioral Attitude	Yes	141	3,67	,895	2,289	307	,023	0.27
	No	168	3,45	,753				
Total Score of the Ecorecreative Attitude Scale	Yes	141	3,67	,827	2,767	265,405	,006	0.33
	No	168	3,43	,658				

Table 5 presents the results of the independent samples t-test according to the nature sports club membership variable. When the findings are examined it is determined that the mean scores of individuals who are members of nature sports clubs in the affective cognitive and behavioral attitude subdimensions as well as the total score of the Ecorecreative Attitude Scale are significantly higher than those of individuals who are not members ($p < 0.05$). This finding indicates that membership in nature sports clubs has a positive effect on individuals' ecorecreative attitude levels.

A consistent pattern of higher scores was observed among participants who were members of nature sports clubs across all subdimensions, indicating a positive association between nature-based engagement and ecorecreative attitudes.

Table 6. Independent samples t test results according to leisure type

Dependent Variables	Leisure Type	N	Mean	s.d.	t	df	p	Cohen's d
Affective Attitude	Active	207	3,51	,855	4,918	307	,000	0.60
	Passive	102	3,02	,754				
Cognitive Attitude	Active	207	3,77	,822	3,020	307	,003	0.39
	Passive	102	3,46	,839				
Behavioral Attitude	Active	207	3,62	,842	2,032	307	,043	0.25
	Passive	102	3,42	,782				
Total Score of the Ecorecreative Attitude Scale	Active	207	3,64	,760	3,362	307	,001	0.43
	Passive	102	3,34	,685				

Table 6 presents the results of the independent samples t-test according to leisure type. When the findings are examined it is determined that the mean scores of individuals who spend their leisure time actively in the affective cognitive and behavioral attitude subdimensions as well as the total score of the Ecorecreative Attitude Scale are significantly higher than those of individuals who spend their leisure time passively ($p < 0.05$). This finding indicates that engaging in active recreational activities during leisure contributes to the positive differentiation of ecorecreative attitude levels.

The results reveal a clear and consistent pattern in which participants engaged in active leisure activities reported higher scores across all subdimensions, highlighting the strong role of active participation in shaping ecorecreative attitudes.

4. Discussion

This study aimed to determine university students' ecorecreative attitude levels and to examine whether these attitudes differ according to selected demographic variables. The findings demonstrated that ecorecreative attitudes were significantly associated with nature sports club membership and active leisure participation, whereas no statistically significant differences were observed according to gender and perceived recreational opportunities.

In the present study, ecorecreative attitudes did not differ significantly by gender. This finding is consistent with previous research conducted with university students, including the study by Yılmaz et al. (2023) which likewise reported no significant gender-based differences in ecorecreational attitudes. Although some studies suggest that women tend to exhibit higher levels of environmental concern and pro-environmental attitudes, the broader literature indicates that such differences are often small or context-dependent (Zelezny et al., 2000; Xiao and McCright, 2015). In this respect, the current findings align with studies reporting negligible gender-based differences, suggesting that environmental attitudes may not be strongly determined by demographic characteristics alone. Instead, attitudes toward ecorecreation may develop through similar levels of environmental awareness and shared experiential factors across genders. Supporting this view, international studies on green space use and ecosystem services have emphasized that pro-environmental attitudes are more closely associated with environmental awareness and engagement rather than gender differences (Clayton et al., 2015; Chawla, 1998).

In the study ecorecreational attitude levels were examined according to the recreational opportunities variable. According to the findings the affective cognitive and behavioral attitude subdimensions as well as the total ecorecreational attitude scores did not show a statistically significant difference. However participants who evaluated recreational opportunities as sufficient had higher mean scores in all subdimensions. This situation suggests that perceiving recreational opportunities as sufficient may positively support individuals' attitudes toward nature-based recreational activities. It is known that the increase in green spaces and recreational opportunities can positively influence individuals' environmental awareness and their interaction with nature (Hartig et al., 2014). In this context improving recreational infrastructure and increasing nature-based recreation opportunities may contribute to strengthening individuals' ecorecreational attitudes (Beery and Jönsson, 2017; Kil, 2016).

The finding that perceived recreational opportunity sufficiency did not significantly influence ecorecreative attitudes is noteworthy and somewhat counterintuitive. One possible explanation is that subjective perceptions of opportunity may not accurately reflect actual engagement with nature-based environments, as individuals may perceive opportunities as sufficient without actively participating in them (Hartig et al., 2014; Whitburn et al., 2018). This suggests that perceived availability alone may be insufficient to shape ecorecreative attitudes. Instead, such attitudes may depend more strongly on experiential and behavioral factors, such as

active participation in nature-based activities, as well as individual-level variables including motivation, social norms, and personal interest in nature (Ajzen, 1991; Rosa et al., 2018). Accordingly, future research should examine these potential mediating mechanisms to better understand the formation of ecorecreative attitudes.

It was determined that ecorecreational attitude levels differed significantly according to the nature sports club membership variable. According to the findings participants who were members of nature sports clubs had significantly higher mean scores in the affective cognitive and behavioral attitude subdimensions as well as in the total ecorecreational attitude score compared to those who were not members. This finding suggests that participation in nature sports clubs may contribute to individuals' increased interaction with nature experiencing the natural environment and developing environmental awareness. Indeed various studies emphasize that participation in nature-based recreational activities strengthens individuals' environmental attitudes and increases their tendency to engage in pro-environmental behaviors (Han, 2023; Theodori et al., 1998). Activities carried out through nature sports enable individuals to establish direct contact with nature and may contribute to the development of values such as environmental sensitivity connection with nature and sustainable environmental awareness (Brymer et al., 2009).

In the study it was determined that ecorecreational attitude levels differed significantly according to leisure type. According to the findings individuals who spent their leisure time actively had significantly higher mean scores in the affective cognitive and behavioral attitude subdimensions as well as in the total ecorecreational attitude score compared to those who spent their leisure time passively. This finding indicates that engaging in active recreational activities during leisure may contribute to the development of environmental awareness and positive environmental attitudes by increasing individuals' interaction with nature. Active recreational activities allow individuals to directly experience the natural environment and contribute to the development of nature connectedness environmental sensitivity and sustainable environmental awareness (Lumber et al., 2017). Recreational activities that involve direct contact with nature increase individuals' environmental awareness and contribute to the development of environmental responsibility (Rosa and Collado, 2019). In this context evaluating leisure time through active recreational activities can be considered an important means of supporting the development of ecorecreational attitudes by enabling individuals to establish more frequent and meaningful interactions with nature.

Limitations

This study has several limitations that should be considered when interpreting the findings. First, the use of convenience sampling may limit the representativeness of the sample and the generalizability of the results. Second, the cross-sectional design does not allow for causal inferences between variables. Finally, the study was conducted within a single university context, which may restrict the applicability of the findings to broader populations. Despite these limitations, the findings of the present study suggest that recreational activities that increase individuals' interaction with nature play an important role in the development of ecorecreational attitudes. In particular, factors such as engaging in active outdoor leisure activities and the presence of awareness regarding nature sports clubs were found to positively influence individuals' affective, cognitive, and behavioral attitudes toward the environment.

5. Conclusions

The findings of the present study suggest that recreational activities that increase individuals' interaction with nature play an important role in the development of ecorecreative attitudes. In particular, active participation in outdoor leisure activities and involvement in nature sports clubs were found to positively contribute to individuals' affective, cognitive, and behavioral environmental attitudes. These findings indicate that direct engagement with nature may support the development of environmental awareness and sustainable environmental consciousness among university students.

