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Original Article

Enhancing ball passing creativity and effectiveness in youth women's football: A single-case study

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Abstract:
The participation of women in soccer has increased, yet there is a notable lack of scientific growth in this area, particularly concerning the tactical and technical aspects. A didactic approach known as psychokinetic games (PGs) has been developed to enhance cognitive abilities, including concentration, attention, and anticipation. Consequently, this study aimed to assess the impact of PGs on tactical creativity, passing effectiveness, and ball control in youth women's soccer players. The study involved 10 female Colombian soccer players under the age of 14 from Club Deportivo Atlético Nacional (Medellín, Colombia), participating in the Antioquia Soccer League's First A division (n = 10; M_{age} = 13.1 ± 0.57 years; M_{height} = 158 ± 6.74 cm; M_{weight} = 52.09 ± 5.98 kg; M_{IMC} = 20.76 ± 2.05; $M_{federated\ experience}$ = 4.5 ± 3.1 years in soccer). These participants were classified as Tier 3 (highly trained/national level). The study employed a single-case design for manipulative strategy, incorporating measurements before and after the intervention. The study occurred during the competition season and included an 8-week training regimen with one session per week lasting approximately 22 min, totaling 174 min. PGs involved multiple players passing the ball, changing positions on the field after each pass, and preparing for the next pass without opposition. Creative performance was evaluated using the KORA (Konzeptorientiertes Expertenrating) and the game test situation taking advantage of openings, known for its ecological validity. Additionally, the effectiveness of passing and control was measured using the 2 vs. 2 game test. The results showed that eight PG sessions influenced the cognitive aspect of youth soccer players by enhancing tactical creativity and technical skills such as passing effectiveness. However, the intervention decreased ball control performance. This study confirms that trainers provide a valuable and diverse training approach to alleviate monotony. However, the approach must be adapted to the players' responses, and the complexity must increase accordingly.
Keywords*:* **coaching, pedagogy, divergent tactical thinking, sport, creativity, game test situation**

Introduction

Football is a team sport characterized by a dynamic, variable, unpredictable, and random environment where two teams confront each other simultaneously, within the same space, and with the same purpose of the game (Castelo, 1999; Sánchez, 2019). This dynamic produces opposing relationships involving attack and defense, marked by constant interactions of cooperation and opposition (Barreira et al., 2014; Garganta, 1997; Muñoz, 2014; Parlebas, 1988). These interactions create a high cognitive demand for players owing to the continuous changes presented in each game interaction (Arias et al., 2013). Consequently, the tactical aspect is crucial (González-Víllora & Da Costa, 2015).

Tactics involve the cognitive selection and motor solution of a problem (González, 2008) in a game situation, which is conditioned by the environment and the player's own conditions. Therefore, tactics represent the process of integrating all the possibilities (physical, technical, psychological, theoretical, etc.) of a player to immediately respond to each problem arising during the game, which is characterized by being different, unpredictable, and unstable due to direct confrontation with opponents (Álvarez, 2002; Alvarez, 2003; Riera, 1995), demands the player's cognitive capacity to navigate the multitude of encountered complex situations. Thus, a technically well-equipped player does not necessarily solve the constant problem situations adequately; on the contrary, a player with technical limitations but with an adequate compression of the game can make better decisions in the game (Álvarez & Sánchez, 2021; Valencia, 2015). However, the ideal players are those who judiciously employ their technical resources in accordance with the game's demands (Sánchez, 2021)—players exhibiting creativity and intelligence. Achieving this requires players to incorporate more unpredictable movement patterns (Coutinho et al., 2018).

Creativity and intelligence have gained prominence in sports instruction (Memmert, 2013; Memmert & Roca, 2019; Wein, 2005), cultivating superior players and disorienting opponents. If a player is creative and solves game situations differently, it can constantly generate uncertainty in his opponent that will bring

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advantage or if a player is intelligent will solve the situation as required by the game, contributing to the offensive and/or defensive process (Memmert, 2013; Memmert & Roth, 2003).

In team and racket sports, two distinct processes are identified: tactical intelligence and tactical creativity (Memmert, 2013; Memmert & König, 2020). Tactical creativity, also known as divergent tactical thinking, involves generating various solutions to individual or group tactical problems that are surprising, rare, strange, unique, and/or original; it encompasses three critical attributes: (a) originality, emphasizing the exceptionality of tactical solutions, i.e., novel responses; (b) flexibility, indicating the diversity of tactical solutions, i.e., a range of actions or responses; and (c) fluidity, denoting the number of tactic solutions generated for a specific situational context (Guilford, 1967; Memmert, 2013). Creativity is fundamental for effectively and productively solving game problems diversely and innovatively. "Novel" implies an original, unexpected response, above all, one that is appropriate, that is, useful (Memmert, 2011; Sternberg & Lubart, 1999). If there is a lot of usefulness in the solution but little originality, creativity is reduced; if there are solutions with a lot of originality but little usefulness, it would not be creative in itself (Garrett, 1987; Roca et al., 2021). On the other hand, tactical intelligence, or convergent tactical thinking, pertains to producing the optimal solution to an individual, group, or team tactical situation (Memmert, 2013; Memmert & König, 2020), guided by effectiveness criteria (Santos et al., 2016). This classification aligns with a consensus in sports, balancing planned and improvised creative behavior (Smith & Cushion, 2006).

