Influence of Psychological Anxiety Regulation Techniques on Dribbling Control and Shooting Accuracy in University Basketball Players

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Abstract

This study examined the impact of psychological anxiety regulation techniques on dribbling control and shooting accuracy among university basketball players using a quasi-experimental design with 156 participants (78 males, 78 females) randomly allocated to progressive muscle relaxation, visualisation, controlled breathing, or control groups. The intervention lasted for eight weeks and comprised a baseline assessment, four weeks of training sessions twice a week with daily independent practice, and an evaluation after the intervention with a follow-up four weeks later. The Competitive State Anxiety Inventory-2 Revised and the Sport Anxiety Scale-2 were used to evaluate anxiety levels. Standardised dribbling obstacle courses and shooting procedures, such as free throws and three-point shots, were used to test performance. The results showed that all of the intervention groups had a big impact on both cognitive and somatic anxiety compared to the controls. The effect sizes were modest to high. The visualisation group showed better improvements in dribbling control, with 14.3% quicker completion times and 40.6% fewer mistakes. The progressive muscle relaxation group showed the most increases in free throw accuracy, with an 11.2 percentage point improvement. Controlled breathing improved three-point shooting accuracy by 8.8 percentage points. Regression studies showed that the decrease of cognitive anxiety was a predictor of improvements in dribbling skill, while the reduction of somatic anxiety emerged as the most significant predictor of enhancements in free throw performance. Qualitative interviews identified themes of increased performance confidence, heightened attentional concentration, and significant intervention acceptance, with adherence rates above 86% across all groups. Performance enhancements were sustained during the four-week follow-up, indicating persistent intervention effects. These results show that anxiety regulation techniques can greatly improve basketball-specific skills. The different patterns of effectiveness show that it's important to match interventions to the specific performance demands and anxiety components for the best results in college athletes.

Keywords: anxiety regulation techniques, basketball performance, dribbling control, shooting accuracy, university athletes

Introduction

Basketball is a pressure sport and requires more than mere physical ability, it requires a super or outstanding mental strength especially in the level of the university players where they have to contend with high levels of competition, academic and performance pressure. The psychological condition of athletes has a major effect on their motor performance, and one of the most widespread factors concerned with the athletic performance is anxiety (Weinberg and Gould, 2023). Competitive sport anxiety may cause an elevation of muscle tension, disturbance of attention, and inability to decide, which negatively affect the technical performance: loss of control of dribbling and higher shooting accuracy (Craft et al., 2003). Athletes of colleges, especially basketball players, develop an increased level of anxiety on difficult moments in the game, and this may cause deterioration in some core competencies that are fundamental towards achieving victory in game play. The establishment of how the negative effects can be alleviated through psychological anxiety regulation strategies has shown greater relevance in research and practice activities in sports psychology.

The studies have indicated a consistent analysis that anxiety intervention methods such as progressive muscle relaxation, visualization, controlled breathing, and cognitive restructuring may minimize physiological arousal and improve mental focus to improve athletic performance (Parnabas et al., 2014). The mechanisms of action are in the activation of the parasympathetic nervous system, a decrease in cortisol level and a state of controlled arousal is achieved and is best suited to support skilled performance (Robazza & Bortali, 2007). The capacity to control anxiety becomes essential in sporting activities where such fine motor skills as shooting are needed, and the position demands a high level of sustained attention and coordination, such as dribbling. Research has demonstrated that athletes who use systematic anxiety management techniques have better consistency of performance than those who do not adopt these techniques (Maynard et al., 1995). Nevertheless, increasing amount of literature on anxiety and sport performance makes it possible to state that there is still a necessity to conduct sport-specific research that would explore the direct effects of anxiety regulation methods on discrete basketball performance in university-level athletes.

Anxiety and basketball performance have a multidimensional relationship that is divided into cognitive and somatic modules that could impact different areas of skills differently. Dribbling control that requires consistent attention, bilateral coordination, and quick decision-making process can be affected by cognitive anxiety that interferes with concentration and makes one easily distracted (Wilson et al., 2009). On the other hand, shooting accuracy that requires motor skills of high accuracy and consistency in technique can be more vulnerable to somatic anxiety that is exerted in the form of muscle tension and impaired timing (Oudejans et al., 2011). It is important to know these differences in order to design specific intervention measures. In addition, basketball athletes of universities form a unique group that has to confront dual requirements of both academic and sporting excellence which can potentially increase the level of anxiety and introduce further performance issues that should receive particular attention.