In this context, universities and local administrations may contribute to the strengthening of ecorecreative awareness by increasing the accessibility of nature-based recreational opportunities and encouraging active student participation in outdoor activities. Supporting activities such as hiking, camping, outdoor sports, and environment-based recreational events may further enhance students' environmental sensitivity and nature connectedness. Furthermore, future studies should examine the long-term effects of participation in nature-based recreation through longitudinal and experimental research designs conducted with different populations and age groups.

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References

Ajzen, I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50(2), 179-211. https://doi.org/10.1016/0749-5978(91)90020-T

Beery, T., & Jönsson, K. I. (2017). Outdoor recreation and place attachment: Exploring the potential of outdoor recreation within a UNESCO Biosphere Reserve. Journal of Outdoor Recreation and Tourism, 17, 54-63. https://doi.org/10.1016/j.jort.2017.01.002

Berdenov, Z. G., Mendybayeva, G., Beketova, A., Sadvakassova, S., Laiskhanov, S., Kara, T., & Kholov, Y. (2025). Technogenesis as a driver in the development of recreational areas for sustainable development and biodiversity conservation. Geo Journal of Tourism and Geosites, 61(3), 1454-1461. https://doi.org/10.30892/gtg.61305-1515

Bratman, G. N., Anderson, C. B., Berman, M. G., Cochran, B., De Vries, S., Flanders, J., Folke, C., … & Daily, G. C. (2019). Nature and mental health: An ecosystem service perspective. Science Advances, 5(7), eaax0903. https://doi.org/10.1126/sciadv.aax0903

Brymer, E., Downey, G., & Gray, T. (2009). Extreme sports as a precursor to environmental sustainability. Journal of Sport & Tourism, 14(2-3), 193-204. https://doi.org/10.1080/14775080902965223

Chawla, L. (1998). Significant life experiences revisited: A review of research on sources of environmental sensitivity. The Journal of Environmental Education, 29(3), 11-21. https://doi.org/10.1080/00958969809599114

Durhan, T. A., & Karaküçük, S. (2020). Ecorecreational attitude of participants in sportive recreation activities. European Journal of Physical Education and Sport Science, 6(7), 60-81. http://dx.doi.org/10.46827/ejpe.v6i7.3329

Ewert, A., Place, G., & Sibthorp, J. (2005). Early-life outdoor experiences and an individual's environmental attitudes. Leisure Sciences, 27(3), 225-239. https://doi.org/10.1080/01490400590930853

Fennell, D. A. (2015). Ecotourism. London, UK: Routledge.

Han, G. S. (2023). Relationships between outdoor recreation-associated flow, pro-environmental attitude, and pro-environmental behavioral intention. Sustainability, 15(13), 10581. https://doi.org/10.3390/su151310581

Hartig, T., Mitchell, R., De Vries, S., & Frumkin, H. (2014). Nature and health. Annual Review of Public Health, 35, 207-228. https://doi.org/10.1146/annurev-publhealth-032013-182443

Hungerford, H. R., & Volk, T. L. (1990). Changing learner behavior through environmental education. The Journal of Environmental Education, 21(3), 8-21. https://doi.org/10.1080/00958964.1990.10753743

Jenkins, J. M., & Pigram, J. J. (2006). Outdoor recreation. In C. Rojek, S. Shaw, and A. Veal (Eds.), A handbook of leisure studies (pp. 363–379). Basingstoke, UK: Palgrave Macmillan.

Karaküçük, S., & Akgül, B. M. (2016). Ekorekreasyon rekreasyon ve çevre. Ankara: Gazi Kitabevi.

Kaynak, İ.H., Bozoğlu, M.S., Kaya, A. & Kılınç, S. (2025). An examination of ecological attitude and nature relatedness among young adults participating in outdoor recreation activities. Journal of Education and Recreation Patterns, 6(1), 54-71. https://doi.org/10.53016/jerp.v6i1.300

Kement, Ü., Karaküçük, S., & Çavuşoğlu, S. (2021). Ekorekreatif tutum ölçeği geliştirilmesi: Geçerlik ve güvenilirlik çalışması. Tourism and Recreation, 3(1), 34-54.

Kil, N. (2016). Effects of vicarious experiences of nature, environmental attitudes, and outdoor recreation benefits on support for increased funding allocations. The Journal of Environmental Education, 47(3), 222-236. https://doi.org/10.1080/00958964.2015.1111188

King, K., & Church, A. (2013). 'We don't enjoy nature like that': Youth identity and lifestyle in the countryside. Journal of Rural Studies, 31, 67-76. https://doi.org/10.1016/j.jrurstud.2013.02.004

Clayton, S., Devine-Wright, P., Stern, P. C., Whitmarsh, L., Carrico, A., Steg, L., ... & Bonnes, M. (2015). Psychological research and global climate change. Nature Climate Change, 5(7), 640-646. https://doi.org/10.1038/nclimate2622

Larson, L. R., Whiting, J. W., & Green, G. T. (2011). Exploring the influence of outdoor recreation participation on pro-environmental behaviour in a demographically diverse population. Local Environment, 16(1), 67-86. https://doi.org/10.1080/13549839.2010.548373

Louv, R. (2006). Last child in the woods: Saving our children from nature-deficit disorder by richard louv. Children, Youth and Environments, 16(1), 200-205. https://doi.org/10.7721/chilyoutenvi.16.1.0200

Lumber, R., Richardson, M., & Sheffield, D. (2017). Beyond knowing nature: Contact, emotion, compassion, meaning, and beauty are pathways to nature connection. Plos One, 12(5), e0177186. https://doi.org/10.1371/journal.pone.0177186

Manning, R. E. (1999). Studies in outdoor recreation: Search and research for satisfaction. Corvallis, OR: Oregon State University Press.

Martin, L., White, M. P., Hunt, A., Richardson, M., Pahl, S., & Burt, J. (2020). Nature contact, nature connectedness and associations with health, wellbeing and pro-environmental behaviours. Journal of Environmental Psychology, 68, 101389. https://doi.org/10.1016/j.jenvp.2020.101389

Mayer, F. S., & Frantz, C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. Journal of Environmental Psychology, 24(4), 503-515. https://doi.org/10.1016/j.jenvp.2004.10.001

Miller, J. R. (2005). Biodiversity conservation and the extinction of experience. Trends in Ecology & Evolution, 20(8), 430-434. https://doi.org/10.1016/j.tree.2005.05.013

Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior. Environment and Behavior, 41(5), 715-740. https://doi.org/10.1177/0013916508318748

Pickering, C. M., & Hill, W. (2007). Impacts of recreation and tourism on plant biodiversity and vegetation in protected areas in Australia. Journal of Environmental Management, 85(4), 791-800. https://doi.org/10.1016/j.jenvman.2006.11.021

Pretty, J., Peacock, J., Sellens, M., & Griffin, M. (2005). The mental and physical health outcomes of green exercise. International Journal of Environmental Health Research, 15(5), 319-337. https://doi.org/10.1080/09603120500155963

Pritchard, A., Richardson, M., Sheffield, D., & McEwan, K. (2020). The relationship between nature connectedness and eudaimonic well-being: A meta-analysis: A. Pritchard et al. Journal of Happiness Studies, 21(3), 1145-1167. https://doi.org/10.1007/s10902-019-00118-6

Puhakka, R. (2021). University students' participation in outdoor recreation and the perceived well-being effects of nature. Journal of Outdoor Recreation and Tourism, 36, 100425. https://doi.org/10.1016/j.jort.2021.100425

Rosa, C. D., & Collado, S. (2019). Experiences in nature and environmental attitudes and behaviors: Setting the ground for future research. Frontiers in Psychology, 10, 763. https://doi.org/10.3389/fpsyg.2019.00763

Rosa, C. D., Larson, L. R., Collado, S., Cloutier, S., & Profice, C. C. (2023). Gender differences in connection to nature, outdoor preferences, and nature-based recreation among college students in Brazil and the United States. Leisure Sciences, 45(2), 135–155. https://doi.org/10.1080/01490400.2020.1800538

Rosa, C. D., Profice, C. C., & Collado, S. (2018). Nature experiences and adults' self-reported pro-environmental behaviors: The role of connectedness to nature and childhood nature experiences. Frontiers in Psychology, 9, 1055. https://doi.org/10.3389/fpsyg.2018.01055

Schultz, P. W. (2001). The structure of environmental concern: Concern for self, other people, and the biosphere. Journal of Environmental Psychology, 21(4), 327-339. https://doi.org/10.1006/jevp.2001.0227

Soga, M., & Gaston, K. J. (2016). Extinction of experience: The loss of human–nature interactions. Frontiers in Ecology and the Environment, 14(2), 94-101. https://doi.org/10.1002/fee.1225

Tabachnick, B. G., and Fidell, L. S. (2013). Using multivariate statistics. Boston, MA: Pearson.

