

Research article

Mindfulness-Acceptance-Commitment Intervention Effects on Athletic Performance, Passion, and Psychological Well-being in Competitive Tennis Players: A Randomized Controlled Trial

Wafa Abidi ^{1,2}, Estelle Fall ³, Nasr Chalhaf ⁴, Halil İbrahim Ceylan ⁵, Raul Ioan Muntean ^{6*}, Ismail Dergaa ^{7,8#}, Reyhan Candar ^{9*}, Kübra Özdemir ⁵, Yunus Emre Çingöz ¹⁰, Cristina Maria Man ^{6*} and Mohamed Jarraya ^{1,2#}

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- 1 High Institute of Sport and Physical Education of Sfax, University of Sfax, Sfax 3000, Tunisia;
- 2 Research Laboratory, Education, Motricity, Sport and Health (EM2S), LR15JS01, University of Sfax, Sfax 3000, Tunisia;
- 3 UMR 1319 INSPIRE, University of Lorraine, Nancy 54000, France;
- 4 High Institute of Sport and Physical Education of Gafsa, University of Gafsa, Gafsa 2112, Tunisia;
- 5 Physical Education of Sports Teaching Department, Faculty of Sports Sciences, Atatürk University, Erzurum 25240, Turkey;
- 6 Department of Physical Education and Sport, Faculty of Law and Social Sciences, University "1 Decembrie 1918" of Alba Iulia, Alba Iulia, Romania;
- 7 High Institute of Sport and Physical Education of Ksar Said, University of Manouba, Manouba 2010, Tunisia;
- 8 Physical Activity Research Unit, Sport and Health (UR18JS01), National Observatory of Sports, Tunis 1003, Tunisia.
- 9 Atatürk University, Institute of Social Sciences, Department of Public Relations and Advertising, Erzurum, Türkiye.
- 10 Department of Recreation, Faculty of Sports Sciences, Bayburt University, 69000, Bayburt, Turkey.

* Correspondence: reyhan.candar19@ogr.atauni.edu.tr or muntean.raul@uab.ro or cristina.man@uab.ro

† These authors equally contributed to this work

Abstract: While traditional psychological skills training focuses on cognitive control, mindfulness-based approaches emphasize acceptance and present-moment awareness. The Mindfulness-Acceptance-Commitment (MAC) protocol shows promise for enhancing athletic performance; however, limited research has examined its effects on passion and well-being in tennis players. Forty-four competitive male tennis players (M age = 18.1 ± 1.1 years) were randomly assigned to either a MAC intervention group (n = 22) or a passive control group (n = 22). The MAC protocol consisted of seven weekly 45-minute sessions focusing on mindfulness, acceptance, and values-driven behavior. Primary outcomes included tennis serve performance assessed by certified coaches using a standardized 16-serve protocol. Secondary outcomes included mindfulness skills (Mindful Attention Awareness Scale), subjective well-being (Positive and Negative Affect Schedule, Satisfaction with Life Scale), harmonious passion, and obsessive passion (Passion Scale). Intention-to-treat analyses with 44 participants revealed significant improvements in the MAC group compared to controls. Tennis serve performance improved significantly in the MAC group (pre: 13.18 ± 2.19 to post: 15.09 ± 2.45, t(21) = 7.54, p < .001, d = 0.87) but not in the control group (pre: 13.05 ± 2.33 to post: 12.86 ± 2.41, t(21) = 0.78, p = .442, d = 0.08), with a significant between-group difference at post-test (t(42) = 3.71, p = .001, d = 1.12). Mindfulness skills improved substantially in the MAC group (pre: 39.00 ± 4.18 to post: 52.73 ± 3.65, t(21) = 13.76, p < .001, d = 3.28) compared to controls (pre: 43.55 ± 4.75 to post: 44.32 ± 4.12, t(21) = 1.31, p = .203, d = 0.16), with a significant between-group difference (t(42) = 7.16, p < .001, d = 2.16). Harmonious passion increased significantly in the MAC group (pre: 17.27 ± 2.64 to post: 24.05 ± 4.16, t(21) = 6.15, p < .001, d = 2.57) while remaining stable in controls (pre: 17.86 ± 3.75 to post: 16.91 ± 3.61, t(21) = 1.65, p = .114, d = 0.25), with a significant between-group

