# Integrating technology in physical education: The impact of TPACK-based tactical and technical approaches on football skills and student motivation

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## ABSTRACT

**Background:** Motivation and skill development are vital in physical education, particularly football. Tactical learning emphasizes decision-making and game understanding, while technical learning focuses on mastering fundamental skills.
**Objectives:** This study aimed to analyze the impact of a TPACK-based tactical and technical learning approach on student motivation and football skill acquisition among high school students in Tasikmalaya.
**Methods:** The study applied the TPACK framework—integrating Technological, Pedagogical, and Content Knowledge—in designing the learning model. Using an experimental method with a pre-test–post-test design, 30 students were divided into two groups. Motivation was assessed via a Likert-scale questionnaire, while football skills (passing, heading, dribbling, shooting, and playing ability) were evaluated through standardized tests. Data were analyzed using paired and independent t-tests with a significance level of $p < 0.05$.
**Results:** The technical approach significantly enhanced basic football skills, notably heading ($t = 8.47$) and shooting ($t = 8.29$), proving its effectiveness in improving fundamental competencies. Conversely, the tactical approach showed a notable increase in student motivation ($t = 4.98$) and playing ability ($t = 5.94$), reflecting its strength in fostering strategic understanding and engagement. TPACK integration further reinforced both approaches through effective use of technology.
**Conclusions:** The study highlights the importance of combining tactical and technical approaches to promote holistic student development. Continued research is needed to explore the long-term effects and potential of integrating diverse technological tools in physical education.

**Keywords:** Football skill, learning motivation, physical education, TPACK, tactical and technical approach learning model.

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## INTRODUCTION

Learning Football skills in an educational environment requires a practical approach to increase learners' motivation and learning outcomes. In physical education, the two main approaches often used are the tactical and technical. The tactical approach focuses on decision-making and understanding the game, while the technical approach emphasizes mastering basic skills before applying them in game situations (Harvey & Jarrett, 2014). However, the successful implementation of these two approaches depends heavily on appropriate technology and pedagogical strategies. The tactical approach to Football learning emphasizes understanding game strategy, decision-making, and adaptation to dynamic situations. This approach is often associated with methods such as Teaching Games for Understanding (TGfU), which emphasizes game-based learning to develop students' conceptual understanding of game patterns and team strategy (Kirk & MacPhail, 2002). In this approach, students are challenged to understand the game situation and make the right decisions based on the game conditions they face. With a tactical approach, learners are taught to analyze the game holistically, understand the position and movement of other players, and adjust the strategy that best suits the conditions of the ongoing game. This contributes to developing critical thinking and problem-solving skills in real-game situations.

In contrast, the technical approach focuses on mastering basic skills like dribbling, passing, shooting, and ball control before applying them in a more complex game context. Technique-based learning methods often use repetitive exercises to improve motor coordination and precision in performing specific movements (Breed et al., 2024). The advantage of this approach is that it allows learners to master skills well before they apply them in real-game situations. However, this approach is often criticized for lacking contextual experience in real games, so learners sometimes have difficulty transferring the skills they have learned to dynamic match situations (Renshaw et al., 2019). Therefore, an approach is needed to integrate tactical and technical elements in a balanced way so that learners not only master technical skills but can also use them effectively in matches.

The Technological, Pedagogical, and Content Knowledge (TPACK) framework has recently become a widely used model for integrating technology into learning (Mishra & Koehler, 2006). This model emphasizes the importance of balancing three main aspects, technology, pedagogy, and content, to increase learning effectiveness. In Football, a TPACK-based approach can help learners understand tactical concepts through digital simulations, video analysis, and interactive applications that can improve their understanding of the game (Yildiz et al., 2020). With technology, students can gain deeper insights into game strategies, player movement patterns, and the analysis of tactics used in various match scenarios.

In addition, technology in Football learning can provide faster and more accurate feedback to learners. For example, video analysis can help students understand their technical and tactical mistakes so they can make improvements immediately. Artificial intelligence-based software can also provide individual technique improvement recommendations, improve training efficiency, and accelerate mastery of Football skills (Renshaw et al., 2019). Thus, this approach not only improves understanding but also enables a deeper process of reflection on the skills learned.