Thapa, B. (2010). The mediation effect of outdoor recreation participation on environmental attitude-behavior correspondence. The Journal of Environmental Education, 41(3), 133-150. https://doi.org/10.1080/00958960903439989

Theodori, G. L., Luloff, A. E., & Willits, F. K. (1998). The association of outdoor recreation and environmental concern: Reexamining the Dunlap-Heffernan thesis 1. Rural Sociology, 63(1), 94-108. https://doi.org/10.1111/j.1549-0831.1998.tb00666.x

Uygur, A., Sevin, H. D., Yayla, O., & Topaçoğlu, O. (2025). The effect of eco-recreational and environmental attitudes on environmental behavior. Sustainability, 17(23), 10660. https://doi.org/10.3390/su172310660

Vaske, J. J., & Kobrin, K. C. (2001). Place attachment and environmentally responsible behavior. The Journal of Environmental Education, 32(4), 16-21. https://doi.org/10.1080/00958960109598658

Weaver, D. (2008). Ecotourism. Hoboken: John Wiley & Sons.

Wells, N. M., & Lekies, K. S. (2006). Nature and the life course: Pathways from childhood nature experiences to adult environmentalism. Children Youth and Environments, 16(1), 1-24. https://doi.org/10.1353/cye.2006.0031

Whitburn, J., Linklater, W. L., & Milfont, T. L. (2018). Exposure to urban nature and tree planting are related to pro-environmental behavior via connection to nature, the use of nature for psychological restoration, and environmental attitudes. Environment and Behavior, 51(7), 787-810. https://doi.org/10.1177/0013916517751009

Xiao, C., & McCright, A. M. (2015). Gender differences in environmental concern: Revisiting the institutional trust hypothesis in the USA. Environment and Behavior, 47(1), 17-37. https://doi.org/10.1177/0013916513491571

Yılmaz, G., Genç, N., & Taştan, Z. (2023). Spor bilimleri fakültesi öğrencilerinin ekorekreasyonel tutumlarının incelenmesi. Uluslararası Holistik Sağlık, Spor ve Rekreasyon Dergisi, 2(1), 42–53. https://doi.org/10.5281/zenodo.8052954

Zelezny, L. C., Chua, P. P., & Aldrich, C. (2000). New ways of thinking about environmentalism: Elaborating on gender differences in environmentalism. Journal of Social Issues, 56(3), 443-457. https://doi.org/10.1111/0022-4537.00177

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ORIGINAL SCIENTIFIC PAPER

Preparedness of Future Coaches for Professional Performance in Children and Youth Sports Schools

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Abstract

The modern system of children's and youth sports imposes increased demands on the professional preparedness of coaches capable of working effectively with children and adolescents in children and youth sports schools. In this context, the problem of forming the readiness of future coaches for professional activity, which combines theoretical training, practical skills, and personal qualities, is of particular relevance. Objective. The aim of the study is to provide a theoretical substantiation and empirical study of the level of readiness of future coaches for professional activity in the conditions of children and youth sports schools. Methods. The study employed theoretical analysis and generalization of scientific and methodological literature; questionnaires and surveys of students majoring in "Physical Culture and Sports"; pedagogical observation during internships; and methods of mathematical statistics for processing the obtained data at a statistical significance level of $p<0.05$. The study involved 72 third- and fourth-year students aged 20–23. Results. It was established that an average level of readiness among future coaches for work in children and youth sports schools prevails. A discrepancy was revealed between a sufficient level of motivation for coaching and the insufficient development of practical skills necessary for the independent organization of the training process. Conclusions. The study results indicate the need to improve the professional training of future coaches by strengthening practice-oriented learning and expanding pedagogical internships in children and youth sports schools.

Keywords: professional training, coaching, sports education, pedagogical internship, professional adaptation.

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1. Introduction

The system of children's and youth sports plays a leading role in shaping the physical, mental, and social development of the younger generation, as well as in training the country's sports reserve. In this context, children and youth sports schools serve as the fundamental link in sports education, combining educational, training, upbringing, and socialization components. The key figure in this process is the coach, whose level of professional preparedness largely determines the effectiveness of the sports development of children and adolescents (Lyle, 2002; Côté & Gilbert, 2009; Gould & Carson, 2008).

Modern socio-economic conditions, the transformation of the higher education system, and the integration of the Ukrainian sports space into global practice lead to increased demands on the professional activity of coaches (Shevchuk, Kohut, & Marynych, 2025). Future specialists are expected to possess not only a thorough mastery of the theory and methodology of sports training but also developed pedagogical skills, communicative abilities, the capacity to work with different age groups, the ability to individualize the training process, and the competence to ensure safe training environments (Cushion, Armour, & Jones, 2003; Cruickshank & Collins, 2020; Yefremenko et al., 2025).

In scientific research, the problem of future coaches' readiness for professional activity is examined from various perspectives. Some authors focus on the formation of professional competencies as the foundation of coaching mastery (Lyle, 2002; Kiprych & Proskurnin, 2024), while others emphasize the development of personal qualities, the motivational sphere, and pedagogical reflection (Gould & Carson, 2008; Kostenko et al., 2023). At the same time, the scientific discourse maintains a debate regarding the balance between theoretical and practical components of coach training, the optimal amount of pedagogical practice, and the criteria for evaluating the level of professional readiness (Côté & Gilbert, 2009; Jůva, Jakubcová, & Roček, 2023).

Special attention is required for the issue of future coaches' readiness specifically for work within children and youth sports schools, which possesses a number of specific features. A coach in a CYSS (Children and Youth Sports School) performs not only the function of training an athlete but also acts as an educator, mentor, and organizer of the educational and training environment (Novopysmennyi & Kononets, 2025; Osadchenko, 2023). Meanwhile, practical results and scientific data indicate that higher education graduates face difficulties during adaptation to the real working conditions of sports schools, which necessitates a revision of approaches to the professional training of coaching staff (Modern Science and Research, 2023; Shevchuk, Kohut, & Marynych, 2024).

Scientific literature lacks systematic empirical data on the level of students' readiness for coaching in children's and youth sports, and the pedagogical conditions that ensure the effective formation of such readiness during professional training are insufficiently highlighted (Chen, 2025; Kiprych & Proskurnin, 2024). This creates a scientific problem consisting of the discrepancy between modern requirements for a coach's activity in a CYSS and the actual level of readiness of future specialists to perform their professional duties.