As a result, the coach is responsible for developing increasingly intelligent and creative players. Traditional sports instruction emphasizes technical skills and often lacks cognitive engagement in exercises and this approach also fosters player dependence on the coach's instructions, limiting their capacity to make sound decisions autonomously (Giraldo & Arias, 2017). This limitation stems from linear environments that hinder adaptation to the game's dynamic nature (Santos et al., 2016). Alternatively, there are other possibilities, such as adopting teaching methods focused on tactical skills or embracing game-based approaches (Kinnerk et al., 2018; Pill et al., 2023; TGfU SIG, 2021), such as the didactic model game action competencies (DMGAC) (Arias, 2012). The DMGAC has received empirical support (Arias, 2012; Arias et al., 2013, 2016; Arias & Valencia, 2015; Díaz et al., 2021; Giraldo & Arias, 2017; Sánchez & Arias, 2021; Vaca et al., 2022; Valencia & Arias, 2015, 2016; Valencia-Sánchez et al., 2021; Valencia-Sánchez & Arias-Arias, 2017). This model has a didactic strategy known as psychokinetic games (PGs), designed to enhance specific cognitive abilities such as concentration, attention, and anticipation (Arias, 2012; Arias et al., 2016; Esposito et al., 2019). PGs involve executing tasks with a significant cognitive and coordinative component (Arias, 2012), leading to more productive and creative tactical solutions (Arias, 2012; Arias et al., 2016). Empirical evidence is found in children's football, where the PG was implemented within the DMGAC, increasing the tactical performance index significantly (Valencia & Arias, 2021; Valencia-Sánchez & Arias-Arias, 2017), the positive feedback of the didactic strategies of the model by child players (Díaz et al., 2021), and improved defensive performance in university basketball players (Giraldo & Arias, 2015).

PG are games with the participation of several players who have to pass the ball to each other, and after the pass they must change position on the field and prepare for the next pass and so on, but without opposition (Arias et al., 2013). These passes are characterized by changes in orientation, requiring anticipation of teammates' positions and precise control of the force and speed of the ball (Arias et al., 2016), resulting in a high degree of variability and uncertainty. The complexity of PGs starts at a basic level and gradually increases (Arias et al., 2013) by introducing additional balls, requiring players to move simultaneously (Arias et al., 2016). As the players navigate changes in position and execute passes in different directions, cognitive dissonance arises (Beckmann, 1984; Howarth, 2005) because two or three actions must be performed almost simultaneously, leading to cognitive conflict. Resolving this cognitive dissonance requires cognitive abilities such as attention, concentration, anticipation, and coordination of individual and collective actions. The modular approach and incidental learning underpinning PGs (Kröger & Roth, 2003) align with the characteristics of sports games (Arias et al., 2016). In essence, PGs provide a distinct approach compared to analytical stimuli for honing technical passing and ball control skills.

The technique involves to the ideal execution of a sports-related technical gesture of a sport in an efficient manner (Verkhoshansky, 2001), coordinating the various systems in interaction with the environment and the game object (Riera, 1995) being an adequate and economical motor action (Weineck, 2005). Specifically, The pass is a tactical-technical action that connects or communicates two players of the same team through the transmission of the ball, where one transmits the ball and the other performs control to dominate the ball (Amado et al., 2015; Azhar, 1999; Conde, 2000; Salazar, 1997; Vargas Cuesta, 2011). This ball control is that technical action that is achieved by mastering or controlling the movements of the ball coming from a teammate, either through cushioning, stopping, semi-stopping, or oriented control, in order to subsequently be able to play in the best conditions possible (Amado et al., 2015; Bejarano, 2015; Grosser et al., 1989). These actions are executed using only the regulatory parts of the game (The International Football Association Board, 2023). In contemporary football, successful teams have transitioned from individual behaviors, like dribbling, to more collaborative team executions, such as passing (Barreira et al., 2014; Wilson, 2013). In recent decades, the pass has evolved into a predominant technical gesture for champion teams (Lawlor et al., 2003), often serving as a precursor to goal-scoring opportunities (Grant et al., 1999; Luhtanen et al., 1997).

Therefore, ball possession is a distinguishing factor (Robles & Castellano, 2007). The effectiveness of passing and control play a fundamental role in establishing the connections among players within tactical circuits. Moreover, these skills are frequently practiced during training sessions (Agudelo & Arias, 2015; Fernández, 2014). This emphasis on proficiency in passing and control may translate into better player and overall game performance.

The practice of football has significantly increased in men and women (Gómez & Barriopedro, 2005; Kannekens et al., 2011), with notably higher male participation, as highlighted by a FIFA census in 2007 recording approximately 265 million individuals engaged in football, where only 10% were women. Hence the interest of researchers in men's football. Over time, female participation continued to increase, reaching 30 million soccer players in 2014 (FIFA, 2014), with a corresponding growth in research attention (Okholm et al., 2022). The continuous expansion of women's football underscores the need for scientific focus on this branch, particularly in training processes. Consequently, this study addresses a gap in the literature, providing empirical evidence on PGs in competitive environments (Kinnerk et al., 2018), within the context of tactical creativity (Memmert & Roca, 2019), and specifically in youth women's football (Okholm et al., 2022). This study investigated the impact of PGs on tactical creativity, passing effectiveness, and ball control in youth women's soccer players.

Materials and methods

Participants

The sampling method was non-probabilistic, specifically chosen for convenience (Hernández-Sampieri et al., 2018). The participants in this study consisted of 10 female Colombian youth soccer players under the age of 14, affiliated with Club Deportivo Atlético Nacional in Medellín, Colombia. These players competed in the Antioquia Soccer League's First A division (n = 10; M_{age} = 13.1 ± 0.57 years; M_{height} = 158 ± 6.74 cm; M_{weight} = 52.09 ± 5.98 kg; M_{IMC} = 20.76 ± 2.05; $M_{federated\ experience}$ = 4.5 ± 3.1 years in soccer). Each player engaged in three training sessions per week, along with an official game over the weekend lasting 70 min. The U14 standard training sessions included 15% warm-up, 10% injury prevention exercises, 25% rondo or technical passing and control skills, 35% small-sided games, concluding with 15% continuous play (11 vs. 11 per side), amounting to a total session time of 90 min. These participants were classified as Tier 3, indicating a high level of training at the national level according to the classification framework (McKay et al., 2022).