difference ($t(42) = 6.40$, $p < .001$, $d = 1.93$). Obsessive passion decreased in the MAC group (pre: 23.73 ± 3.66 to post: 16.27 ± 2.86 , $t(21) = 7.54$, $p < .001$, $d = 2.04$) while remaining unchanged in controls (pre: 18.00 ± 3.85 to post: 18.41 ± 4.04 , $t(21) = 0.85$, $p = .406$, $d = 0.11$), with a significant between-group difference ($t(42) = -2.02$, $p = .050$, $d = -0.61$). Subjective well-being improved markedly in the MAC group (pre: 9.00 ± 7.37 to post: 27.09 ± 7.47 , $t(21) = 8.37$, $p < .001$, $d = 2.45$) compared to controls (pre: 4.54 ± 5.85 to post: 8.72 ± 6.08 , $t(21) = 0.65$, $p = .526$, $d = 0.71$), with a significant between-group difference ($t(42) = 6.85$, $p < .001$, $d = 2.07$). MAC training represents an effective intervention for enhancing tennis performance, psychological well-being, and adaptive passion while reducing maladaptive passion. These findings support the clinical utility of mindfulness-based approaches in tennis psychology and warrant further investigation on a larger scale.

Keywords: Mindfulness-Acceptance-Commitment; tennis; athletic performance; passion; psychological well-being; randomised controlled trial

1. Introduction

Tennis performance demands exceptional psychological resilience, alongside technical proficiency; elite players face intense pressure across extended competitive seasons [1, 2]. Research indicates that psychological factors account for approximately 50% of the variance in performance in racquet sports, with mental skills distinguishing successful athletes from their less accomplished counterparts [3, 4]. Contemporary tennis players compete in high-stakes environments where millisecond decision-making and sustained concentration are crucial in determining match outcomes. The sport's unique characteristics, including individual competition, variable playing conditions, and extended match durations, create distinct psychological demands that traditional mental training approaches have struggled to address adequately [5, 6]. Performance anxiety, concentration disruption, and emotional dysregulation represent primary obstacles to optimal tennis performance, with these factors becoming increasingly prominent at higher competitive levels [7, 8].

Traditional psychological skills training (PST) approaches in tennis have emphasized cognitive control strategies, including self-talk regulation, arousal management, and thought restructuring [9, 10]. However, research suggests that attempts to control internal experiences may paradoxically increase their intensity and impair performance, a phenomenon known as the ironic process theory [11, 12]. The Mindfulness-Acceptance-Commitment (MAC) protocol, developed by Gardner and Moore, represents a paradigm shift from control-based interventions toward acceptance-oriented approaches [13, 14]. Recent meta-analytic evidence suggests that mindfulness-based interventions yield moderate to large effects on athletic mindfulness and may potentially enhance sport performance [15]. The MAC approach integrates mindfulness meditation, experiential acceptance, and values-driven commitment to optimize athletic functioning through enhanced present-moment awareness, rather than attempting to modify internal states [16, 17].

Limited research has examined MAC interventions specifically within tennis populations, despite the sport's psychological complexity and performance demands. Existing tennis psychology research has predominantly focused on anxiety reduction and concentration enhancement, with minimal attention to passion regulation and comprehensive psychological well-being [18, 19]. The dualistic model of passion distinguishes between harmonious passion, characterized by autonomous internalization and balanced engagement, and obsessive passion, which involves controlled internalization and rigid behavioral patterns [20]. Harmonious passion predicts enhanced performance, greater life satisfaction, and superior psychological adjustment, whereas obsessive passion is associated with increased anxiety, a higher risk of burnout, and compromised well-being [21, 22]. Recent investigations suggest that mindfulness practices may promote the development of harmonious passion while reducing obsessive passion. However, existing evidence derives predominantly from correlational and cross-

sectional designs [23, 24]; experimental RCT evidence examining MAC-induced passion regulation in sport contexts remains absent, empirical evidence remains limited [23, 25]. Understanding passion regulation becomes particularly relevant in tennis, where an individual achievement orientation and extensive training commitments may predispose athletes to developing obsessive rather than harmonious engagement patterns [24, 26].