Thus, the relevance of the study is determined by the need for a scientific substantiation of the essence and structure of future coaches' readiness to work in children and youth sports schools, as well as the need to identify the actual state of its formation among students of higher education institutions specializing in physical culture and sports (Shevchuk et al., 2025; Novopysmennyi & Kononets, 2025). Resolving these issues is of significant theoretical and practical importance for improving the system of training coaching staff and enhancing the quality of children's and youth sports.

The aim of the article is to theoretically substantiate the essence and structure of future coaches' readiness for work in children and youth sports schools and to determine the level of its formation among students of physical education and sports higher education institutions.

2. Materials and Methods

The study was conducted to examine the level of readiness of future coaches for professional activity in children and youth sports schools. The research methods were selected in accordance with the objective and were limited to the material available at the time of the study's development.

The following methods were used in the study:

– Theoretical analysis and generalization of scientific and methodological literature. At the first stage of the research, an analysis of modern scientific sources on the problems of professional training of physical culture and sports specialists, coaching activities, and the formation of professional readiness was carried out.

– Questionnaires and surveys of students. To study the level of readiness of future coaches for work in children and youth sports schools, the questionnaire method was applied. The study involved 72 third- and fourth-year students majoring in "Physical Culture and Sports" (38 men and 34 women) aged 20–23.

The questionnaire consisted of 20 closed-ended and semi-open-ended questions and was aimed at assessing readiness for coaching activities. The survey was conducted in a classroom setting, adhering to the principles of voluntariness and anonymity. Before the start of the survey, all participants were informed about the purpose of the study and provided informed consent to participate.

The study was conducted in compliance with the ethical standards and principles outlined in the World Medical Association (WMA) Declaration of Helsinki. Student participation was voluntary, and all data obtained were used exclusively in an aggregated form for scientific purposes.

Methods of Mathematical Statistics. For the processing and interpretation of the results, methods of mathematical statistics were applied: calculation of percentages, mean values, and testing of the statistical significance of the results. Statistical analysis was performed using the significance criterion at a level of $p<0.05$, which ensured the objectivity and reliability of the study's findings.

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3. Results

The survey results showed that 61.1% of students demonstrate a steady interest in working as a coach in children and youth sports schools (CYSS) and consider this field a priority for their future professional activity. 26.4% of respondents indicated partial interest, citing doubts regarding working conditions, the level of responsibility, and the need for constant self-improvement. 12.5% of those surveyed do not plan to work in a CYSS after graduation, primarily motivating this by insufficient practical training and high demands placed on the coach.

Regarding theoretical preparation, 54.2% of students assessed their knowledge of the theory and methodology of sports training as sufficient for working with children. 31.9% rated their level of knowledge as average, and 13.9% as insufficient, particularly concerning the age-specific characteristics of child development, as well as planning and structuring the training process at the initial stages of sports training. These data indicate a need to strengthen the cognitive component of preparation through additional courses and practical sessions on coaching methodology.

The analysis of practical readiness showed that only 19.4% of students feel completely confident in their ability to independently organize and conduct training sessions in a CYSS. 58.3% of respondents indicated partial readiness and a need for mentorship from an experienced coach, while 22.3% admitted to being unready for independent coaching activity due to limited practical experience. These data emphasize the need to expand pedagogical practice, including the modeling of training sessions and supervision in the student training process.

Based on the analysis, it was established that a high level of readiness is characteristic of 17.8% of students who demonstrated steady motivation for coaching, a sufficient volume of theoretical knowledge, and confidence in their ability to independently organize and conduct the training process.

The average level of readiness, identified in 54.2% of respondents, is characterized by a positive attitude toward future professional activity and basic theoretical knowledge, yet it is accompanied by insufficient development of practical skills and a need for methodological support and mentorship from experienced coaches.

A low level of readiness was found in 26.3% of students, indicating limited professional motivation, fragmentary knowledge of the theory and methodology of sports training, and a lack of confidence in their own professional capabilities regarding work with children (Figure 1).

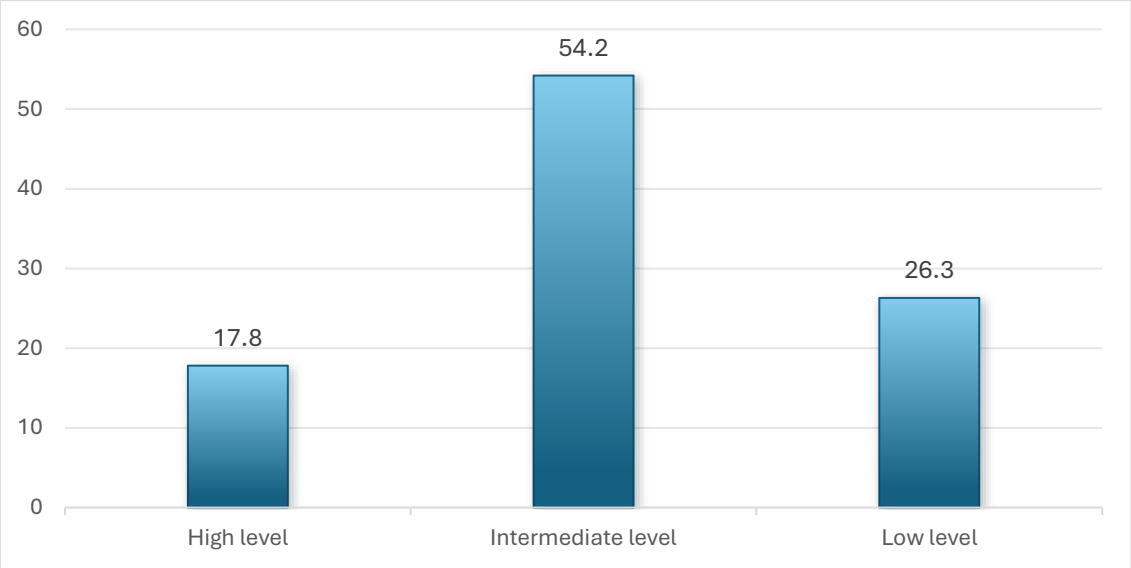

Figure 1. *General level of readiness of future coaches for professional coaching activity*

Overall, the results obtained indicate a predominance of an average level of readiness among future coaches, which necessitates a purposeful improvement of the professional training system with an emphasis on the development of practical skills and the integration of learning with real-world operating conditions in sports schools.

The findings demonstrate a prevalence of an average readiness level among future coaches. This underscores the need to enhance the professional training system by strengthening the practical orientation of education, expanding pedagogical internships in sports schools, and building students' confidence in their own professional capabilities.

Additionally, it is worth noting that the operational (activity-based) component proved to be the most problematic aspect of readiness, while the motivational and cognitive components were better developed. This disproportion indicates the need for targeted work on students' practical skills and their adaptation to real-world work with children.

4. Discussion

The results of the study confirm the relevance of the problem regarding the formation of future coaches' readiness for professional activity within children and youth sports schools. The identified dominance of the average level of readiness is consistent with the findings of scientific works that emphasize the insufficient practice-oriented nature of coaching staff training in higher education institutions specializing in physical culture and sports (Cushion et al., 2003; Modern Science and Research, 2023).

The imbalance between the students' motivational orientation toward coaching and their confidence in their own professional capacity deserves special attention. A similar trend is described in studies noting that a positive attitude toward the profession is not always

accompanied by the development of practical skills necessary for effective work with children (Gould & Carson, 2008; Chen, 2025). This indicates the need to rethink the role of practical training within the structure of future coaches' professional education.

The obtained data also align with modern approaches, according to which a coach's readiness is viewed as an integrative construct formed through the combination of theoretical knowledge, practical experience, and the development of personal qualities (Côté & Gilbert, 2009; Kostenko et al., 2023). The insufficient level of the operational component identified in the study supports the position of scholars regarding the need to expand opportunities for students to independently organize the training process during their undergraduate studies (Cruickshank & Collins, 2020).