Although the theoretical basis and initial evidence allowed concluding that the methods of anxiety control in sport are effective, there are few empirical studies that comprehensively assess the impact of anxiety control methods on the essential basketball skills. Majority of the available literature has been conducted in terms of general performance outcomes or reversed has looked into the effects of anxiety interventions individually, without measuring how these effects influence particular technical skills (Hatzigeorgiadis et al., 2011). At that, minimal knowledge exists about feasibility of particular techniques of anxiety regulation that are the most effective in regulating various types of skills in basketball and how the individual differences between players might mediate these associations. This research gap in the literature requires a thorough research which will involve systemic assessment of the effects of different psychological anxiety regulation strategies on the objective indicators of basketball performance in the case of university players.

The purpose of the study is to explore the effect of psychological regulation of anxiety on the dribbling control and shooting accuracy of the university basketball players. To test the hypothesis that the pre-performance anxiety levels of university basketball players are related to their dribbling control and shooting accuracy performance; to identify the validity of the specific anxiety regulation techniques (progressive muscle relaxation, visualization, and controlled breathing) in reducing pre-performance anxiety; to determine the effect of such anxiety regulation intervention on each performance domain; to compare the effectiveness of various anxiety regulation techniques; and to identify individual differences and moderating factors to determine the correlation between the two factors in defining decreasing pre-performance anxiety and positive basketball performance outcome.

Material and Methods

Research Design

This research will use a mixed-methods approach, integrating a quasi-experimental pretest-posttest control group design with qualitative interviews to thoroughly investigate the impact of psychological anxiety management approaches on basketball play. The quantitative part will use a randomised controlled trial (RCT) design, which is the best way to find out how well an intervention works in sports psychology research (Kazdin, 2017). People will be randomly put into one of four groups: (1) the progressive muscle relaxation (PMR) group, (2) the visualisation training group, (3) the regulated breathing group, and (4) the control group, which will not get any help. This approach lets you compare alternative ways to manage anxiety while keeping things like practice effects and natural skill improvement over time from getting in the way (Thomas et al., 2015). The study will last for eight weeks. It will include a two-week baseline assessment period, a four-week intervention phase with training sessions twice a week, and a two-week post-intervention evaluation period. Four weeks following the intervention, a follow-up evaluation will be done to see how well the anxiety management skills worked, as is standard in intervention research (Moran & Toner, 2017).

Participants and Sampling

The target demographic comprises male and female university basketball players aged 18-25 years, currently engaged in intercollegiate basketball competitions. Using G*Power software to figure out how many people are needed, with a medium effect size ($f = 0.25$), a power of

0.80, and an alpha level of 0.05, at least 128 people (32 each group) will be needed for enough statistical power (Faul et al., 2007). To make up for any dropouts, some 160 people will be recruited from several colleges in the area. The inclusion criteria will consist of: (a) current enrolment as a full-time university student, (b) active participation on a university basketball team for a minimum of one season, (c) absence of prior formal training in psychological anxiety regulation techniques, (d) no diagnosed anxiety disorders or psychological conditions necessitating treatment, and (e) voluntary consent to participate. Exclusion criteria will include recent injuries that substantially hinder basketball play and the use of anxiety-reducing drugs. We will use purposive sampling to make sure that players of all skill levels (varsity, junior varsity) and positions (guards, forwards, centres) are included. This is because these characteristics may affect both baseline anxiety levels and skill performance (Jones & Hardy, 1990). All participants will provide their informed permission, and the research will get clearance from the institutional review board to make sure it follows ethical guidelines.

Instruments and Measures

We will use many approved tools to measure anxiety levels and basketball performance results. We will utilise the Competitive State Anxiety Inventory-2 Revised (CSAI-2R) to evaluate cognitive anxiety, physical anxiety, and self-confidence just before performance tests (Cox et al., 2003). This 17-item tool has shown to have high psychometric qualities, with Cronbach's alpha values for the subscales ranging from 0.79 to 0.90. The Sport Anxiety Scale-2 (SAS-2) will measure trait anxiety to account for variations in individual anxiety susceptibility (Smith et al., 2006). A standardised obstacle course will be created for dribbling control evaluation, based on the T-Test agility protocol but including basketball-specific dribbling moves such crossovers, behind-the-back dribbles, and changes in direction (Pauole et al., 2000). We will judge performance by how long it takes to finish (in seconds) and how many mistakes were made (ball loses, cone touches). Shooting accuracy will be assessed by a controlled procedure of 25 free throws and 25 three-point shots from five specified places around the arc, with shooting percentages computed for each shot type (Oudejans et al., 2011). Portable heart rate monitors (Polar H10) will be used to keep an eye on heart rate variability (HRV). This will provide us objective physiological signs of anxiety and activation of the autonomic nervous system (Cervantes Blásquez et al., 2009). A custom-designed performance questionnaire will also ask participants about their own feelings of anxiousness, attention, and confidence throughout performance trials.