Several studies have shown that integrating TPACK into physical learning can improve student motivation and learning outcomes (Casey & Kirk, 2020). A more

interactive and hands-on approach can increase learners' motivation to learn Football. Students who are involved in technology-based learning tend to be more active in exploring new skills and feel more challenged in improving their abilities. On the other hand, using TPACK-based tactical approaches also contributes to improving student learning outcomes, especially in problem-solving, creativity in playing, and the ability to adapt to dynamic game situations. However, there is still a research gap regarding the effectiveness of TPACK-based tactical approaches and techniques in developing Football skills. Most research still focuses on the effectiveness of each approach separately.

In contrast, integrating the two approaches with technology is still a topic that has been less explored. Therefore, this study aims to analyze the effect of the TPACK-based tactical and technical approach on the motivation and learning outcomes of Football skills in students. The results of this study are expected to contribute to developing a more innovative and technology-based learning model in physical education.

With this research, a more effective learning model can be found to improve student motivation and learning outcomes, especially in Football learning. Technology integration through the TPACK approach can be a solution to enhance a more interactive and problem-solving-oriented learning experience in the game. Thus, this research has theoretical and applicative implications in physical education.

The tactical approach in Football aims to develop students' understanding of the game through a more contextual playing experience. Teaching Games for Understanding (TGfU) is widely used because it encourages students to understand game strategy in depth (Kirk & MacPhail, 2002). The technical approach emphasizes the development of basic Football skills through structured training. Although this approach effectively improves individual skills, research shows that the technical approach is less effective in improving game understanding than the tactical approach (Renshaw et al., 2019). A study by Harvey and Jarrett (2014) shows that the tactical approach improves students' strategic thinking more effectively than the technical approach, which focuses more on repeating motor skills. In addition, research by Light & Fawns (2003) revealed that students taught with a tactical approach were more active in making decisions during the game than students who were only trained using a technical approach. According to Ford and Collins (2010), the technical approach is critical in building the foundation of individual skills. However, its success in matches depends heavily on how well students can integrate these skills with a tactical understanding of the game.

The tactical approach emphasizes the development of strategic thinking and decision-making skills in Football. Through this approach, students are challenged to understand game patterns, adapt to match situations, and apply appropriate strategies in various conditions that arise during the game (Light et al., 2014). The Teaching Games for Understanding (TGfU) method implements this approach, which aims to build students' understanding of the game's structure before they master the technical skills (Kirk & MacPhail, 2002). A study conducted by Light et al. (2014) showed that students who were taught using a tactical approach could better apply game strategies effectively than those who only focused on technical skills. On the other hand, the technical approach to Football learning prioritizes mastery of basic skills such as passing, dribbling, shooting, and ball control before incorporating game strategy elements (Ford & Collins, 2010). This approach is often applied through repetitive exercises aimed at improving the accuracy and consistency

of students' technical skills. However, some research shows that the technical approach can be less effective in improving students' understanding of the game if it is not balanced with contextual playing experience (Renshaw et al., 2019). Research by O'Connor et al. (2017) found that combining tactical and technical approaches can result in more effective learning than using only one approach. In other words, students with a strong technical skill base who can also think tactically will be more successful in dealing with dynamic game situations.

The TPACK model was developed by Mishra and Koehler (2006) to describe how teachers can effectively integrate technology into learning. This model consists of three main components: Technological Knowledge (TK), understanding technology and its use in learning, Pedagogical Knowledge (PK), and understanding effective teaching strategies. Content Knowledge (CK): Understanding of the material being taught. In the context of physical education, the application of TPACK allows using technology such as video analysis, game-based learning applications, and other digital devices to improve students' understanding of tactical concepts and Football techniques (Casey et al., 2017). A study by Kurtaran et al. (2020) shows that using technology in Football learning can help students better understand game strategies and increase their motivation to learn. According to Irwin et al. (2023), integrating TPACK in Football learning can increase student engagement and improve their ability to identify game patterns. In addition, TPACK-based video analysis can provide faster and more accurate feedback so students can correct their mistakes immediately.