In the context of modern youth sports practice, the study results emphasize the importance of early student involvement in real working conditions within sports schools. Practice shows that direct interaction with trainees, participation in planning training sessions, and responsibility for the outcomes of the educational and training process contribute to increasing the level of professional readiness of future coaches (Jůva et al., 2023; Shevchuk et al., 2024).

Thus, the research findings confirm the propositions in contemporary scientific literature that forming future coaches' readiness for work in children and youth sports schools requires a systemic approach. This approach entails the integration of theoretical training with practical activity, as well as the development of reflective and pedagogical skills (Lyle, 2002; Kiprych & Proskurnin, 2024). The identified trends can be used to improve educational programs for coach training and meet the current needs of the modern youth sports system.

5. Conclusions

The conducted study confirmed that the majority of future coaches demonstrate an average level of readiness for professional activity in children and youth sports schools, indicating a need to improve the specialist training system. Although the motivational component of students' readiness is sufficiently high, the operational (activity-based) component is characterized by low development, limiting the ability to independently organize and conduct the training process. The results of the questionnaires and pedagogical observation revealed a gap between theoretical training and students' practical capacity, highlighting the necessity of integrating practice-oriented measures into the educational process. The obtained data suggest that the effective formation of future coaches' professional readiness for work in sports schools is possible through strengthening practical training, expanding pedagogical internships, and developing reflective skills. The identified trends can be utilized to enhance educational programs for coaching staff training and improve the quality of children and youth sports in modern conditions.

References

Chen, R. (2025). Professional coaching among trainers and sports adaptability among students in an institute in China. Journal of Education and Educational Research, 12(2). doi: 10.54097/jeer.v12i2.25

Côté, J., & Gilbert, W. (2009). An integrative definition of coaching effectiveness and expertise. International Journal of Sports Science & Coaching, 4(3), 307–323. doi: 10.1260/174795409789623892

Cruickshank, A., & Collins, D. (2020). The sport coach: The real world of high performance coaching. Routledge. doi: 10.4324/9781315102320

Cushion, C. J., Armour, K. M., & Jones, R. L. (2003). Coach education and continuing professional development: Experience and learning to coach. Quest, 55(3), 215–230. doi: 10.1080/00336297.2003.10491802

Dutchak, M., & Koval, K. (2026). Anti-doping education in sport: assessment of the current state and development prospects in Ukraine (based on a survey of coaches). *Physical Culture and Sport: Scientific Perspective*, (4), 24–32. doi: 10.31891/pcs.2025.4.3

Gould, D., & Carson, S. (2008). Life skills development through sport: Current status and future directions. International Review of Sport and Exercise Psychology, 1(1), 58–78. doi: 10.1080/17509840701834573

Jůva, V., Jakubcová, K., & Roček, M. (2023). Development of a questionnaire focused on sports coaches learning. Studia Sportiva, 17(1), 22–32. doi: 10.5817/StS2023-1-3

Kiprych, S., & Proskurnin, A. (2024). Pedagogical conditions for training future coaches to apply sports selection technologies in professional activity. *Ukrainian Professional Education*, (16), 106–114. doi: 10.33989/2519-8254.2024.16.314314

Kostenko, M., Putrov, S., Krotov, H., & Kostenko, S. (2023). A model for training coaches to develop group reflexivity in athletes in team sports. *Scientific Journal of the Ukrainian State University named after Mykhailo Drahomanov. Series 15: Scientific and Pedagogical Issues of Physical Culture (Physical Culture and Sport)*, (1(159)), 87–92. doi: 10.31392/NPU-nc.series15.2023.1(159).22

Lyle, J. (2002). Sports coaching concepts: A framework for coaches' behaviour. Routledge. doi: 10.4324/9780203463918

Modern Science and Research. (2023). Professionally pedagogical preparation of coaches and its improvement with the use of educational tests. Modern Science and Research, 2(10). doi: 10.5281/zenodo.10051684

Novopysmennyi, A., & Kononets, N. (2025). Didactic model for forming the readiness of future coach-teachers to work in youth sports schools of powerlifting. *Origins of Pedagogical Mastery*, (36), 167–177.. doi: 10.33989/2075-146x.2025.36.339458

Osadchenko, T. (2023). Theoretical aspects of forming the professional readiness of future track and field coaches to work with children with musculoskeletal disorders. *Pedagogical Sciences*, (100), 125–130. doi: 10.24919/2308-4634.2023.273302

Shevchuk, O., Kohut, I., & Marynych, V. (2025). Organizational foundations of professional training of coaches worldwide and in Ukraine. *Sport Science Spectrum,* (1), 90–98. doi: 10.32782/spectrum/2025-1-13

Shevchuk, O., Kohut, I., & Marynych, V. (2024). Coaches' readiness to work with athletes with special educational needs: a nationwide study based on the COM-B model. *Slobozhanskyi Herald of Science and Sport*, 28(4), 175–184. doi: 10.15391/snsv.2024-4.01

Sushchenko, L. P., Vasylenko, M. M., & Korkh-Cherba, O. V. (2022). Pedagogical technologies of professional training of future fitness trainers. *Scientific Journal of the National Pedagogical Dragomanov University. Series 15: Scientific and Pedagogical Issues of Physical Culture (Physical Culture and Sport)*, (3K(147)), 399–403.

Yefremenko, A., Aleksenko, Ya., Marchenkov, M., Nasonkina, O., & Poltoratska, H. (2025). Digital competence of sport-specific coaches: pathways for development. *Education. Innovation. Practice*, 13(1), 23–28. doi: 10.31110/2616-650X-vol13i1-003

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ORIGINAL SCIENTIFIC PAPER

PREVENTION AND CORRECTION OF KYPHO-LORDOSIS THROUGH HYDROKINETOTHERAPY

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Abstract

Purpose: The aim of this study was to evaluate the effectiveness of a hydrokinetotherapy program in improving postural indicators in primary school children diagnosed with kypho-lordosis.

Methods: The research was designed as a longitudinal pedagogical experiment carried out over six months. The sample consisted of eight pupils aged 9-10 years, selected from schools in Arad and diagnosed with kypho-lordosis. Participants attended three sessions per week, combining corrective exercises performed on land, in shallow water and in deep water, with respiratory gymnastics and swimming drills. Assessments were conducted initially, intermediately and finally using the plumb line test in the sagittal plane and goniometric measurement. Arithmetic mean, amplitude, coefficient of variability and standard deviation were used for statistical interpretation. The study is exploratory in nature, and the analysis of the results was carried out using descriptive statistical methods, without applying inferential tests and without including a control group. **Results:** The plumb line assessment showed a cumulative improvement of 0.70 cm from initial to final testing. The goniometric assessment showed a cumulative improvement of 4.00 degrees. Variability indicators also decreased, suggesting a more homogeneous postural response to the intervention. **Conclusions:** The results support the use of hydrokinetotherapy as a useful complementary method for improving postural alignment in children with kypho-lordosis, provided that the program is progressive, supervised and adapted to the participants' functional level.

Keywords: postural alignment; pediatric rehabilitation; therapeutic swimming; spinal assessment; motor education

1. Introduction

Correct body posture during childhood is an important component of physical development and motor education. The school period is characterized by rapid growth, frequent changes in body proportions and increasing exposure to prolonged sitting, carrying loads and sedentary

activities. These factors can contribute to postural deviations when they are not balanced by systematic physical exercise, postural education and early corrective intervention (Ahmadi et al., 2020; Calb, 2000; Cîrlă, 1992; Plas & Hagron, 2001).