The inclusion criteria for participation in the study were U14 female soccer players, signed informed assent, consent from the participant and the legal representative, and a minimum attendance of 75% at training in the two months preceding the study. Exclusion criteria encompassed individuals with a history of cardiovascular diseases preventing physical exercise, players in the recovery phase of an acute musculoskeletal injury, or a history of diagnosis with a learning disorder.

Design

The research employed a single-case design for the manipulative strategy, incorporating measurements before and after the intervention (Ato et al., 2013).

Bias control

To minimize biases, meticulous recording of each test was ensured. Trained support personnel conducted the video recordings, having received prior instruction on the methodology of each test. Stringent adherence to selection criteria was maintained for the players, and thorough verification was conducted to ensure data completeness. Pilot tests were performed to assess the camera usage, video management, measurements, and data collection, aiming to identify and address potential issues that may arise during test execution or video recording, thereby enhancing the reliability of the data collection process. Goalkeepers were deliberately excluded from the study to prevent any potentially misleading conclusions.

Training intervention

The study was performed during the competition season, and the training regimen spanned 8 weeks, consisting of one session per week lasting approximately 22 min each (totaling 174 min), as outlined in Table 1. An experienced football coach with 5 years of youth coaching experience led all training sessions.

Table 1. Characteristics of PGs

PG	Players	Dimensions per play area (m)	Prescription of the intervention	Total volume (min)
1	3	3 × 3 = 9	4 × 3 min / 1.5 min rest	18
2	7	7 × 6 = 42	6 × 2.75 min / 1 min rest	22.5
3	4	5 × 5 = 25	6 × 2.75 min / 1 min rest	22.5
4	8	6 × 6 = 36	6 × 2.75 min / 1 min rest	22.5
5	4	6 × 5 = 30	6 × 2.5 min / 1.25 min rest	22.5
6	2	5 × 4 =20	4 × 4 min / 1.25 min rest	21
7	8	5 × 8 =40	6 × 2.75 min / 1 min rest	22.5
8	5	5 × 5 =25	6 × 2.75 min / 1 min rest	22.5

PG = Psychokinetic game; m = meter; m^2: meter squared; n = number; min = minutes

PGs were performed in the initial part of the session immediately following the warm-up. These games, characterized as cooperative and without opposition, required players to perform two or three tasks nearly simultaneously—specifically, engaging in ball-passing activities and moving to free spaces. As an illustration, PG number one (PG1) involved performing a braiding pattern. Player two initiated with a diagonal pass to player four, immediately moving to pass behind teammate four; player four controlled and passed the ball diagonally to player three and immediately moved to pass behind player three. Finally, player three controlled and passed the ball diagonally back to player two (Fig. 1). The players executed these tasks without direct coach feedback. Once proficient, the coach introduced greater complexity. For instance, in PG number two, players formed a circle, with one player beginning in the circle's center (Player B). Player A, possessing the ball, passed it to Player B, who promptly moved towards the direction of the pass and assumed the central position. Player B then controlled the ball and passed it to the next teammate in the circle (Player C). This sequence continued with fluid ball circulation and positional exchanges between players. When executed without errors, the coach removed field demarcation and introduced a second ball (Fig. 2). The game started with two players holding possession at opposite ends of the circle and two players in the middle orienting themselves towards those with the ball. Game complexity gradually increased by adding extra balls until a ratio of one ball for every three participating players was achieved.

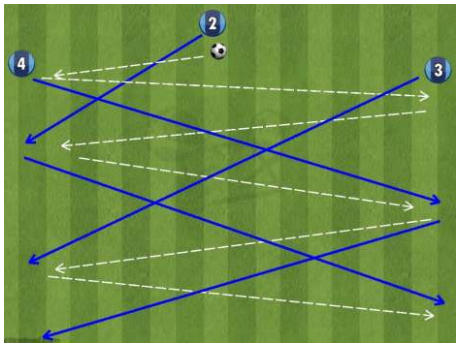

Fig. 1. Psychokinetic game number one

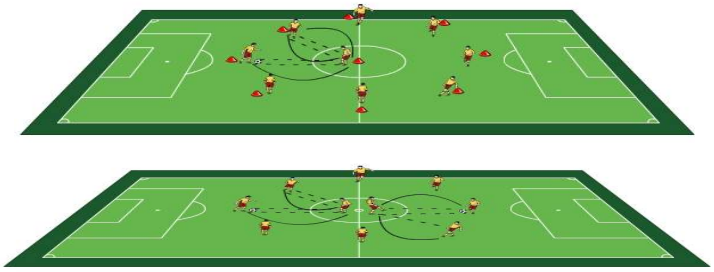

Fig. 2. Psychokinetic game number two (taken from Arias, 2012)

Instruments

Creative performance was assessed using the Konzeptorientiertes Expertenrating (KORA) (Table 2) and the game test situation taking advantage of openings (GTS) (Fig. 3) developed by (Memmert & Roth, 2003). The GTS is known for its ecological validity because it studies human behavior within natural and complex scenarios typical of team sports (Memmert, 2010a). The test demonstrates strong internal consistency with a coefficient of 0.72 (Memmert, 2010a). This cooperative/oppositional game mirrors situations commonly encountered in an actual match.