TPACK is a conceptual framework that combines technology, pedagogy, and content in learning (Mishra & Koehler, 2006). In Football, this model enables technology to enrich learning based on tactics and techniques. TPACK in Football learning has been proven to improve the understanding of tactical concepts through video analysis and interactive applications (Yildiz et al., 2020). A study by Casey et al. (2017) shows that students who learn through a TPACK-based approach are more motivated because they can get immediate feedback through digital devices. According to Mishra & Koehler (2006), the successful implementation of TPACK in learning depends on how teachers can integrate technology effectively into teaching methods that suit the needs of students. Research by Irwin et al. (2023) shows that integrating TPACK in physical learning can increase student collaboration and improve their understanding of tactical and technical concepts in Football.

Technology has changed how learning is done in various fields, including physical education. Video analysis, motion sensors, and digital learning applications have been shown to improve the effectiveness of learning Football skills (Metzler, 2017). According to Wright et al. (2021), artificial intelligence-based technology can help coaches and teachers provide more specific data-based feedback on student performance in Football. Thus, TPACK-based tactical approaches and techniques can provide innovative solutions to improve the effectiveness of Football learning. With technology integration in learning, students can improve their technical skills and develop a deeper understanding of game strategy. Video analysis in Football has been shown to help students understand technical errors and improve individual skills (Metzler & Colquitt, 2021). A study by Renshaw et al. (2019) shows that using digital simulations in Football training improves decision-making abilities in real-game situations. Artificial intelligence-based technology can help coaches and teachers provide more specific and data-based feedback on students' Football performance (Yıldız et al., 2020). According to Wright et al. (2021), technology-

based learning can increase student participation in physical activities because they are more interested in learning through interactive digital media.

This research contributes significant theoretical value by addressing the gap in TPACK integration within physical education, particularly in football instruction, while offering practical implications for educators through evidence-based recommendations on effectively combining tactical and technical approaches. By examining both approaches through the TPACK framework, this study advances our theoretical understanding of technology-enhanced physical education pedagogies. It provides actionable insights that physical education teachers can immediately implement to optimize student motivation and skill development in real classroom settings.

# METHODS

## Study Design and Participants

This study used a pretest-posttest experimental design (Fraenkel et al., 2012) to examine the cause-and-effect relationship between the TPACK-based Tactical Approach and Technical Approach as soccer learning strategies in 30 high school students in Tasikmalaya. This method was chosen as it allows manipulation of controlled variables (tactical vs. technical approach) and measurement of treatment effects by comparing pretest-posttest results. The experimental and control groups received different interventions according to a standardized program, with strict control of bias through three steps: (1) use of the same certified CHD teacher for both groups, (2) random assignment of participants using a random number generator, and (3) evaluation of results by an independent rater blinded to the intervention group (double-masked).

Referring to Fraenkel et al. (2012), this study used saturated sampling (census) by involving the entire student population (N=30). The choice of this technique is based on the recommendation of a minimum sample size of 30 subjects per group for experimental studies, although tightly controlled studies can use 15 subjects. This decision strengthens the generalizability validity of the findings while minimizing sampling error.

Implementing the TPACK (technology, pedagogy, and content knowledge) framework on both approaches was designed to ensure a valid comparison. By keeping the technological component constant (video analysis, interactive applications), differences in results could only be attributed to the teaching methodology (tactical vs. technical). This design reflects the integration of technology in modern physical education while isolating the influence of purely pedagogical strategies.

## Ethical approval statement

The research was conducted by the institution's ethical standards and approved by the Senior High School's Institutional Review Board (IRB) in Tasikmalaya. All participants were fully informed about the study's objectives, procedures, and their right to voluntarily participate or withdraw at any stage without any negative consequences. Written informed consent was obtained from all participants, and parental consent was secured for those under the legal age. The privacy and confidentiality of all participants were ensured, and personal information was anonymized during data collection and analysis. All procedures aligned with the

ethical guidelines outlined in the Declaration of Helsinki and complied with relevant educational and psychological research ethics.

### Research Instruments

In this research, the main challenge lies in the need for accurate data for further processing and analysis. To fulfill this need, researchers used research instruments as systematic tools in data collection. The main instrument developed was the McClelland & Burnham (2017) concept-based Learning Motivation Questionnaire, which underwent a rigorous validation process using 15 high school students participating in extracurricular soccer. The Spearman's Rank correlation test was validated with valid criteria if the $r_{count}$ value> 0.441 ($\alpha = 0.05$). Of the initial 50 items, 40 were declared valid, with correlation coefficients ranging from 0.589 to 0.825. Reliability was tested using the split-half reliability method, which yielded a coefficient of 0.946 (94.6%), which included a very high category according to Guilford's classification.