Corrective aquatic programs may represent an alternative or a complement to classical physical therapy in the prevention and correction of postural deviations in children and adolescents. The properties of the aquatic environment—buoyancy, hydrostatic pressure, and water resistance—facilitate the performance of movements with reduced joint impact, allow postural control, and promote activation of the trunk muscles. Recent studies have highlighted the positive effects of corrective exercises performed in water on hyperkyphosis, forward head posture, and rounded shoulders, while the literature on postural disorders in children emphasizes the importance of conservative, individualized, and early interventions (Ahmadi et al., 2020).

Xiang et al. (2024) present a scoping review is presented that supports the use of aquatic therapy in children and adolescents, emphasizing that the properties of water—buoyancy, hydrostatic pressure, and hydrodynamic resistance—facilitate therapeutic exercise and functional recovery (Iordan et al., 2025). The specialized literature highlights the limited number of applied studies on the effects of hydrokinetic therapy on the posture of younger school-aged children.

Swimming and aquatic exercise are often recommended in physical education and rehabilitation because the aquatic environment reduces mechanical load, facilitates movement control and offers graded resistance through water viscosity. The buoyancy of water supports the body, decreases joint loading and can help children perform movements that are more difficult or less comfortable on land (Baciu, 1981; Cordun, 1999; Dănoiu, 2006). These properties are relevant in corrective programs that aim to improve spinal alignment, trunk control, respiratory function and general motor confidence

Kypho-lordosis is a postural deviation in the sagittal plane that combines dorsal kyphotic accentuation with lumbar lordotic accentuation. The two deviations can appear successively, with one curve developing compensatory characteristics in relation to the other (Barczyk et al., 2009; Drăgan et al., 1994). The corrective approach must therefore address both the dorsal and the lumbar regions, while also improving abdominal tone, back extensor control, pelvic position and breathing mechanics.

The scientific rationale of the present research derives from the need to use school- and community-accessible methods for postural correction. Previous literature on corrective gymnastics, kinesiology and aquatic therapy indicates that corrective exercise can influence postural control when it is applied regularly, with appropriate dosage and individualized progression (Ahmadi et al., 2020; Badiu et al., 2003; Barczyk et al., 2009; Bighea, 2013). The aim of this study was to evaluate whether a six-month hydrokinetotherapy program could improve measurable postural indicators in children aged 9-10 years diagnosed with kypho-lordosis.

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2. Materials and Methods

Study design

The study was organized as a longitudinal pedagogical experiment. The intervention lasted six consecutive months, from October 2022 to March 2023, and included three testing moments: initial testing, intermediate testing and final testing. The research design was based on repeated measurements of the same participants before, during and after the application of the corrective program.

Participants

The sample included eight pupils aged 9-10 years, selected from schools in Arad municipality. The research group consisted of 8 male students. All participants had been diagnosed with kypho-lordosis and were recommended corrective exercises and swimming-based therapeutic activity. Sex distribution was not used as an inclusion criterion or an analysis variable in the original data set; this aspect should be considered when interpreting the results.

The inclusion criteria were: age between 9 and 10 years; diagnosis of kypho-lordosis; ability to follow a common corrective program; participation in the same exercise structures; and readiness to respond to the requirements of the sessions. The children had previously acquired basic swimming skills, including floating, gliding, breathing and elementary crawl and backstroke technique.

The small number of subjects was determined by the local recruitment conditions, the children's availability, and parental consent. The small sample size is explained by the exploratory nature of the research and by the specific limitations related to participant recruitment in the local context, with the study serving as a basis for future research on larger samples.

Setting and intervention

The diagnosis of kypholordosis and the study were carried out in the private practice office of the Izvorul Sănătății Treatment Center in Arad, owned by Dr. Iulian Cibotaru, senior physiotherapist. The Izvorul Sănătății Treatment Center in Arad is equipped with various devices used in the treatment of physical deficiencies, including some with support-pulley systems, exercise benches, melacart tim boards necessary for promoting movement, ergometric bicycles, medicine balls, small and large dumbbells, sandbags, wall bars, gym benches, a skateboard-type movement board, etc.

The assessment was performed using a plumb line and a goniometer. These students are registered in the records of the sports medicine office of the Arad Municipal Hospital and have medical exemptions from physical education and sports classes, in accordance with the law. However, they were recommended by the specialist physiotherapist to perform corrective exercises both during physical education lessons and through swimming.

The aquatic sessions took place at the Subcetate swimming pool in Arad, a 25 m pool with five lanes, with shallow water of approximately 0.7 m at one end and deeper water of

approximately 1.8 m at the other end. Complementary assessment and land-based corrective activities were conducted in a private treatment facility in Arad equipped with therapeutic exercise apparatus, gym benches, wall bars, medicine balls, weights, pulleys and other materials used in postural rehabilitation.

The intervention consisted of three sessions per week, on Monday, Wednesday and Friday. A 14-day consolidation period was initially used to harmonize the participants' swimming skills. After this preparatory stage, corrective exercise structures specific to kypho-lordosis were applied until the winter break, followed by continuation of the program after the break until final testing. The program combined static corrective positions, dynamic exercises for the trunk and limbs, respiratory exercises, basic swimming drills and corrective tasks performed in shallow and deep water.

During the entire six-month intervention period, the pupils performed corrective exercises specific to kypho-lordosis both in the aquatic environment and on the poolside. The exercises were selected from basic gymnastics and adapted for execution in shallow or medium-depth water, as well as through specific swimming techniques, particularly front crawl and backstroke.

The specific means used included static exercises, dynamic exercises targeting the trunk, upper limbs and lower limbs, and breathing exercises (Cordun & Cîrlă, 1999).

In designing the exercise structures, the following aspects were considered: the specificity of the means in relation to the objectives of swimming; the possibility of applying these means in school settings and their applicability by other coaches or specialists interested in this topic; the possibility of both quantitative and qualitative evaluation; and their recognized effectiveness in the instructional and educational practice of therapeutic swimming.

The main means used for the correction of kypho-lordosis are presented in Table 1.

Table 1. Main means used for the correction of kypho-lordosis

Type of exercise	Reference
Physical training exercises performed in water	Calb, 2000
Exercises performed on the poolside	Cordun, 1999
Exercises performed in shallow water	—
Exercises performed in medium-depth water	Cîrlă, 1992; Culda et al., 2000
Respiratory gymnastics program	—

The dosage parameters applied throughout the intervention are presented in Table 2.

Table 2. Dosage parameters of the exercise intervention

Parameter	Value
Duration of one session	1 hour
Weekly frequency	3 times per week
Number of repetitions	8 repetitions
Number of sets	2 sets
Exercise intensity	Below average
Progression	Gradual increase in difficulty over six months, in accordance with participants' adaptation and positive progress

The selected exercises aimed to increase the tone of dorsal and abdominal muscle groups, improve the length-tension relationship of the sacro-lumbar region and anterior thoracic wall, and form a correct postural reflex of the trunk and lower limbs (Barczyk et al., 2009; Bitang, 2009a; Drăgan, 2002; Jeleascov, 2000; Sbenghe, 1986). Exercise positions included standing, kneeling, sitting, lying and hanging variations. Movements included bending, stretching, thoracic extension, rotations and controlled trunk actions. Portable and fixed materials included sticks, elastic cords, medicine balls, small sandbags, wall bars, gym benches and inclined planes.

Measurements and investigated parameters

Two measurement procedures were used. The plumb line test was performed in the sagittal plane to determine deviations in relation to the dorsal region. Goniometric measurement was used to quantify angular changes associated with the postural deviation. The investigated parameters were the arithmetic mean, amplitude, coefficient of variability and standard deviation for each testing moment and each measurement method.