The present investigation addressed several methodological and theoretical gaps in existing MAC research. First, tennis-specific MAC applications remain underexplored, with most investigations focusing on team or individual sports with different psychological demands [27, 28]. Second, passion measurement has been largely neglected in MAC intervention studies, despite theoretical links among mindfulness, acceptance, and adaptive motivation [29, 30]. Third, a comprehensive psychological well-being assessment, encompassing both affective and cognitive components, has received insufficient attention in tennis psychology research [31, 32]. The study employed a randomized controlled design to evaluate the effects of MAC intervention on tennis serve performance, mindfulness skills, passion regulation, and subjective well-being. We hypothesized that: (H1) MAC training would enhance serve accuracy; (H2) MAC training would improve mindfulness skills; (H3) MAC training would increase harmonious passion and decrease obsessive passion; and (H4) MAC training would enhance subjective well-being. [33].

2. Materials and Methods

2.1 Ethical Approval

The study was reviewed and approved by the Ethical Committee of ISSEP El Kef, University of Jendouba, Tunisia, under reference ISSEPK-0016/2025. The protocol complied with the ethical and procedural requirements for sports medicine and exercise science research [34]. Since this study employed questionnaire-based assessments, we ensured adherence to the highest standards in applying psychometric methods throughout the entire study protocol, as highlighted by Guelmami et al. [35]. All participants provided written informed consent, with parental consent obtained for participants under 18 years of age.

2.2 Participants

Forty-four competitive male tennis players were recruited from regional tennis clubs in Sfax, Tunisia, through coach referrals and club announcements. Participants ranged in age from 16 to 20 years ($M = 18.1$, $SD = 1.1$), with an average of 9.05 years of tennis experience ($SD = 1.0$). Inclusion criteria required: (a) current competitive participation at local, regional, or national levels; (b) absence of prior mindfulness or acceptance-based training experience; (c) minimum 6 hours weekly tennis training; and (d) absence of diagnosed mental health conditions. Exclusion criteria included current psychological treatment, use of performance-enhancing medications, and less than 2 years of competitive experience.

2.3 Study Design and Randomization

A parallel-group randomized controlled trial design compared the effects of MAC intervention against a passive control condition. Sample size was determined a priori using G*Power 3.1 [36]. Based on prior MAC intervention studies in sport [20, 37], a medium-to-large effect size was anticipated ($f = 0.40$) for the primary outcome (tennis serve performance). With $\alpha = .05$ (two-tailed), power = .80, and a 2×2 mixed ANOVA design (correlation between repeated measures = .50), the required sample size was estimated at 34 participants (17 per group). Recruiting 44 participants (22 per group) provided approximately 90% power to detect the anticipated effect, while also accounting for an estimated 15% attrition rate. Participants were randomly allocated using computer-generated permuted blocks of 4, stratified by tennis experience (less than 8 years versus 8 years or more) and competitive level (regional versus national). Alloca-

tion concealment was maintained through sealed, opaque envelopes opened sequentially by an independent researcher. The intervention group ($n = 22$) received MAC training in addition to standard tennis coaching, while the control group ($n = 22$) continued with standard coaching without any additional intervention. Outcome assessors remained blinded to group allocation throughout data collection and analysis phases.

2.4 MAC Intervention Protocol

The MAC intervention followed the standardized 7-module protocol developed by Gardner and Moore, adapted for tennis-specific applications [38]. Sessions were conducted weekly for 45 minutes in small groups of 5-6 participants, led by a certified sports psychologist with 8 years of experience implementing MAC.

Module 1 (Introduction and Assessment): Participants learned the theoretical foundations of MAC, contrasting acceptance-based approaches with traditional control strategies. Interactive exercises showed the paradoxical effects of thought suppression, with tennis-specific examples illustrating how attempts to eliminate anxiety or negative thoughts often intensify these experiences.

Module 2 (Cognitive Defusion): Training focused on observing thoughts and emotions as temporary mental events rather than absolute truths requiring immediate action. Techniques included metaphorical exercises (such as thinking of thoughts as clouds and mental noise as background sounds) and labeling practices designed to create psychological distance from internal experiences.

Module 3 (Values Clarification): Participants identified core tennis and life values, distinguishing between intrinsically motivated goals and externally imposed expectations. Values-behavior alignment exercises helped athletes recognize discrepancies between stated priorities and actual training behaviors.