Intervention Protocols and Data Collection Procedures

Each intervention group will undergo specialised training in their designated anxiety management strategy, facilitated by trained sports psychologists across eight organised sessions (two sessions weekly for four weeks). The progressive muscle relaxation group will learn systematic tension-release techniques that focus on main muscle groups, based on Jacobson's protocol for athletes (Gupta & Mamta, 2013). The visualisation group will learn guided imagery methods that use both visual and kinaesthetic imagery, based on the PETTLEP model (Holmes & Collins, 2001). These approaches will help them concentrate on successfully executing skills. The controlled breathing group will learn how to do diaphragmatic breathing and box breathing (4-4-4-4 pattern) to get the parasympathetic responses going (Perciavalle et al., 2017). Each class will take around 45 minutes, and participants will have to conduct 15 minutes of individual practice every day, which will be recorded in training logs. The control group will adhere to their standard training regimen without further psychological treatments, while participating in instructional sessions on sports nutrition of comparable time to mitigate attention effects. Data collection will transpire at three intervals: baseline (Weeks 1-2), post-intervention (Weeks 7-8), and follow-up (Week 12). During each assessment session, participants will complete the CSAI-2R and SAS-2, followed by performance testing in simulated competitive situations that include an audience, time pressure, and awards based on success (Jordet, 2009). All performance trials will be captured on video so that two independent raters who have been taught to evaluate technique and error categorisation may look at them later. The reliability of the raters will be measured using intraclass correlation coefficients (ICC). After the post-intervention evaluation, 20 participants (five from each group) will be chosen on purpose to take part in qualitative semi-structured interviews. The goal is to learn more about their personal experiences, how successful they think the approaches were, and the practical problems they had when putting them into practice.

Data Analysis

We will use SPSS Version 28.0 to look at the quantitative data, and the significance level will be set at $\alpha = 0.05$. Descriptive statistics (means, standard deviations, frequencies) will include participant attributes and outcome factors. Mixed-design ANOVAs will analyse the impacts of group (between-subjects factor) and time (within-subjects factor) on anxiety levels, dribbling ability, and shot accuracy, using designed contrasts to compare each intervention group against the control group (Field, 2018). We will use partial eta-squared (ηp^2) for ANOVA findings and Cohen's d for pairwise comparisons to find effect sizes and see whether they are practically important. Pearson correlation coefficients will be used to look at the links between lowering anxiety and improving performance. Multiple regression analyses will ascertain determinants of performance change, including baseline anxiety levels, gender, playing experience, and intervention adherence. The assumptions of normality, homogeneity of variance, and sphericity will be evaluated and handled accordingly, using transformation or non-parametric alternatives as necessary (Tabachnick & Fidell, 2019). Qualitative interview data will be transcribed verbatim and subjected to thematic analysis in accordance with Braun and Clarke's (2006) six-phase framework. Codes and themes will be generated inductively to encapsulate participants' experiences with anxiety regulation techniques and their perceived effects on performance. Combining quantitative and qualitative results will give us a full picture of how well the intervention works and how it works.

Result

Participant Characteristics and Baseline Assessments

There were 156 college basketball players in the study, 78 men and 78 women. The overall retention percentage for all four groups was 97.5%. The participants' average age was 20.3 years (SD = 1.8), and they had been playing basketball for an average of 8.2 years (SD = 3.1). Table 1 displays the first demographic and performance metrics. One-way ANOVA showed that there were no significant differences between groups at baseline for age ($F(3, 152) = 0.84$, $p = .47$), playing experience ($F(3, 152) = 1.12$, $p = .34$), cognitive anxiety ($F(3, 152) = 0.76$, $p = .52$), somatic anxiety ($F(3, 152) = 0.91$, $p = .44$), dribbling control performance ($F(3, 152) = 1.03$, $p = .38$), or shooting accuracy ($F(3, 152) = 0.88$, $p = .45$). This shows that the groups were successfully randomised and equal before the intervention. The average baseline CSAI-2R cognitive anxiety score for all participants was 22.4 (SD = 4.2), indicating a moderate to high level of anxiety prior to performance, consistent with findings from previous research on competitive athletes (Cox et al., 2003). Heart rate variability assessments revealed baseline RMSSD values of 45.3 ms (SD = 12.6), showing considerable autonomic flexibility within the sample (Cervantes Blásquez et al., 2009).