To measure technical and tactical ability, this study adopted two standardized instruments: The Football Skills Test (Nusri et al., 2024) and the Game Performance Assessment Instrument (GPAI) by Oslin et al. (1998). Both instruments were chosen due to their relevance to the research context and their comprehensive ability to assess technical soccer skills and tactical awareness. The validity and reliability of both instruments refer to published test results in the original study, given that they have been methodologically verified previously.

The selection of this combination of instruments was designed to provide holistic measurement coverage, combining aspects of psychological motivation with physical and cognitive competencies in a physical education setting.

### Data Analysis

The research data were analyzed using paired sample t-tests, independent sample t-tests, and parametric statistical tests with the help of SPSS 25 software. The paired sample t-test was applied to compare differences in pretest-posttest scores within the same group (tactical/technical). In contrast, the independent sample t-test was used to compare differences between groups (tactical vs. technical). Learning motivation variables were analyzed using 40 valid questionnaire items ($\alpha = 0.946$) scored with a Likert scale, while football skills were measured through objective tests (Football Skills Test) and observation (GPAI).

Data normality assumptions were tested with Shapiro-Wilk ($p > 0.05$) and homogeneity of variance with Levene's Test ($p > 0.05$). All data met parametric assumptions. Effect size calculation (Cohen's d) was conducted to determine the magnitude of the impact of the intervention. The analysis results are presented in Tables 1-6, with the interpretation of significance referring to the p value <0.05.

## RESULTS

The experimental outcomes demonstrated differential impacts of the TPACK-based tactical and technical approaches on motivation, fundamental skills, and gameplay performance. Statistical analysis using paired and independent t-tests ($\alpha = 0.05$) revealed significant improvements ($p < 0.05$) across all measured variables. The tactical approach group showed superior gains in motivation and integrated gameplay skills, while the technical approach group excelled in isolated technical competencies. Tables 1–6 present the detailed results. Tables 1–6 systematically

present these findings, with Table 1 summarizing motivational shifts, Tables 2–5 detailing basic skill improvements (keepball, heading, dribbling, and shooting), and Table 6 illustrating overall gameplay performance. All results are contextualized against the theoretical frameworks of TGfU and TPACK, as outlined in the Methods section.

**Table 1.** Comparison of Pre-Post Intervention Learning Motivation Scores Between Tactical and Technical Groups (N=30, Tasikmalaya High School, 2024)

| | | Mean | Standard Deviation | t | df | Sig. (2-tailed) | Description |
|---|---|---|---|---|---|---|---|
| Tactical Group | Motivation before and after | 11.51 | 8.96 | 4.97 | 14 | 0.000 | Significant |
| Technical Group | Motivation before and after | 18.69 | 17.38 | 4.17 | | 0.001 | Significant |

**Table 2.** Paired Sample t-Test Results for Keepball Skills (Tactical vs. Technical Groups)

| | | Mean | Standard Deviation | t | df | Sig. (2-tailed) | Description |
|---|---|---|---|---|---|---|---|
| Tactical Group | Keepball before and after | 6.27 | 4.95 | 4.90 | 14 | 0.000 | Significant |
| Technical Group | Keepball before and after | 12.07 | 4.30 | 10.87 | | 0.000 | Significant |

**Table 3.** Improvement in Heading Accuracy Pre-Post Intervention

| | | Mean | Standard Deviation | t | df | Sig. (2-tailed) | Description |
|---|---|---|---|---|---|---|---|
| Tactical Group | Skills Ball Heading before and after | 8.33 | 4.43 | 7.28 | 14 | 0.000 | Significant |
| Technical Group | Skills Ball Heading before and after | 13.27 | 6.08 | 8.46 | | 0.000 | Significant |

**Table 4.** Dribbling Speed Changes in Tactical and Technical Groups

| | | Mean | Standard Deviation | t | df | Sig. (2-tailed) | Description |
|---|---|---|---|---|---|---|---|
| Tactical Group | Skills Ball Dribbling before and after | -4.67 | 2.88 | -6.28 | 14 | 0.000 | Significant |
| Technical Group | Skills Ball Dribbling before and after | -4.05 | 1.78 | -8.84 | | 0.002 | Significant |