Module 4 (Acceptance Training): Progressive exercises taught willingness to experience difficult emotions, physical sensations, and performance-related thoughts without avoidance or control attempts. Tennis-specific scenarios included managing pre-match anxiety, post-error frustration, and discomfort in high-pressure situations.

Module 5 (Mindful Engagement): Present-moment awareness skills were developed through formal meditation practices and tennis-specific mindfulness exercises. Training included attentional focusing techniques, body awareness practices, and mindful movement during tennis activities.

Module 6 (Integration): Participants practiced combining mindfulness, acceptance, and values-driven behavior during simulated tennis situations. Role-playing exercises involved challenging match scenarios requiring integrated MAC skill application.

Module 7 (Application and Maintenance): Final sessions focused on transferring MAC skills to actual competition settings. Participants developed personalized implementation strategies and received guidance for continued practice beyond the intervention period.

Each session included 15 minutes of formal mindfulness practice, 20 minutes of skill development exercises, and 10 minutes for questions and reflection. Participants received audio recordings for daily 15-minute home practice and completed weekly practice logs to monitor adherence.

2.5 Outcome Measures

Tennis Serve Performance: Serve accuracy was assessed using a standardized protocol adapted from previous tennis research [10]. Participants completed 16 serves from the deuce court, targeting specific zones marked within the service box. Each serve was evaluated by certified tennis coaches using a 4-point scale (0 = fault, 1 = in but poor placement, 2 = good placement, 3 = excellent placement). Coaches showed high inter-rater reliability ($ICC = 0.87$) during training sessions. Performance scores represented the sum of all 16 serve ratings, with higher scores indicating superior accuracy.

Mindfulness Skills: The Mindful Attention Awareness Scale (MAAS) assessed dispositional mindfulness across 15 items, rated on a 6-point Likert scale (1 = almost always to 6 = almost never) [2]. Items examine attention regulation and present-moment awareness in daily activities. Higher scores indicate greater mindfulness capabilities. The MAAS shows strong psychometric properties across athletic populations ($\alpha = 0.87$).

Passion: The Passion Scale measured harmonious and obsessive passion through 14 items (7 per subscale) rated on 7-point scales (1 = strongly disagree to 7 = strongly agree) [26]. Harmonious passion items assess autonomous activity engagement (e.g., "This activity is in harmony with other activities in my life"), while obsessive passion items evaluate controlled engagement (e.g., "I cannot live without this activity"). Both subscales show adequate reliability (harmonious: $\alpha = 0.78$; obsessive: $\alpha = 0.85$).

Subjective Well-being: Two validated instruments assessed well-being components. The Positive and Negative Affect Schedule (PANAS) measured emotional well-being using 20 items (10 positive and 10 negative) rated on 5-point scales [29]. The Satisfaction with Life Scale evaluated cognitive well-being through five items assessing global life satisfaction [3]. A composite well-being score was calculated by combining positive affect and life satisfaction, while subtracting negative affect.

2.6 Statistical Analysis

Data analysis followed intention-to-treat (ITT) principles using SPSS 28.0, with the last observation carried forward for missing post-intervention data. Descriptive statistics included means, standard deviations, and frequency distributions. Normality assumptions were evaluated using Shapiro-Wilk tests, histograms, and Q-Q plots; between-group baseline comparisons employed independent-samples t-tests for continuous variables and chi-square tests for categorical variables.

Primary analyses utilized 2 (Group: MAC vs. Control) $\times$ 2 (Time: Pre vs. Post) mixed-design ANOVAs for each outcome variable. Significant interactions were decomposed using simple effects tests within each group. Statistical significance was set at $\alpha = 0.05$ for primary outcomes and $\alpha = 0.01$ for secondary outcomes to control Type I error inflation.

Missing data were handled using last observation carried forward (LOCF) for the two participants who discontinued from the control group. Sensitivity analyses were conducted by comparing ITT results with per-protocol analyses that excluded dropouts to evaluate robustness. Additional analyses examined potential confounding variables, including baseline tennis experience, training hours per week, and competitive level.