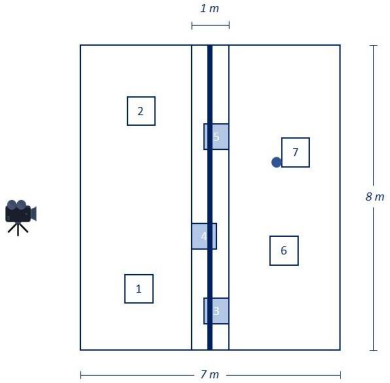

Fig. 3. Game test situation taking advantage of openings (taken from Memmert, 2013, p. 303)

The test involves two attacking teams, A (players 1 and 2) and A+ (players 6 and 7), each consisting of two players positioned in the outer zones. Additionally, a defending team B, comprising three players (numbers 3, 4, and 5), operates within the center of the field, confined to a 1-m delimited zone. Teams A and A+ are prohibited from entering this zone. The objective for the attackers is to pass the ball beyond team B, below the upper boundary, in the middle of the field. Players must maintain their designated positions (left or right of the field of action) and cannot run with the ball. Passing is allowed between the two attacking teams and between the players of each team. Based on ball possession, the defending team shifts its focus between teams A and A+. The players take turns, engaging in two rounds each, systematically varying the positions and equipment of both players and opponents. Each game lasts 6 min, with each participant's involvement in a turn lasting 3 min. The entire gameplay was recorded. The court dimensions were 8 m × 7 m, featuring a 1-m delimited space in the middle and a height reference of 1.5 m. The camera was strategically positioned to capture the playing field (Memmert, 2010b, p. 2, 2013) in this study, 8 m.

To analyze the players' actions during the test (Memmert, 2010b, 2013; Memmert & Roth, 2003), the concept-oriented expert rating (KORA) evaluation system was used (Table 2). This assessment encompasses "originality" and "flexibility," representing key aspects of creativity. Each action receives a rating on a scale of 1–10 based on predefined indicators. The technical execution of passes is not factored into the evaluation (Memmert, 2013). The "anchor examples" section offers a simulation that aids the evaluator in assimilating the actions effectively.

Table 2. Scaling for tactical creativity assessment: KORA (Memmert, 2013, p. 303)

Originality of solutions to the situation (using gaps or passing)	Flexibility of solutions to the situation (using gaps or passing)	Scaling	Anchor examples
Way above average (very unusual)	Two or more (different, original actions)	10	The child demonstrated different, highly unusual solutions to the situations. The gaps and passes found were absolutely unique.
Way above average (unusual)	Two or more (different, original actions)	9	The child demonstrated different, unusual solutions to the situations. Finding of gaps or passes were unique.
Above-average (rare)	Two (different, original/rare actions)	8	The child demonstrated different, still unusual solutions to the situations. The gaps and passes found were very rare.
Average (relatively rare)	Two (different, rare actions)	7	The child demonstrated two different solutions to situations which were not unusual, but still very rare. The gaps and passes found were very surprising.
Average (quite rare)	Two (different, rare/new actions)	6	The subject demonstrated two different solutions to the situations, which were not unusual but rare. The gaps and passes found were surprising.
Just below average (still new)	One (rare action)	5	The child demonstrated one solution to situations which was not the usual standard, but which had already occurred. The gaps and passes found were still innovate.
Just below average (very little new)	One (new action)	4	The child demonstrated one solution to situations which was not the usual standard, but which had already occurred often. The gaps and passes found were still innovate.
Below average (relatively standard)	None	3	The child generally offered standard solutions to situations which had been displayed often. The gaps and passes found were rarely innovate.
Way below average (almost all standard)	None	2	The child almost exclusively offered standard solutions to situations which had all been displayed already. The gaps and passes found were very rarely innovate.
Way below average (only standard)	None	1	The child only offered standard solutions to situations. The gaps and passes found were never new.

Effectiveness of passing and ball control

The 2 vs. 2 game test was adapted from Vegas (2006) by García et al. (2019). The dimensions of the test area were 11 m × 12.5 m (34 m^2/player) with a scoring area of 1.5 m. In this test, two teams, each consisting of two players, face off against each other, clearly identifiable by their clothing (color and numbering). The test duration is 2 min, and a coin toss determines the kick-off (Fig. 3).

The game operated freely, adhering to some football rules such as kick-off and goal kick and treating fouls as indirect fouls. To execute fouls, the offending team was required to provide a three-meter distance and resume the game at goal, throw-in, or after scoring. The game excluded the offside rule. Throw-ins, goal kicks, and actions following a score were performed with the foot; the ball should be stationary and placed on the boundary line. Hands were strictly prohibited from being used to play with the ball. To score, the ball had to be controlled after a teammate's pass inside the end zone; driving to that place to score was not permitted. For

recording purposes, the camera was positioned approximately 20 m away to capture the entire field at a comfortable height for the recording assistant. Four assistants (wearing yellow) oversaw placing balls in each corner whenever the game ball exited the designated area (Fig. 3). Notably, the assistants did not intervene by passing the ball to any of the players at any point. The test employed a calibrated size 5 balloon (Euforia 2.0 Professional, Golty, Colombia) (measurement = 68–70 cm, ball weight = 410–450 g, pressure = 0.6–0.8 bar).