**Table 5.** Shooting Skill Improvement Across Groups

| | | Mean | Standard Deviation | t | df | Sig. (2-tailed) | Description |
|---|---|---|---|---|---|---|---|
| Tactical Group | Skills Ball Dribbling before and after | 1.40 | .91 | 5.96 | 14 | 0.000 | Significant |
| Technical Group | Skills Ball Dribbling before and after | 2.40 | 1.12 | 8.29 | | 0.000 | Significant |

**Table 6.** Overall Gameplay Performance Post-Intervention

| | | Mean | Standard Deviation | t | df | Sig. (2-tailed) | Description |
|---|---|---|---|---|---|---|---|
| Tactical Group | Skills Ball Dribbling before and after | 2.4 | 1.724 | 5.392 | 14 | 0.000 | Significant |
| Technical Group | Skills Ball Dribbling before and after | 1.0 | 1.00 | 3.873 | | 0.002 | Significant |

Tables 2 and 3 reveal the superiority of the technical approach in developing basic skills such as keep-ball (t=10.87 vs. 4.90) and heading (t=8.46 vs. 7.28). These results are consistent with the literature stating that repetition and focus on specific techniques are more effective for mastering basic motor skills. The significant improvement ($p<0.05$) in the technical group demonstrates the effectiveness of this method in building the foundation of football skills.

Tables 4 and 5 present a consistent pattern where the technical approach significantly improved dribbling (t=-8.84) and shooting (t=8.29) skills. The negative t-value in the dribbling analysis indicates a faster completion time after the intervention, supporting the idea that structured and repetitive drills are more suitable for individual technical skill development. These findings provide coaches and educators with practical strategies for skill enhancement, empowering them with actionable insights.

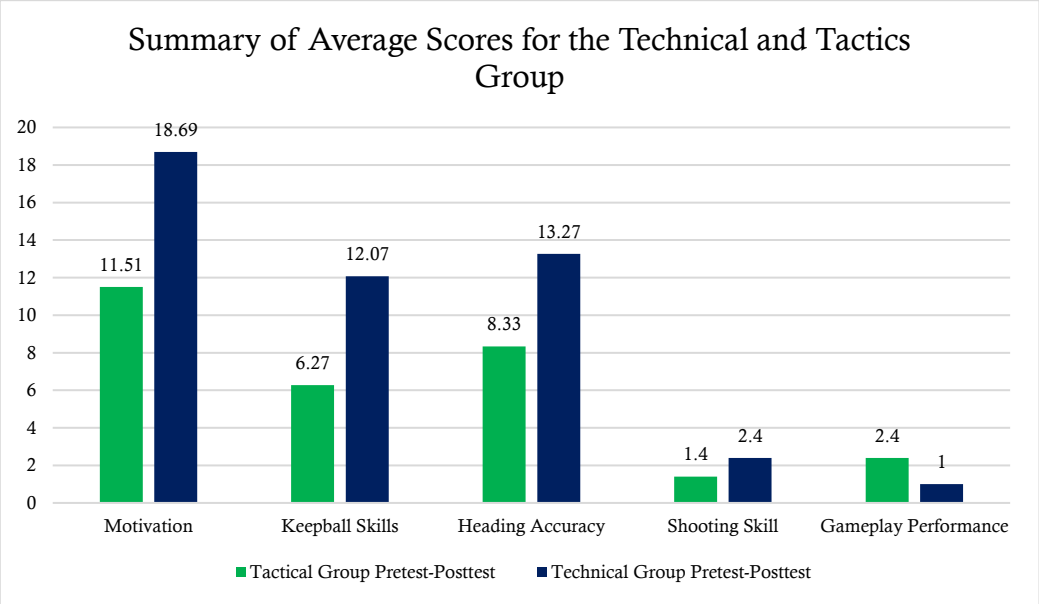


**Figure 1.** Summary of Average Scores for the Technical and Tactics Group

Table 6, on the other hand, demonstrates the superiority of the tactical approach in overall playing skills (t=5.39 vs 3.87). This outcome perfectly aligns with the TGfU (Teaching Games for Understanding) theoretical framework, which underscores the significance of tactical understanding in real games. The significant difference ($p<0.05$) further validates the effectiveness of the tactical approach in integrating various skills into a real game context, reinforcing the audience's theoretical understanding. Figure 1 is summary of average scores for the technical and tactics group.