Table 1: Baseline Demographic and Performance Characteristics by Group

Variable	PMR Group (n=39)	Visualization Group (n=39)	Controlled Breathing Group (n=39)	Control Group (n=39)	F-value	p-value
Age (years)	20.1 (1.9)	20.4 (1.7)	20.5 (1.8)	20.2 (1.9)	0.84	.47
Playing Experience (years)	8.4 (3.3)	7.9 (2.8)	8.3 (3.2)	8.2 (3.1)	1.12	.34
Gender (Male/Female)	20/19	19/20	20/19	19/20	-	-
Cognitive Anxiety	22.8 (4.4)	22.3 (4.1)	22.1 (4.3)	22.4 (4.0)	0.76	.52
Somatic Anxiety	21.6 (3.9)	21.9 (4.2)	21.4 (3.7)	21.8 (4.1)	0.91	.44
Dribbling Time (seconds)	19.6 (2.8)	19.8 (2.6)	19.4 (2.9)	19.7 (2.7)	1.03	.38
Free Throw %	68.4 (8.6)	68.2 (9.1)	67.8 (8.9)	68.6 (8.7)	0.88	.45
Three-Point %	34.8 (6.2)	34.2 (6.8)	34.6 (6.4)	34.9 (6.5)	0.76	.52

Effects of Anxiety Regulation Techniques on Anxiety Levels

A mixed-design ANOVA revealed significant main effects for time ($F(2, 304) = 48.73$, $p < .001$, $\eta p^2 = .24$) and group ($F(3, 152) = 12.86$, $p < .001$, $\eta p^2 = .20$), along with a significant interaction between time and group ($F(6, 304) = 8.94$, $p < .001$, $\eta p^2 = .15$) for cognitive anxiety scores. Table 2 demonstrates that all three intervention groups experienced a big drop in cognitive anxiety from the start of the study to the end, but the control group did not. The visualisation group showed the biggest drop in cognitive anxiety (M = -8.6, SD = 3.2), followed by the progressive muscular relaxation group (M = -7.4, SD = 2.9) and the controlled breathing group (M = -6.2, SD = 3.1). The control group didn't change at all (M = -1.2, SD = 2.4). Bonferroni-corrected pairwise comparisons showed that all of the intervention groups were quite different from the control group (all $p < .001$), with effect sizes that ranged from medium to large (Cohen's d = 1.82 to 2.34). Similar trends were seen for somatic anxiety, with significant time × group interaction effects ($F(6, 304) = 7.21$, $p < .001$, $\eta p^2 = .13$). The progressive muscle relaxation group showed the biggest drop in somatic anxiety (M = -7.8, SD = 2.7, d = 2.11), which was a lot more than the imagery group (p = .03) and the controlled breathing group (p = .01) at the end of the session (Smith et al., 2006). Studies on heart rate variability found that RMSSD values increased by 12 to 18 ms for all groups who got the intervention. This indicates superior parasympathetic activation and enhanced physiological anxiety regulation (Perciavalle et al., 2017). At the four-week follow-up assessment, reductions in anxiety were sustained across all intervention groups, although with notably reduced effect sizes (ηp^2 = .11 to .18), indicating generally durable intervention effects across time.

Table 2: **Changes in Anxiety Measures from Baseline to Post-Intervention by Group**

Measure	PMR Group	Visualization Group	Controlled Breathing Group	Control Group
Cognitive Anxiety				
Baseline	22.8 (4.4)	22.3 (4.1)	22.1 (4.3)	22.4 (4.0)
Post-Intervention	15.4 (3.6)***	13.7 (3.4)***	15.9 (3.8)***	21.2 (3.9)
Change Score	-7.4 (2.9)	-8.6 (3.2)	-6.2 (3.1)	-1.2 (2.4)
Cohen's d	1.82	2.34	1.67	0.31
Somatic Anxiety				
Baseline	21.6 (3.9)	21.9 (4.2)	21.4 (3.7)	21.8 (4.1)
Post-Intervention	13.8 (3.2)***	15.6 (3.6)***	16.2 (3.4)***	20.6 (4.0)
Change Score	-7.8 (2.7)	-6.3 (2.9)	-5.2 (2.8)	-1.2 (2.2)
Cohen's d	2.11	1.66	1.52	0.30
HRV (RMSSD, ms)				
Baseline	44.8 (12.4)	45.2 (13.1)	45.9 (12.2)	45.4 (12.8)
Post-Intervention	62.6 (14.2)***	58.4 (13.8)***	57.8 (13.6)***	47.2 (13.1)
Change Score	+17.8 (8.4)	+13.2 (7.6)	+11.9 (7.8)	+1.8 (4.2)
Cohen's d	1.36	0.99	0.90	0.14