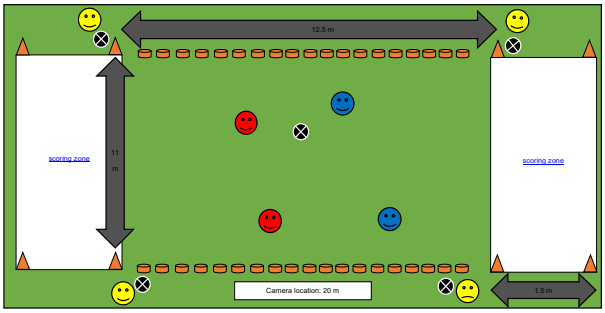

Fig. 3. Test 2 vs. 2 (García et al., 2019, p. 76)

Data collection The tests were introduced to the participants one week before the pretest measurement. Before each testing session, a standardized 15-min warm-up focused on joint mobility and ball possession games without goals was administered. All individuals were tested before (pre-test) and after an 8-week experimental period (post-test). The pre- and post-test measurements were conducted in two sessions on natural grass surfaces.

Several balls were placed across the field to ensure accessibility and prompt replacement. Coach intervention was kept to a minimum, disallowing any feedback during the game. Consistency was maintained across all test sessions, conducted at the same time (from 3:00 p.m. to 5:00 p.m.) and under similar ambient conditions (31°C temperature, 39% relative humidity, and an elevation of 1495 MASL).

Statistical analysis The Shapiro–Wilk test was employed to assess the data distribution for the quantitative variable. Data exhibiting normal distribution were presented using mean and standard deviation, while qualitative variables were summarized using percentages. Intragroup differences for normally distributed quantitative variables were examined using the Student's t-test for paired samples. The McNemar test was applied to compare percentages. The percentage change between the pretest and post-test was calculated using the formula: $\Delta\% = [\text{Post-test} - \text{Pretest}] / \text{Pretest} \times 100$. Effect sizes were computed using Cohen's d and Phi (φ), and the interpretation followed the guidelines established by Rhea (2004) for highly trained individuals: <0.25, trivial; 0.25–0.50, small; 0.50–1.00, moderate; >1.00, large. The study had a reliability of 95% and a statistical significance threshold of $p \leq 0.05$. The statistical tools used included IBM SPSS Statistics 22 for Windows (SPSS Inc., Chicago, Illinois, USA), EPIDAT 3.1 for Windows (Xunta de Galicia, Spain) for the epidemiological analysis of tabulated data, G*Power 3.1.9.7 for Windows (Düsseldorf, Germany) for statistical power analysis, and Microsoft Excel (Microsoft Inc., Redmond, WA, USA).

Ethical aspects The study adhered to Resolution 8430 of 1993, establishing the risks and ethical considerations associated with research involving human subjects in Colombia. A minimum risk level was established, aligning with the requirements of the Declaration of Helsinki. The university endorsed the study, ensuring the respect, dignity, and protection of participants' rights and well-being. Before commencing the trial, informed consent was signed by parents and participants. All study participants were informed of their option to withdraw from the study at any point.

Results

The sample comprised 10 youth soccer players who met the inclusion and exclusion criteria and willingly agreed to participate in the study. Study participants attended 85% of the intervention program (Fig. 4).

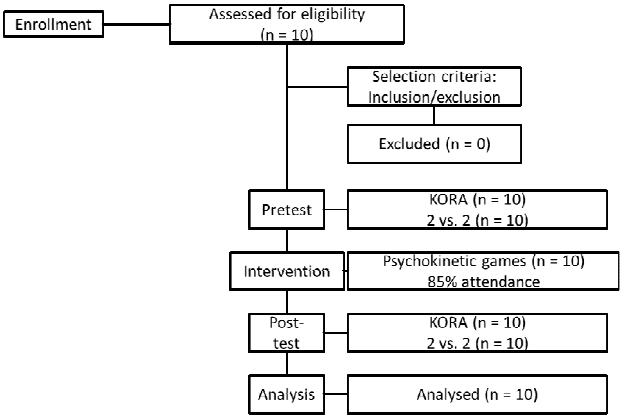

Fig. 4. Flowchart

The findings regarding tactical creativity are presented in Table 3. The data reveal a noteworthy performance increase exceeding 10%, which is statistically significant (p = 0.053; t = −2.22; CI 95% = −0.806; 0.006; ES = 0.705) following the intervention.

Table 3. Pretest vs. post-test in the KORA

KORA	Test	Tactical creativity index	Statistical (t)	p-value	CI 95%	Δ %	ES
Pretest	□	3.70					
	SD	1.005					
Posttest	□	4.10	-2.228	0.053*	-0.806;0.006	10.81	0.705
	SD	1.074					

□ = mean; SD = standard deviation; t = t-student for related samples; CI 95% = 95% confidence interval; Δ % = percentage of change between the posttest and the pretest; ES = effect size; *statistically significant differences

Regarding the pass variable, there was an 8% improvement in efficiency, signifying a statistically significant increase (McNemar = 5.80; p = 0.016), with a large difference in effect size. Conversely, ball control efficiency experienced a decrease of approximately 6% (McNemar = 14.38; p = 0.0001), and this reduction was considered large based on the effect size (Table 4).

Table 4. Pretest vs. post-test in the 2 vs. 2 test

Variable	Test	Effective (%)	Not effective (%)	Total	Statistical (McNemar)	P value	CI 95%	Δ %	ES
Passes	**Pretest**	46 (63)	27 (37)	73	5.80	0.016*	3.65;26.69	8.03	1.83
	Post-test	49 (68.06)	23 (31.9)	72					
Controls	**Pretest**	37 (78.7)	10 (21.28)	47	14.38	0.0001*	-40.53; -15.14	-5.97	-4.54
	Post-test	37 (74)	13 (26)	50					

% = percentage of effectiveness; Δ % = percentage of change between the post-test and the pretest; CI 95% = 95% confidence interval; ES = effect size; *Statistically significant differences