To reduce measurement variability, all assessments were performed by the same evaluator, under similar conditions, using the same instruments and the same working procedure.

Statistical analysis

The statistical analysis was descriptive. The arithmetic mean was used to estimate the central tendency of the group values. Amplitude described the range of values observed in the group. The coefficient of variability was used to estimate the relative homogeneity of the sample, while standard deviation described dispersion around the mean. The available manuscript data allow

interpretation of the differences between initial, intermediate and final testing, rather than inferential testing. Because the sample was small (n = 8), the results should be interpreted as preliminary and exploratory.

Ethical considerations

All investigations involving children should conform to the Code of Ethics of the World Medical Association, Declaration of Helsinki. Participation should be documented as having been based on medical recommendation and parental/legal guardian consent.

3. Results

The results are presented according to the two assessment methods used in the study. The most important findings were the progressive improvement observed between initial and final testing and the reduction of variability indicators, suggesting a more consistent postural response among participants.

Table 3. Study design and assessment moments

Stage	Period/date	Main activity	Assessment
Initial assessment	30 September 2022	Baseline clinical-functional assessment	Plumb line and goniometer
Preparatory stage	3-16 October 2022	Consolidation of swimming fundamentals	Technical observation
Intervention stage I	October-December 2022	Corrective aquatic and land exercises	Intermediate testing on 19 December 2022
Winter break	December 2022-January 2023	Interruption according to school calendar	No testing
Intervention stage II	16 January-21 March 2023	Continuation of corrective program	Final testing on 21 March 2023

The plumb line test indicated a gradual improvement in postural deviation. The difference between initial and intermediate testing was 0.2875 cm, while the difference between intermediate and final testing was 0.4125 cm. The cumulative improvement from initial to final testing was therefore 0.70 cm. The amplitude did not change between the first two measurements but changed by 0.30 at final testing. The coefficient of variability decreased by 2.07 points between initial and final testing. Standard deviation changed by 0.10 between initial and intermediate testing and by 0.25 between intermediate and final testing.

Table 4. Evolution of plumb line indicators in the sagittal plane

Indicator	Initial to intermediate	Intermediate to final	Initial to final	Interpretation
Arithmetic mean	0.2875 cm improvement	0.4125 cm improvement	0.70 cm improvement	Progressive reduction of postural deviation
Amplitude	No change	0.30 change	0.30 change	Range became more favorable at final testing
Coefficient of variability	-	-	2.07 decrease	Greater group homogeneity
Standard deviation	0.10 change	0.25 change	0.35 cumulative change	Reduced dispersion tendency

The goniometric assessment showed a larger numerical change than the plumb line assessment because it quantified angular deviation. The difference between initial and intermediate testing was 2.08 degrees, and the difference between intermediate and final testing was 1.92 degrees, resulting in a cumulative improvement of 4.00 degrees. The amplitude changed by 1.10 between initial and intermediate testing and by 0.50 between intermediate and final testing. The coefficient of variability changed by 3.20 and 1.66 respectively, while standard deviation changed by 0.51 and 0.31.

Table 5. Evolution of goniometric indicators

Indicator	Initial to intermediate	Intermediate to final	Initial to final	Interpretation
Arithmetic mean	2.08 degrees improvement	1.92 degrees improvement	4.00 degrees improvement	Consistent angular correction
Amplitude	1.10 change	0.50 change	1.60 cumulative change	Improved range of values
Coefficient of variability	3.20 change	1.66 change	4.86 cumulative change	More homogeneous group response

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Standard deviation	0.51 change	0.31 change	0.82 cumulative change	Lower dispersion of results

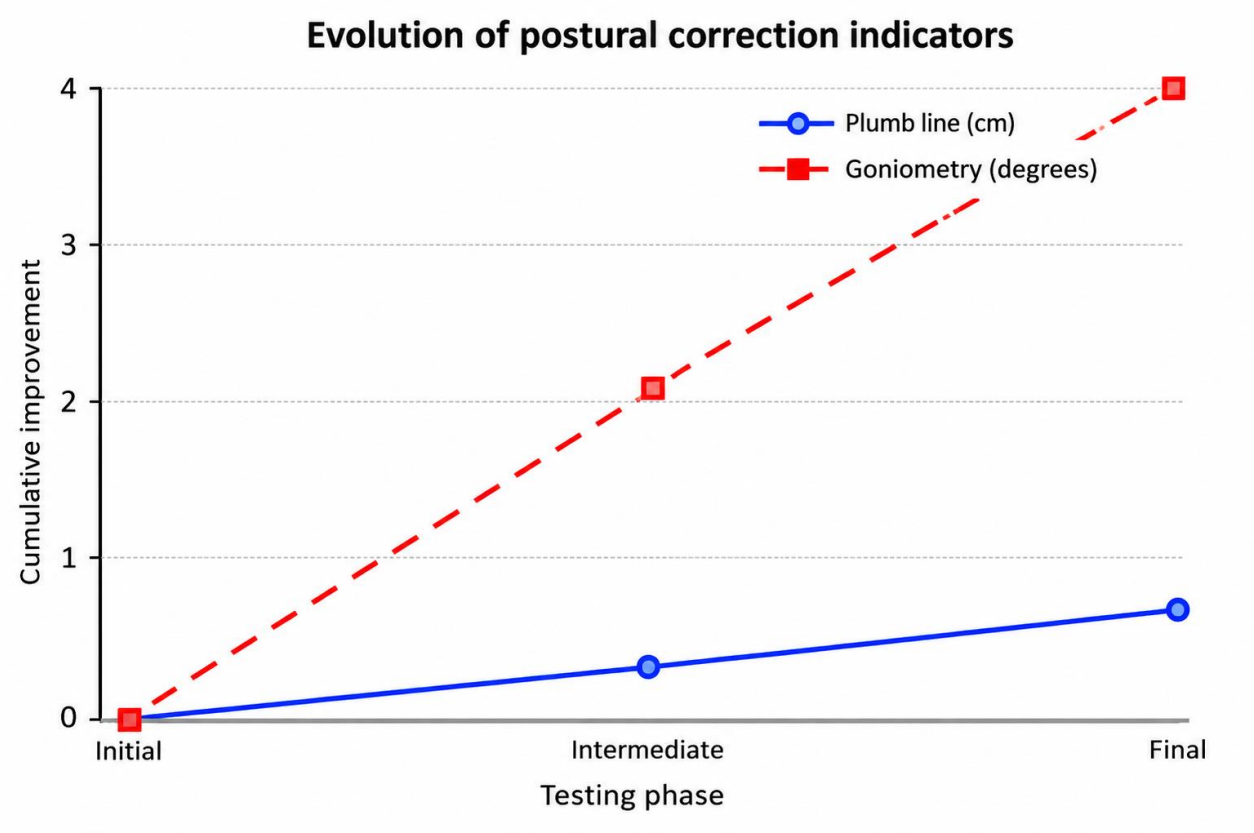

Figure 1. Cumulative improvement of postural indicators between testing moments. Values are presented in their original measurement units: centimeters for the plumb line test and degrees for goniometry.

In the absence of clear clinical thresholds for this age category, the results should be interpreted with caution.

A particular feature of the program implementation was the interruption caused by the winter holiday. This break may have influenced the pace of progress; therefore, the evolution of the results between the intermediate and final assessments should be interpreted with caution.

4. Discussion

The findings indicate that the six-month hydrokinetotherapy program produced favorable changes in both linear and angular indicators of postural deviation. Although the sample was small, the direction of change was consistent across the two measurement methods. This supports the practical value of combining aquatic exercise, corrective gymnastics and respiratory work in children with kypho-lordosis.