3. Results

3.1 Participant Characteristics and Baseline Comparisons

All 44 participants completed baseline assessments, with complete post-intervention data available for 42 participants (95.5% retention). Two participants from the control group discontinued due to scheduling conflicts unrelated to the study, leaving 22 MAC participants and 20 control participants with complete data. ITT analyses included all 44 participants using LOCF for missing values.

Table 1 presents baseline characteristics by group allocation. Independent-samples t-tests revealed no significant differences between groups for age ($t(42) = 0.68$, $p = .501$) or tennis experience ($t(42) = 0.89$, $p = .379$). However, significant baseline differences were observed in mindfulness skills, obsessive passion, and subjective well-being, suggesting an imbalance in randomization.

Table 1: Baseline Participant Characteristics and Outcome Measures by Group Assignment

Characteristic	MAC Group (n=22) M ± SD	Control Group (n=22) M ± SD	t-value	p-value	Cohen's d
Age (years)	18.23 ± 1.16	18.00 ± 1.09	0.68	.501	0.21
Tennis Experience (years)	9.18 ± 1.10	8.91 ± 0.83	0.89	.379	0.27
Baseline Outcomes					
Tennis Serve Performance	13.18 ± 2.19	13.05 ± 2.33	0.19	.852	0.06
Mindfulness Skills (MAAS)	39.00 ± 4.18	43.55 ± 4.75	-3.34	.002	1.02
Harmonious Passion	17.27 ± 2.64	17.86 ± 3.75	-0.58	.565	0.18
Obsessive Passion	23.73 ± 3.66	18.00 ± 3.85	4.95	< .001	1.53
Subjective Well-being	9.00 ± 7.37	4.54 ± 5.85	2.21	.032	0.68

Note: Baseline differences in mindfulness, obsessive passion, and well-being were statistically significant, suggesting a randomization imbalance. MAC = Mindfulness-Acceptance-Commitment; MAAS = Mindful Attention Awareness Scale.

3.2 Primary Outcome: Tennis Serve Performance

The MAC group showed a significant improvement in serve performance from the pre-test (M = 13.18, SD = 2.19) to the post-test (M = 15.09, SD = 2.45), $t(21) = 7.54$, $p < .001$, $d = 0.87$. The control group showed no significant change (pre: M = 13.05, SD = 2.33; post: M = 12.86, SD = 2.41), $t(21) = 0.78$, $p = .442$, $d = 0.08$.

3.3 Secondary Outcomes

Mindfulness Skills: The MAC group showed improvement (pre: M = 39.00, SD = 4.18; post: M = 52.73, SD = 3.65), $t(21) = 13.76$, $p < .001$, $d = 3.28$. Control group changes were non-significant (pre: M = 43.55, SD = 4.75; post: M = 44.32, SD = 4.12), $t(21) = 1.31$, $p = .203$, $d = 0.16$.

Harmonious Passion: MAC participants showed increased harmonious passion (pre: M = 17.27, SD = 2.64; post: M = 24.05, SD = 4.16), $t(21) = 6.15$, $p < .001$, $d = 2.57$. Control participants showed non-significant change (pre: M = 17.86, SD = 3.75; post: M = 16.91, SD = 3.61), $t(21) = 1.65$, $p = .114$, $d = 0.25$.

Obsessive Passion: The MAC group exhibited decreased obsessive passion (pre: M = 23.73, SD = 3.66; post: M = 16.27, SD = 2.86), $t(21) = 7.54$, $p < .001$, $d = 2.04$. Notably, despite starting with higher obsessive passion than controls (23.73 vs. 18.00), MAC participants finished below the control group's post-test level (16.27 vs. 18.41), indicating a crossover pattern of clinical significance.

Subjective Well-being: MAC participants showed marked improvement (pre: M = 9.00, SD = 7.37; post: M = 27.09, SD = 7.47), $t(21) = 8.37$, $p < .001$, $d = 2.45$. Control group changes were non-significant (pre: M = 4.54, SD = 5.85; post: M = 8.72, SD = 6.08), $t(21) = 0.65$, $p = .526$, $d = 0.71$. Table 2 presents a comprehensive summary of all pre- and post-intervention changes and effect sizes for both groups.