## DISCUSSION

The unique contribution of this study lies in the integration of TPACK to reinforce both tactical and technical approaches. The finding that the tactical group excelled in motivation (t = 4.97) is consistent with TGfU principles (Kirk & MacPhail, 2002), where contextualized learning enhances cognitive engagement.

The tactical group's superior motivation aligns with Harvey & Jarrett's (2014) assertion that decision-making in real-game scenarios increases intrinsic motivation. Conversely, the technical group's skill gains reflect Blomqvist et al.'s (2005) emphasis on structured repetition for motor skill development. In contrast to O'Connor et al. (2017), who recommended a hybrid approach, our findings suggest that tactical-technical balance (not hybrid) is more effective when integrated with TPACK.

The TPACK framework's role in amplifying both approaches is critical. Video analysis and AI feedback (Yildiz et al., 2020) provided actionable insights for tactical learners, while interactive apps enhanced technical precision—a finding consistent

with Casey et al.'s (2017) work on technology-mediated engagement. Nevertheless, the short intervention period (8 weeks) limits generalizability, echoing Renshaw et al.'s (2019) caution about ecological validity in skill-transfer studies.

The results of this study show that the TPACK-based tactical approach has a more significant impact on increasing students' learning motivation than the technical approach. This aligns with the findings of Memmert & Harvey (2008), which state that a tactical approach in physical education can increase students' tactical understanding and motivation through a more meaningful learning experience. Theoretically, the tactical approach allows students to develop a conceptual understanding of game strategy before executing motor skills. In the context of Football, students not only learn basic techniques but also understand how and when these skills are applied in real game situations. This is consistent with research conducted by Harvey & Jarrett (2014), which found that the tactical approach can improve students' decision-making and game skills.

On the other hand, the study's results also show that basic football skills are more developed in groups that use a technical approach rather than a tactical one. This supports the opinion of Blomqvist et al. (2005), who state that the technical approach is more effective in developing specific motor skills through structured and repetitive exercises. However, when referring to football playing skills, the tactical group shows more optimal improvement than the technical group. This finding aligns with research by Gray & Wegner (2011), which shows that the tactical approach can improve students' understanding of the game and tactical skills more effectively than the technical approach.

These findings suggest that educators should consider combining tactical and technical strategies, balancing structured repetition with contextual decision-making. TPACK integration allows both approaches to become more interactive, measurable, and responsive to learner needs. The choice of learning approach in physical education must be tailored to the learning objectives to be achieved. If the goal is to holistically improve motivation and playing skills, then the TPACK-based tactical approach is a more effective choice. Conversely, if the main objective is to master technical skills quickly and systematically, then the technical approach is more appropriate.

### Limitations of the study

This study has several limitations. First, an 8-week intervention may not be sufficient to measure long-term retention of skills. Secondly, the homogeneous sample (30 students from one school) limits the generalizability of the findings. Follow-up studies need to include more diverse age groups and backgrounds. Future research should explore long-term effects and the roles of gender, previous skill levels, and teacher competence in effectively using TPACK. Additionally, investigating how different technological tools might enhance each approach could provide valuable insights for practitioners seeking to optimize physical education instruction.

## CONCLUSIONS

Based on the analysis, the TPACK-based tactical approach significantly improved motivation and playing skills, while the technical approach was more effective for basic skills. Technology integration through TPACK, such as using video analysis

apps (from week 1) for the tactical approach and AI-based repetitive drills (week 4) for the technical approach, strengthens both approaches.

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## DATA AVAILABILITY

The data supporting this study's findings, including the motivation questionnaires and football skills test results, are available upon reasonable request from the corresponding author. Due to the sensitive nature of the participants' data, including their involvement in extracurricular activities, access to the raw data will be provided only to those with proper ethical and academic approval. The data are not publicly available to ensure participant confidentiality and compliance with ethical standards.

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## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding this research. The authors conducted the study independently without any external influences that could affect the results or interpretation of the data. Applicable ethical standards were carried out in all research procedures, and no personal or financial interests influenced the conduct of the study.

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