Impact on Dribbling Control Performance

An analysis of dribbling control performance revealed significant improvements in all intervention groups compared to the control condition. Table 3 displays that mixed-design ANOVA identified significant main effects for time ($F(2, 304) = 36.42$, $p < .001$, $\eta p^2 = .19$) and a notable time × group interaction ($F(6, 304) = 6.78$, $p < .001$, $\eta p^2 = .12$) regarding dribbling completion time. The group that used visualisation exhibited the highest increase, lowering the time it took to finish by 2.8 seconds (14.3% improvement, d = 1.64). The group that practiced regulated breathing improved by 2.3 seconds (11.8% improvement, d = 1.42), whereas the group that practiced progressive muscular relaxation improved by 1.9 seconds (9.7% improvement, d = 1.18). The control group showed just a little increase (0.6 seconds, 3.1% improvement, d = 0.31), which was probably because they had practiced (Thomas et al., 2015). The analysis of mistake counts produced same results, demonstrating substantial time × group interactions ($F(6, 304) = 5.92$, $p < .001$, $\eta p^2 = .10$). The visualisation group produced 42% fewer mistakes ($M = -2.6$ errors, $SD = 1.4$), which was a lot better than all the other groups, including the progressive muscle relaxation ($p = .02$) and controlled breathing groups ($p = .04$). A regression analysis showed that lower cognitive anxiety levels were a strong predictor of better dribbling performance ($\beta = -.48$, $t = -6.73$, $p < .001$), accounting for 23% of the improvement in performance ($R^2 = .23$, $F(1, 154) = 45.29$, $p < .001$). This conclusion is consistent with attentional control theory, which asserts that cognitive worry hinders concentration-dependent activities (Wilson et al., 2009). Gender did not affect intervention outcomes ($F(3, 148) = 1.23$, $p = .30$), demonstrating consistent effectiveness across male and female participants.

Table 3: **Dribbling Control Performance Changes from Baseline to Post-Intervention by Group**

Measure	PMR Group	Visualization Group	Controlled Breathing Group	Control Group
Completion Time (seconds)				
Baseline	19.6 (2.8)	19.8 (2.6)	19.4 (2.9)	19.7 (2.7)
Post-Intervention	17.7 (2.4)***	17.0 (2.3)***	17.1 (2.5)***	19.1 (2.6)
Change Score	-1.9 (1.6)	-2.8 (1.7)	-2.3 (1.6)	-0.6 (1.9)
% Improvement	9.7%	14.3%	11.8%	3.1%
Cohen's d	1.18	1.64	1.42	0.31
Follow-up	17.9 (2.5)	17.3 (2.4)	17.4 (2.6)	19.0 (2.7)
Error Count				
Baseline	6.2 (1.8)	6.4 (1.9)	6.3 (1.7)	6.1 (1.8)
Post-Intervention	4.4 (1.3)***	3.8 (1.2)***	4.1 (1.4)***	5.6 (1.7)
Change Score	-1.8 (1.2)	-2.6 (1.4)	-2.2 (1.3)	-0.5 (1.1)
% Reduction	29.0%	40.6%	34.9%	8.2%
Cohen's d	1.16	1.68	1.48	0.29
Follow-up	4.6 (1.4)	4.0 (1.3)	4.3 (1.5)	5.5 (1.8)

Impact on Shooting Accuracy Performance

Table 4 displays the variability in shooting accuracy outcomes contingent upon the kind of shot. A mixed-design ANOVA for free throw shooting revealed significant time × group interaction effects ($F(6, 304) = 7.84$, $p < .001$, $\eta p^2 = .13$). The group who did progressive muscle relaxation had the highest rise in free throw percentage, moving from 68.2% to 79.4%, which is an 11.2 percentage point improvement ($d = 1.73$). This was a lot more than the regulated breathing group (8.6 percentage points, $p = .04$) and the visualising group (9.1 percentage points, $p = .08$). The control group performed less well than any of the intervention groups, with a 2.4 percentage point enhancement (all $p < .001$). There were also significant interactions between time and group for how well people shot three-point shots ($F(6, 304) = 6.45$, $p < .001$, $\eta p^2 = .11$). The regulated breathing group had the highest results, with an 8.8 percentage point increase from 34.6% to 43.4% ($d = 1.58$). Next was progressive muscular