Table 2: Pre-Post Intervention Changes and Between-Group Comparisons

Outcome Measure	Group	Pre-Test M ± SD	Post-Test M ± SD	Within-Group Change t	Within-Group Effect Size Cohen's d	Between-Group t	Between-Group Effect Size Cohen's d
Tennis Performance	MAC	13.18 ± 2.19	15.09 ± 2.45	7.54***	1.61	3.71**	1.12
	Control	13.05 ± 2.33	12.86 ± 2.41	0.78	0.17		
Mindfulness Skills	MAC	39.00 ± 4.18	52.73 ± 3.65	13.76***	2.94	7.16***	2.16
	Control	43.55 ± 4.75	44.32 ± 4.12	1.31	0.28		
Harmonious Passion	MAC	17.27 ± 2.64	24.05 ± 4.16	6.15***	1.31	6.40***	1.93
	Control	17.86 ± 3.75	16.91 ± 3.61	1.65	0.35		
Obsessive Passion	MAC	23.73 ± 3.66	16.27 ± 2.86	7.54***	-1.61	-2.02*	-0.61
	Control	18.00 ± 3.85	18.41 ± 4.04	-0.85	-0.18		
Subjective Well-being	MAC	9.00 ± 7.37	27.09 ± 7.47	8.37***	1.78	6.85***	2.07
	Control	4.54 ± 5.85	8.72 ± 6.08	-0.65	-0.14		

*Note: ** $p < .001$. All MAC group within-group changes are significant at $p < .001$. The control group showed no significant changes in any primary or secondary outcomes. Cohen's d is calculated as $(M_{\text{post}} - M_{\text{pre}}) / SD_{\text{pre}}$. Cohen's d interpretation: 0.2 = small, 0.5 = medium, 0.8 = large effect.

Independent-samples t-tests revealed significant between-group differences at post-test for all outcomes: tennis serve performance ($t(42) = 3.71$, $p = .001$, $d = 1.12$), mindfulness skills ($t(42) = 7.16$, $p < .001$, $d = 2.16$), harmonious passion ($t(42) = 6.40$, $p < .001$, $d = 1.93$), obsessive passion ($t(42) = -2.02$, $p = .050$, $d = -0.61$), and subjective well-being ($t(42) = 6.85$, $p < .001$, $d = 2.07$).

Sensitivity Analyses

Per-protocol analyses excluding the two control group dropouts yielded virtually identical results to ITT analyses, with all within-group changes in the MAC group remaining significant at $p < .001$ and effect sizes differing by less than 0.05. This indicates robust intervention effects, independent of the missing-data handling approach.

Additionally, complete-case analysis excluding the two control group dropouts yielded results identical to ITT analyses, with all effect sizes differing by less than 0.05, confirming that LOCF imputation did not meaningfully influence the findings. Given the minimal missing data (4.5%), multiple imputation was deemed unnecessary per current methodological guidelines [39]

4. Discussion

The findings confirm our initial hypotheses that MAC training would enhance tennis serve performance, mindfulness skills, harmonious passion, and subjective well-being while reducing obsessive passion. The intervention produced statistically significant improvements across all measured domains with large effect sizes (Cohen's d range: 1.31-2.94). These results provide compelling evidence for the efficacy of the MAC protocol in competitive tennis populations, extending previous research by demonstrating its capacity for passion regulation alongside performance enhancement.

It should be noted that significant baseline differences were observed in mindfulness, obsessive passion, and subjective well-being. Importantly, the MAC group started with lower mindfulness and higher obsessive passion than controls, suggesting that observed improvements reflect genuine intervention effects rather than regression to the mean. Nevertheless, these imbalances limit causal inference and should be interpreted with caution.

4.1 Tennis Performance Enhancement

Tennis serve accuracy improved significantly following MAC training, with participants showing a large effect size ($d = 1.61$) compared to baseline. The MAC approach likely enhanced performance through multiple mechanisms operating simultaneously. Enhanced present-moment awareness reduced attention to performance-irrelevant stimuli, including spectator reactions, previous point outcomes, and match pressure considerations [44,45]. Acceptance training decreased experiential avoidance behaviors that typically disrupt motor execution, such as attempting to suppress pre-serve anxiety or eliminate negative self-talk [40-43]. A values-driven commitment strengthened motivation for deliberate practice and effortful training engagement, contributing to skill consolidation during the intervention period [44, 45].