Discussion

The study's primary aim was to assess the impact of PGs on tactical creativity, passing effectiveness, and ball control in youth women's soccer players. Applying Hill's (1965) causality criterion, which examines the dose–response relationship, it was observed that eight sessions were sufficient to enhance tactical creativity (p = 0.05) with a moderate effect size. This contrasts with other studies that advocate for a higher dose to elicit significant responses or changes (Memmert, 2011, 2015; Santos et al., 2018). Regarding technical skills, the study noted an improvement in passing effectiveness while the effectiveness of ball control decreased. This discrepancy suggests that the applied dose or stimulus may not have been sufficient to generate an adequate response in the latter variable. Notably, García et al. (2019) compared technical action isolated with small-sided games after eight weeks, revealing that the technical gesture of passing the ball required approximately 1600 repetitions. In contrast, ball control required 1184 repetitions for performance enhancement. The present study did not control the number of repetitions to respect the ecological aspect of the interventions, but it is hypothesized that by improving the passes in terms of strength, speed and precision in a 2 vs 2 small-side game, it generated greater demands for the adaptation of the trajectory of the ball, positioning the body in a profiled manner to give continuity to the game action, increasing the number of errors. Thus, in this game, they were able to make passes with the intention to progress and finish, not with the intention of keeping the ball, which increases the risk of losing possession of the ball by failing a control in the opposite field or failing in the end zone, given that the scoring of the game was achieved by a control in that area. In other words, the characteristics of the test (2 vs. 2) does not allow the players to keep the ball; they force them to move forward and perform forward passes to the target.

PGs appear to positively affect performance, particularly in the passing variable, because the players engage in ball passes with uncertain movements. However, the influence on ball control performance was not as pronounced. This discrepancy suggests that the number of repetitions in games is likely to be in favor of passing the ball because, after a mistake, you restart the game with a pass without forgetting that the training surface was sand, and this increased the complexity of ball control.

The relatively lower performance in ball control can be attributed to the absence of opposition in the PGs. Without opposition, players faced less pressure in terms of time and space when making decisions and executing ball control. Players used all the time and space to adapt to the situation to pass and carry out the control, and the test used is a small-side game with high demands to make the score and with great pressure in terms of time and space.

Additionally, the 2 vs. 2 test was conducted only once, and a greater number of participants in the game is essential to approach actual player performance. To establish reliable performance patterns, a minimum of four games is recommended (Sánchez, 2019). Possible alternatives to enhance the intervention include increasing the stimuli, introducing opposition to the PGs to elevate complexity, and evaluating players against opposing teams at least four times to identify consistent individual performance patterns.

Regarding the causality criterion of biological plausibility (Hill, 1965), PG stimulated the plasticity of the brain, that capacity that allows it to be molded or worked on based on stimuli, and in this case, especially on attention, concentration, and anticipation. At first, it was common to find errors in the execution, but after various executions in which these activities were carried out, myelination is generated, nerve impulses travel at a higher speed, and this implies that there was an increase in neuronal activity (Bartzokis & Lu, 2009; Sánchez, 2021). This means that practicing the same skill will help the brain incorporate new knowledge, which could be the cause of better tactical creativity; that is, they would be the tools to produce original, flexible, and fluid tactical solutions that are consequently creative. Original because they have the ability to generate new and unique actions that others probably will not perform; flexible because they have the ability to produce different actions; and fluidity because they have the ability to execute as many effective movement actions as possible (Santos et al., 2018).

The most creative players have a better visual strategy for decision-making using a broader focus of attention but with shorter fixations in a different sequential order, and they also focus their attention on offensive players who have positions of advantage for the team before the offensive phase than the least creative players in football (Roca et al., 2018). Creative adult players demonstrate more fixations of shorter duration on informative locations, indicating a wider attention span to absorb more information compared to less creative players. Moreover, creative players verbalize thoughts related to the current evaluation and possible planning of responses in attack situations (Roca et al., 2021). Consequently, creative players generate more verbal reports concerning the current situation and future planning of game actions than less creative players (Roca et al., 2021). Furthermore, the significance of cognitive processes, such as anticipation, perception, attention, game intelligence, and working memory, in producing creative solutions, particularly in team and racket sports, has been identified in isolation (Memmert & Roca, 2019). Players with high intelligence possess high tactical creativity (Memmert & Roca, 2019), which is one of the key parts of performance in sports (Roca et al., 2021). Creative players dedicate more time to informal, unorganized, and free play in soccer during their childhood and adolescence than less creative players (Roca & Ford, 2021). Consequently, in this intervention, the coach did not provide too much tactical information to the players (Memmert, 2015), given that motivational foci influence creativity (Memmert & Roca, 2019).

PGs are not a passive copy of the answers. They actively promote exploration and simultaneously foster P-creativity (personal/psychological) (Hristovski et al., 2011), an internal aspect within the player that contributes to the cultivation of individual problem-solving skills in daily routines (Santos et al., 2016). This is a result of the high variability (Schollhorn et al., 2012) induced by adaptive movements, which enhance the performance of young soccer players (Chow et al., 2021). Therefore, the age of 13 is considered sensitive to increase creative performance (Santos et al., 2018). Despite the typical decline in creative thinking with age, potentially attributed to the rise in convergent thinking (Santos et al., 2016) and the natural decrease in imagination over a lifetime owing to intentional actions (Glăveanu, 2011) suggesting a plateau around the age of eight according to neuroscience (Huttenlocher, 1990), it is crucial to acknowledge that a linear progression of creativity has not been consistently observed when comparing children and adolescents (7 vs. 10 vs. 13 years old) (Memmert, 2011).