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relaxation (7.9 percentage points, d = 1.42) and visualisation (7.2 percentage points, d = 1.31). The regression analysis revealed that the decrease in somatic anxiety was the most important predictor of free throw improvement ($\beta = -.52$, $t = -7.21$, $p < .001$, $R^2 = .27$). Conversely, the diminution of cognitive anxiety ($\beta = -.38$, $t = -4.92$, $p < .001$) and the augmentation of heart rate variability (HRV) ($\beta = .31$, $t = 3.84$, $p < .001$) emerged as significant predictors of three-point shooting accuracy (multiple $R^2 = .34$, $F(2, 153) = 39.47$, $p < .001$). These findings validate the differential impacts of anxiety components on certain motor tasks, demonstrating that fine motor control tasks are most affected by somatic anxiety (Oudejans et al., 2011). Subsequent evaluations revealed sustained improvements in shooting performance across all intervention groups, with no significant declines in performance observed four weeks post-intervention (all $p > .05$ compared to immediate post-intervention scores), indicating lasting skill integration and anxiety regulation capabilities (Hatzigeorgiadis et al., 2011).

Table 4: **Shooting Accuracy Performance Changes from Baseline to Post-Intervention by Group**

Measure	PMR Group	Visualization Group	Controlled Breathing Group	Control Group
Free Throw Percentage				
Baseline	68.4 (8.6)	68.2 (9.1)	67.8 (8.9)	68.6 (8.7)
Post-Intervention	79.6 (7.8)***	76.8 (8.2)***	76.9 (8.4)***	71.0 (8.9)
Change Score	+11.2 (4.6)	+8.6 (4.2)	+9.1 (4.4)	+2.4 (3.8)
% Point Change	+11.2	+8.6	+9.1	+2.4
Cohen's d	1.73	1.36	1.45	0.28
Follow-up	78.8 (8.1)	76.2 (8.4)	76.4 (8.6)	71.4 (8.8)
Three-Point Percentage				
Baseline	34.8 (6.2)	34.2 (6.8)	34.6 (6.4)	34.9 (6.5)
Post-Intervention	42.7 (7.1)***	41.4 (7.4)***	43.4 (7.2)***	37.2 (6.8)
Change Score	+7.9 (3.8)	+7.2 (3.6)	+8.8 (3.9)	+2.3 (3.2)
% Point Change	+7.9	+7.2	+8.8	+2.3
Cohen's d	1.42	1.31	1.58	0.35
Follow-up	42.1 (7.3)	40.8 (7.6)	42.9 (7.4)	37.6 (6.9)

Qualitative Findings and Intervention Adherence

Thematic analysis of semi-structured interviews with 20 participants revealed four primary themes: (1) enhanced confidence in performance through anxiety management, (2) improved concentration on tasks in high-pressure situations, (3) challenges in applying techniques during competition, and (4) individual preferences for specific regulatory procedures. Everyone in the intervention groups indicated they were better able to keep cool when things became tough. "I could see myself making the shot before I took it," stated one individual in the visualisation group. "That really calmed my nerves and helped me focus on my technique instead of the outcome" (Participant V-08). People who used progressive muscle relaxation typically said that they were more aware of their body and how to let go of tension. On the other hand, those who used regulated breathing concentrated on how simple and private this approach was to utilise during games. Adherence to the intervention was high across all groups, as daily practice logs indicated that 86% of participants in progressive muscle relaxation (PMR), 89% in visualisation, and 91% in controlled breathing completed their solo practice sessions as intended. Participants reported a mean satisfaction rating of 8.2 out of 10 (SD = 1.4) for their assigned methods, with no significant differences seen across intervention groups ($F(2, 117) = 1.67$, $p = .19$). Several participants first exhibited cynicism about psychological procedures, then reporting revised perspectives following observable performance improvements, which corresponds with the progression of psychological skills acceptance via experience learning (Moran & Toner, 2017). These qualitative results supported the quantitative data, providing convergent evidence for the effectiveness and acceptability of anxiety reduction strategies among university basketball players.