The improvement observed in the plumb line test suggests better sagittal alignment and postural control. In practical terms, this may reflect improved awareness of trunk position and more balanced activation of the muscle groups involved in spinal support. The goniometric improvement of 4.00 degrees provides additional support for the corrective effect of the program. Because kypho-lordosis involves both dorsal and lumbar components, the combined use of trunk extension control, abdominal strengthening, respiratory gymnastics and swimming drills is methodologically justified.

The aquatic environment may have facilitated these changes through several mechanisms. Buoyancy decreases loading and allows children to perform movements with less fear and less compensatory tension. Water viscosity provides continuous resistance, which can support symmetrical muscle activation and controlled movement execution. Hydrostatic pressure and the sensory characteristics of immersion may also contribute to postural awareness and respiratory control (Baciu, 1981; Bitang, 2009b; Marcu, 2000; Ogonowska-Słodownik et al., 2024). These mechanisms are consistent with contemporary descriptions of aquatic therapy as a rehabilitation environment that supports postural control, motor learning and functional participation in children (Becker, 2009; Culda et al., 2000; Mureșan et al., 2006; Sbenghe, 1986).

The results are also consistent with the broader literature on corrective exercise in water. Barczyk and colleagues reported that corrective exercises performed in a water environment can influence antero-posterior spinal curves and the functional status of the locomotor system in children with spinal deviations (Becker, 2009; Firică, 1998; Fozza, 2002; Fozza & Nicolaescu, 1980). The present study does not claim generalizable clinical efficacy because it did not include a control group, but it provides applied pedagogical evidence that aquatic corrective programs can be implemented in school-aged children when the program is supervised and progressively dosed.

A strength of the study is the duration of the intervention and the repeated assessment design. The program lasted six months and included three sessions per week, which is a sufficient pedagogical framework for observing postural adaptations. Another strength is the use of both land-based and water-based corrective means, which made it possible to address posture, breathing and swimming skill consolidation together.

The study also has limitations. The number of participants was small, sex distribution was not recorded as an analysis variable, and the available data were summarized descriptively. Future studies should include larger samples, a control group, standardized photographic or digital postural analysis, individual raw values and inferential statistical testing. It would also be useful to evaluate whether improvements are maintained several months after the end of the intervention.

5. Conclusions

The six-month hydrokinetotherapy program was associated with measurable improvements in postural indicators among children aged 9-10 years diagnosed with kypho-lordosis.

The plumb line assessment showed a cumulative improvement of 0.70 cm, and goniometry showed a cumulative improvement of 4.00 degrees from initial to final testing.

The combined use of corrective exercises on land, exercises in shallow and deep water, respiratory gymnastics and swimming drills appears to be a useful method for supporting postural correction in primary school children.

The findings support the inclusion of supervised aquatic corrective programs in school and rehabilitation contexts, while future studies with larger samples and control groups are needed to strengthen the evidence base.

Given the small sample size, the absence of a control group, and the exclusive use of descriptive statistics, the results should be interpreted as favorable trends observed within this sample, without being generalizable to the entire school population.

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References

1. Ahmadi, H., Yalfani, A., & Gandomi, F. (2020). Effect of eight weeks of corrective exercises carried out in water on static and semi dynamic balance on students with upper crossed syndrome (Janda approach). The Scientific Journal of Rehabilitation Medicine, 9(3), 286–296.
2. Baciu, C. (1981). Kinetoterapie. Editura Sport-Turism.
3. Badiu, T., Hâncu, N., & Chiriac, P. (2003). Îndrumar metodic de kinetoprofilaxie și terapie a deficiențelor fizice. Editura Școala Gălățeană.
4. Barczyk, K., Zawadzka, D., Hawrylak, A., Bocheńska, A., Skolimowska, B., & Małachowska-Sobieska, M. (2009). The influence of corrective exercises in a water environment on the shape of the antero-posterior curves of the spine and on the functional status of the locomotor system in children with I degree scoliosis. Ortopedia, Traumatologia, Rehabilitacja, 11(3), 209–221.
5. Becker, B. E. (2009). Aquatic therapy: Scientific foundations and clinical rehabilitation applications. PM&R, 1(9), 859–872. https://doi.org/10.1016/j.pmrj.2009.05.017
6. Bighea, A. (2013). Metodologia de kinetoterapie: Note de curs. Craiova.
7. Bitang, V. (2009a). Predarea și învățarea tehnicii de înot la copii și juniori (ed. a 2-a rev.). Editura Vasile Goldiș University Press.

8. Bitang, V. (2009b). Programe și structuri operaționale utilizate în instruirea înotătorilor și canotorilor (ed. a 2-a rev.). Editura Vasile Goldiș University Press.
9. Calb, M. (2000). Anatomie funcțională și biomecanică. Editura Fundației România de Mâine.
10. Cîrlă, L. (1992). Înotul, mijloc asociat al kinetoterapiei. Editura Caritas.
11. Cordun, M. (1999). Kinetologia medicală. Editura A.X.A.
12. Cordun, M., & Cîrlă, L. (1999). Hidrokinetoterapia în afecțiuni reumatismale. Editura Printech.
13. Culda, C., Dungaciu, P., & Culda, P. (2000). Manual de gimnastică. Editura Fundației România de Mâine.
14. Dănoiu, M. (2006). Kinetologie. Editura Didactică și Pedagogică.
15. Drăgan, L., et al. (1994). Medicina sportivă aplicată. Editura Editis.
16. Drăgan, L. (2002). Medicina sportivă. Editura Medicală.
17. Firică, A. (1998). Examinarea fizică a bolnavilor cu afecțiuni ale aparatului osteoarticular. Editura Național.
18. Fozza, C. A. (2002). Îndrumar pentru corectarea deficiențelor fizice. Editura Fundației România de Mâine.
19. Fozza, C. A., & Nicolaescu, V. (1980). Gimnastica corectivă și masaj. I.E.F.S.
20. Ionescu, A. (1994). Masajul: Procedee tehnice, metode, efecte, aplicații în sport. Editura All.
21. Iordan, D. A., et al. (2025). Postural disorders of the spine in children and adolescents. Balneo and PRM Research Journal, 16(4).
22. Jeleascov, C. (2000). Gimnastica ritmică de bază. Editura Fundației România de Mâine.
23. Marcu, V. (2000). Bazele teoretice ale exercițiilor fizice în kinetoterapie. Editura Universității din Oradea.
24. Mureșan, E. (2000). Înot: Curs. Editura Fundației România de Mâine.
25. Mureșan, E., Jeleascov, C., & Mureșan, D. (2006). Corectarea deficiențelor fizice: Mijloace utilizate în apă și pe uscat. Editura Fundației România de Mâine.
26. Ogonowska-Słodownik, A., et al. (2024). Aquatic therapy in children and adolescents with disabilities: A scoping review. Children, 11(11), 1404.
27. Plas, F., & Hagron, E. (2001). Kinetoterapie activă. Editura Polirom.
28. Sbenghe, T. (1986). Cura balneo-climaterică. Editura Medicală.
29. Sbenghe, T. (1987). Kinetologia profilactică, terapeutică și de recuperare. Editura Medicală.
30. Sbenghe, T. (2002). Kinesiologie: Știința mișcării. Editura Medicală.
31. Xiang, A., Fu, Y., Wang, C., Huang, D., Qi, J., Zhao, R., Wu, L., Fan, C., & Zhang, Q. (2024). Aquatic therapy for spastic cerebral palsy: A scoping review. European Journal of Medical Research, 29, 569. https://doi.org/10.1186/s40001-024-02171-1