While the progression from 7 to 10 years is noticeable (Memmert & Roca, 2019), at the age of 10, the absolute maximum number of synapses and synaptic density is achieved (Casey et al., 2005), indicating an optimal window for trainability. Establishing proficient motor skills during childhood is integral to developing creative thinking (Santos & Monteiro, 2021). A separate study indicated that a training program grounded in creative thinking, diversified practice, physical literacy, and non-linear pedagogy holds significant potential to enhance overall creativity in nine-year-old children (Santos et al., 2017). Generally, children tend to seek unconventional solutions (Santos et al., 2017). However, more research is needed to substantiate the trainability of creativity in the later stages of player development (Santos et al., 2016). Factors such as age, expertise level, training, and motivation are relevant, but it is proposed that creativity should not be confined by age (Memmert & Roca, 2019) because experience plays a differentiating role between the most creatively adept and the less creatively talented players (Memmert et al., 2010).

In a six-month longitudinal study involving 195 talented soccer players in Germany aged 12 to 13, creativity did not exhibit improvement (Memmert, 2011). Conversely, a different study demonstrated that the creative and positional behavior of U13 soccer players showed a more substantial increase than that of U15 players following small-sided game situations, particularly within a group exposed to differential learning. This led to the development of creative components after five months, encompassing 40 sessions with an average duration of approximately 90 min per week (Santos et al., 2018).

Consequently, coaches are urged to exercise patience, allowing players to execute various actions even if they may not be immediately effective and acknowledging the effort put forth in each action (Santos et al.,

2018). Adopting a broad attentional focus has proven more effective than providing direct instructions during training sessions, emphasizing the importance of minimizing the number of instructions to indirectly influence players' attention spans (Memmert, 2013). Moreover, coaches can introduce variations, such as altering the size of the ball to induce variability and adaptation in players (Santos et al., 2016, 2020). These characteristics align with PGs. Hence, it is evident that creativity is trainable (Memmert, 2015), albeit demanding a substantial amount of training (Beaty, 2015), with PGs being a viable option for coaches.

Santos et al. (Santos et al., 2016) place the players aged between 13 and 15 in the creation phase, emphasizing the need for stimuli characterized by a sports environment that guides actions to solve problems. This concept termed the creativity developmental framework, combines various training objectives for creativity development, encompassing (a) the practice pathway from diversification to specialization, (b) physical literacy involving the learning of fundamental movements and game skills, (c) nonlinear pedagogy as the foundation for the constraints-led approach, teaching games for understanding, and differential learning, and (e) creative thinking encompassing divergent and convergent thinking. In this creation stage, small-space games with high collective demands are introduced (Tan et al., 2012). Memmert (2015) proposes a training model for tactical creativity development featuring seven methodological principles: one-dimensional games, diversification, deliberate practice, deliberate play, deliberate coaching, deliberate memory, and deliberate motivation. PGs align with the principles of diversification, deliberate memory, deliberate coaching, deliberate motivation, and deliberate play. However, the effects of combining structured and unstructured activities remain unclear (Santos et al., 2016).

In addition, focus instruction promotion was used to improve divergent (Memmert, 2013), which consists of a focus on achievements and aspirations (Higgins, 1997), where positive results are perceived as enjoyable and free from suffering (Memmert & Roca, 2019). Santos et al. (2017) reported favorable outcomes following implementing a training program named Skills4genius. This program, backed by diversification, physical literacy, teaching games for understanding, and differential learning, aims to foster creative behavior development.

Thus, the conventional approach to teaching, characterized by repetitive drills and persistent errors, needs to be reevaluated (Schöllhorn et al., 2009). Coach-supervised training tends to be overly prescriptive (Ford et al., 2010), potentially hindering the development of creativity and the ability to adapt to the dynamic nature of game situations (Roca & Ford, 2021). Developing creativity is contingent on such adaptability (Memmert & Roca, 2019), emphasizing the need to move away from linear pedagogy that emphasizes standardized task conditions (Chow et al., 2021). Therefore, ongoing exploration of various practice types and activities is essential to comprehend how these elements can facilitate and contribute to creativity development in sports (Roca & Ford, 2021).

Tactical creativity, also known as divergent knowledge, has been explored in Germany. In a study involving 48 participants, they were divided into three groups: one undergoing an attention expansion training program (13 participants), another undergoing an attention reduction training program (12 participants), and a control group (23 participants). The intervention consisted of 48 sessions, each lasting 60 min, with the GTS as the evaluation instrument (Memmert, 2007). The results revealed that only the attention expansion training group exhibited a significant increase in overall creative performance across measurement times, aligning with the findings of this study where attention is facilitated through PGs.

In another study employing the same measurement tool, 70 talented individuals born in Germany were investigated through two measurements, each spaced six months apart. The findings showed that none of the participants experienced a decline in their creativity; on the contrary, young football players had a slight inclination to enhance their creative abilities. While the individual study period spanned six months, more than a handful of talents from the German Football Foundation talent program (n = 39) demonstrated improvements in tactical creativity. Specifically, some subjects exhibited increases of over 5%, while others surpassed 10%, with three players achieving a remarkable improvement of more than 20% in their creative performance (Memmert, 2010b). These results underscore the potential for intraindividual enhancements in line with divergent tactical behavior (Memmert, 2010b). The participants in this study are talented female players who belong to a representative team of the country and achieved a group increase of more than 10%, which is coherent in terms of increasing performance.

Therefore, talent appears to be intricately linked to tactical creativity, irrespective of experience. Thus, another study compared children's creative development based on their experience level and caregiving processes. This study involved children categorized as experts (those involved in equipment management) and non-experts (n = 120) aged 7, 10, and 13. The research encompassed divergent thinking tasks (specific/non-specific) and attention tasks (specific/non-specific) in a cross-sectional design. The findings revealed a substantial improvement in creative performance across all age groups. Additionally, the study suggested that children exhibiting enhanced fluidity, flexibility, and originality in generating ideas generally demonstrated superior creative thinking skills, particularly in sports-related tasks, and vice versa (Memmert, 2010b). Therefore, it can be inferred that a significant amount of time (exceeding eight sessions and a greater volume in minutes) is imperative because the cognitive conditions of each subject and the nature of the stimuli play crucial roles in determining the timing of improvements in the tactical creativity index.