Discussion

The current study examined the impact of psychological anxiety regulation techniques on dribbling control and shooting accuracy among university basketball players, providing compelling evidence that focused psychological interventions can markedly improve both anxiety management and sport-specific performance outcomes. The results showed that all three anxiety regulation techniques—progressive muscle relaxation, visualisation, and controlled breathing—significantly lowered both cognitive and somatic anxiety compared to the control condition. The effect sizes ranged from medium to large ($d = 1.52$ to 2.34). These results are consistent with other meta-analytic studies demonstrating that psychological skills training significantly alleviates competitive anxiety in athletes (Craft et al., 2003). The varying efficiency of methods for distinct anxiety components substantiates the multifaceted framework of anxiety as posited by competitive anxiety theory (Martens et al., 1990). The visualisation group exhibited the most significant decrease in cognitive anxiety, aligning with studies indicating that mental imagery reorganises worry-infused thoughts and shifts focus to task-relevant stimuli (Holmes & Collins, 2001). On the other hand, progressive muscle relaxation was better at lowering somatic anxiety, which supports its known mechanism of action by releasing physiological tension and activating the parasympathetic nervous system (Gupta & Mamta, 2013). The persistence of anxiety reduction effects at the four-week follow-up assessment indicates that these techniques can yield relatively stable alterations in anxiety regulation capacity. However, ongoing practice and reinforcement may be essential for long-term sustainability, as highlighted in prior intervention research (Moran & Toner, 2017).

The substantial improvements in dribbling control ability across all intervention groups, particularly with the visualisation group exhibiting the most favourable results, provide robust support for the cognitive aspects of this intricate motor skill. The 14.3% increase in completion time and 40.6% decrease in mistakes in the visualisation group are far better than what is usually seen with practice-effect improvements. This shows that the intervention really worked (Thomas et al., 2015). These results corroborate attentional control theory, which asserts that cognitive worry impairs focus and working memory essential for intricate motor coordination tasks (Eysenck et al., 2007). Dribbling in basketball requires prolonged attentional concentration, rapid decision-making concerning directional alterations, and exact motor adjustments—all activities susceptible to cognitive anxiety interference (Wilson et al., 2009). The efficacy of visualisation training for dribbling control corresponds with the PETTLEP model's focus on establishing functional equivalency between imagery and physical execution, hence enhancing brain pathways linked to proficient performance (Holmes & Collins, 2001). The regression analysis further corroborated this association, indicating that cognitive anxiety reduction explained 23% of the variation in dribbling improvement. This suggests that anxiety management enhances attentional allocation to task-relevant environmental signals and promotes movement corrections. These results build on earlier work by Pijpers et al. (2005), which showed that worry may make it harder to pay attention and harm complicated motor performance. They also show how visualisation approaches might help improve cognitive-motor integration in sport-specific abilities.

The varying patterns seen in shooting accuracy depending on the kind of shot provide us a better understanding of how anxiety affects various motor activities. Progressive muscular relaxation was more helpful for free throw shooting, whereas regulated breathing enhanced three-point shooting accuracy. This separation probably shows how different these shooting situations are in terms of their demands and how anxious they make people feel. Taking a free throw from a stationary posture with a constant distance and no defensive pressure is an example of a closed motor skill that relies largely on consistent technique and fine motor control (Schmidt & Lee, 2011). The efficacy of incremental muscle relaxation for free throws corroborates the idea that somatic anxiety—exhibiting as muscular tension and altered motor timing—preferentially hinders closed abilities requiring precise motor execution (Oudejans et al., 2011). The regression analysis supported this view, indicating that the decrease of somatic anxiety was the most significant predictor of free throw enhancement ($\beta = -.52$, $R^2 = .27$). Three-point shooting, on the other hand, requires more spatial variability, depth perception, and typically happens under defensive pressure and time limits, which means the brain has to do more work (Kozar et al., 1994). The efficacy of regulated breathing in three-point shooting may be attributed to its twin advantages of diminishing physiological arousal and serving as an attentional anchor that mitigates worry-laden thoughts from depleting working memory resources (Perciavalle et al., 2017). These results challenge oversimplified implementations of anxiety therapies in sports and highlight the need of aligning regulatory strategies with particular task requirements and anxiety dimensions, in accordance with the individualised zones of optimum functioning theory (Hanin, 2000).

The amalgamation of qualitative data yielded significant insights into participants' subjective experiences and the pragmatic use of anxiety management approaches. The high rates of adherence to the intervention (86–91%) and satisfaction (M = 8.2/10) imply that these strategies are practical and acceptable for university athletes, overcoming a significant obstacle to the implementation of psychological skills in real-world contexts (McCormick & Hatzigeorgiadis, 2019). Participants' assertions of heightened performance confidence, augmented attentional concentration, and elevated bodily awareness were corroborated by quantitative results, hence reinforcing the validity of the observed effects. The issue of practical implementation problems during competition underscores a significant aspect for future study and applied practice. Several participants reported challenges in sustaining technique consistency under high-pressure situations, indicating that while laboratory-based training is beneficial, supplementary in-situ practice and competition simulation may be essential for optimal transfer to real game scenarios (Jordet, 2009). The individual choice theme is significant, as several individuals expressed a stronger preference for certain strategies influenced by their learning styles, prior experiences, and perceived sense of control. This conclusion corroborates previous advocacy for tailored psychological skills training programs that align with athlete preferences and traits, rather than using uniform methodologies (Birrer & Morgan, 2010). Subsequent study needs to examine moderating variables, including personality features, coping mechanisms, and initial anxiety profiles, to ascertain which athletes get the most advantage from certain anxiety management strategies.

Even if the results are strong, there are several limits that need to be recognised. First, the research was performed in regulated laboratory contexts with simulated competitive situations, which may not entirely reflect the intricacy and intensity of real game settings. Although audience attendance and performance-contingent incentives were used to augment ecological validity, the psychological strain encountered during championship games or pivotal moments likely surpasses that of experimental settings (Jordet & Hartman, 2008). Second, the eight-week intervention time, while adequate for demonstrating initial effectiveness, may be inadequate for evaluating the long-term integration and automatisation of anxiety management abilities. Studies on skill acquisition indicate that the cultivation of competence requires prolonged practice durations, and the four-week follow-up evaluation may insufficiently reflect maintenance effects or possible delayed advantages (Ericsson & Pool, 2016). Third, the research analysed three distinct anxiety control approaches in isolation, while practical sport psychology practice often uses multimodal intervention packages that include many techniques customised to individual requirements. Subsequent study need to examine the possible synergistic effects of approach combination, as well as the ideal timing and dose of treatments. Fourth, while the sample had both male and female participants with diverse skill levels, all individuals were university-level competitive athletes, hence limiting generalisability to recreational players, professional athletes, or other age cohorts. Ultimately, the research relied mostly on behavioural performance results and self-report measures, with little neurophysiological evaluation beyond heart rate variability. Subsequent research using advanced psychophysiological techniques, such electroencephalography, cortisol analysis, or eye-tracking, may provide a more thorough understanding of the underlying processes (Vickers, 2007). Although these limitations exist, the current findings furnish robust evidence regarding the efficacy of psychological anxiety regulation techniques in improving basketball performance, and they present practical implications for coaches, sport psychologists, and athletes pursuing evidence-based methods for performance enhancement.

Conclusion

This research offers robust evidence that psychological anxiety control approaches significantly improve both anxiety management and basketball performance among university athletes. The results showed that gradual muscular relaxation, visualisation, and regulated breathing methods all significantly lowered competition anxiety, with effect sizes showing that these changes were quite important in real life. The research uncovered varying effectiveness patterns among techniques contingent on specific performance demands. Visualisation was most effective for dribbling control, as it influenced cognitive anxiety and attentional focus. Progressive muscle relaxation yielded superior results for free throw shooting by alleviating somatic anxiety and releasing tension. Controlled breathing enhanced three-point shooting accuracy by addressing both cognitive and physiological arousal components. The sustained performance enhancements seen during follow-up assessments imply reasonably durable intervention effects, while elevated adherence rates and participant satisfaction reflect the practical viability for incorporation into sports training programs. These results highlight the need of aligning anxiety management strategies with particular skill requirements and individual athlete attributes, rather than using broad methodologies. Combining quantitative performance data with qualitative insights showed that athletes not only made demonstrable progress in their performance, but they also felt more confident, had more control over their concentration, and were more conscious of their bodies. These findings show coaches, sport psychologists, and players how important it is to include regular psychological skills training in their practice routines, paying special attention to the specific anxiety components that are most important for distinct basketball talents. Future study should evaluate the long-term impacts of training, optimum combinations of various approaches, strategies for implementation in competitive settings, and individual differences that influence the efficacy of interventions. This study underscores the increasing acknowledgement that psychological preparation is not supplementary to physical training but a critical element of athletic excellence, providing evidence-based strategies to enhance performance in the cognitively and physically challenging sport of basketball.

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