In a study conducted by Valencia & Arias (2021), following the intervention of the DMGAC, which included PGs, a noticeable improvement in tactical performance ($p = 0.025$) among children football players was observed, mirroring the outcomes of our study wherein a similar application was implemented. Only PGs enhanced the tactical creativity index ($p = 0.05$). Apply 10 DMGAC sessions (including the PG) to enhance the attacking game (measured using the team sport assessment procedure) in a different study conducted by Arias et al. (2013). On the other hand, Giraldo and Arias (2017), in the study carried out on basketball players, showed that 12 weeks of applying the DMGAC generated statistically significant changes in the effectiveness index (measured with the game action evaluation system), and Valencia & Arias (2021) compared the DMGAC with the Didactic Model of Direct Instruction after 12 sessions, concluding that the DMGAC could be an appropriate model for football teaching. Therefore, interventions enhance the creativity of football players, suggesting that weekly stimuli can improve creativity, as illustrated by the findings of Valencia & Arias (2021). However, the disparity in the number of training hours remains a distinguishing factor between more and less creative players (Memmert & Roca, 2019). These training hours may contribute to other processes (Colzato et al., 2013).

Coutinho et al. (2018) discovered that a training program based on physical literacy and differential learning, focusing on physical, technical, creative, and tactical aspects, is more effective for offensive players under 15 than those under 17. Similarly, a study by Vegas (2006) involving 60 children aged 10–11 demonstrated an effectiveness in passes and ball control of 57.5% and 76.1%, respectively. In our study, players exhibited a pass effectiveness of 70% and a ball control effectiveness of 76%, comparable to the findings of González-Víllora, et al. (2012), who analyzed 24 soccer players using the 2 vs. 2 test. In their study, the effectiveness of passes was 83.35%, while ball control reached 84.8%. While comprehensive programs have shown gains in technical skills (Kinnerk et al., 2018; Pizarro et al., 2017; Práxedes et al., 2016), the intervention in this case, incorporating PGs, proved insufficient to enhance ball control but effective in improving passing accuracy. Similarly, the 2 vs. 2 test was employed in a study conducted in Malaga with 60 players aged 10–11. Across both test sessions, control and passing were the predominant skills. Notably, 57.5% of executed passes were accurate, and controls were correct in 76.1% of cases. Controls reached 83.65% accuracy in the final assessment, while passes were successful in 69.23% of instances (Vegas, 2006). The passing effectiveness of the players in this study closely resembled that of the under-11 players, mirroring the ball control variable.

Training programs should include stimuli to develop creativity. Whatever the path chosen, creative players should be promoted because it allows them to make more effective decisions with unique performance solutions that are very difficult for the opponent to predict (Memmert & Roca, 2019). This empirical evidence serves as valuable guidance for educators, coaches, and sports scientists, aiding in developing more effective enrichment environments to enhance creativity (Santos & Monteiro, 2021).

PGs are based on Festinger's (1962) theory of cognitive dissonance. Psychokinetics is a science that explores the convergence of reasoning (psyche) and movement (kinetics). The exercises should initially be easy and enjoyable to prevent player rejection. As players gain experience, the complexity of these exercises should progressively increase (Esposito et al., 2019). It is advisable to introduce psychokinetic stimuli at the beginning of training, immediately after the warm-up, when players are still fresh and attentive, to maintain focus throughout the exercise (Esposito et al., 2019).

Conclusions

The participation of women in soccer has increased, but scientific exploration, particularly in the tactical–and technical aspects, has not kept pace. One didactic strategy, known as PGs, aims to enhance players' cognitive abilities, including concentration, attention, and anticipation. In this study, PGs positively influence female youth soccer players' cognitive and technical aspects, specifically enhancing tactical creativity and passing effectiveness. However, the intervention decreased ball control performance. PGs involve multiple players engaged in continuous ball passing, changing positions on the field after each pass, and preparing for subsequent actions, all without opposition. PGs seem to affect performance positively because players must make passes of the ball with movements that have uncertainty. However, in the ball control variable, these stimuli were not enough to increase performance. In this sense, the number of repetitions in games is likely to be in favor of passing the ball because, after a mistake, restarting the game with a pass without forgetting that the training surface was sand and increases the complexity of ball control. This study shows that coaches possess a valuable and diverse training tool that avoids training monotony. However, it emphasizes the necessity of adapting this approach based on players' responses, with increasing complexity tailored to their capabilities. Hence, the coach's ability to modify without giving the players the answer promotes the participation and cooperation of all participants to achieve the set objective.

Recommendations

To validate and extend the findings of this study, it is advisable to replicate the research with female players exhibiting similar characteristics, incorporating a control group for data verification and comparison. Additionally, investigating varied age groups will allow us to observe diverse responses based on the subjects' ages. Extending the study to include male participants and ensuring a minimum of eight sessions would further contribute to a comprehensive understanding of the impact of PGs on tactical creativity and technical performance across different demographics.

Limitations

The study was conducted during the competitive period, constraining the frequency and quantity of stimuli implemented in the research. Attendance decreased because some players were called up to the department's representative team (Antioquia); hence, co-interventions were not controlled. The training surface was sand, intensifying the complexity of PGs execution, while the tests were conducted on a grass surface.

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Conflicts of interest

The authors reported no potential conflicts of interest.

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