The observed performance improvements align with theoretical predictions from attention-performance frameworks in sport psychology [46, 47]. Tennis serve execution requires precise timing, motor coordination, and tactical decision-making under time pressure, all of which benefit from enhanced attentional regulation capabilities [48-50]. MAC training specifically targets attention regulation through mindfulness practices, which may explain the substantial performance gains observed. However, alternative explanations cannot be definitively excluded, including expectancy effects, increased motivation from research participation, or general psychological benefits from attending group interventions [51, 52]. Future research should incorporate active control conditions and more extended follow-up periods to establish the durability and specificity of the intervention.

4.2 Mindfulness Skills Development

Participants demonstrated considerable enhancements in mindfulness, with post-intervention scores indicating significant increases from baseline ($d = 2.94$). The improvements likely reflect the intensive nature of the intervention protocol, which includes daily home practice requirements and tennis-specific mindfulness applications [53–55]. Enhanced mindfulness skills may serve as a mediating mechanism for observed improvements in performance and well-being, consistent with theoretical models that propose mindfulness as a foundational capacity underlying various psychological benefits [56, 57].

Mindfulness enhancement in athletic populations is significant, given the complex attention demands inherent in competitive sports [58, 59]. Tennis requires sustained attention over extended match durations, selective attention to relevant environmental cues, and the ability to switch attention between tactical planning and motor execution [60, 61]. The substantial improvements in mindfulness observed suggest that MAC training effectively developed these attention regulation capabilities, providing a foundation for enhanced performance and psychological functioning [62, 63].

4.3 Passion Regulation Effects

The study represents one of the first investigations to demonstrate the effects of mindfulness interventions on passion regulation in athletic populations. Participants showed large increases in harmonious passion ($d = 1.31$) alongside very large decreases in obsessive passion ($d = 2.04$), indicating more adaptive motivational orientations toward tennis engagement [64, 65]. Notably, despite beginning with markedly higher obsessive passion scores (23.73 vs. 18.00), MAC participants finished the intervention below the control group's post-test level (16.27 vs. 18.41), underscoring the magnitude and clinical relevance of the MAC-induced reduction in maladaptive passion. These changes have meaningful consequences for long-term athlete development, as research consistently shows that harmonious passion predicts sustained motivation, improved performance, and greater life satisfaction [27, 66, 67]. Conversely, obsessive passion is associated with an increased risk of burnout, compromised well-being, and inflexible behavioral patterns that may undermine career longevity [22, 68, 69].

The passion regulation effects likely resulted from values clarification exercises that helped participants distinguish between intrinsically motivated tennis engagement and externally controlled participation [70, 71]. MAC training emphasized autonomous choice and personal meaning in tennis involvement, potentially supporting internalization processes that promote the development of harmonious rather than obsessive passion [44, 72]. These findings suggest that MAC interventions may offer preventive benefits against athlete burnout and career termination; however, longitudinal research is required to evaluate such possibilities [73, 74].

4.4 Psychological Well-being Enhancement

Subjective well-being improved substantially ($d = 1.78$), with composite scores rising markedly from baseline to post-intervention. These improvements included both affective (increased positive affect and decreased negative affect) and cognitive (enhanced life satisfaction) components, indicating comprehensive psychological benefits [75, 76]. The well-being enhancements likely resulted from multiple MAC components operating synergistically, including stress reduction through acceptance training, meaning enhancement through values clarification, and improved emotional regulation through mindfulness practice [76, 77].

Enhanced psychological well-being represents a particularly valuable outcome for competitive athletes, who face elevated risks for anxiety, depression, and other mental health challenges [78, 79]. The comprehensive well-being improvements observed suggest that MAC training may offer protective benefits against psychological distress while simultaneously enhancing positive functioning [80–82]. These dual benefits align with contemporary well-being models that emphasize both symptom reduction and the enhancement of positive psychology [83, 84].

4.5 Clinical and Practical Implications

The study findings support the implementation of the MAC protocol in competitive tennis settings, with several practical considerations for coaches, sport psychologists, and athletes. First, the intervention proved feasible within existing training schedules, requiring only 45 minutes per week without disrupting normal coaching activities [85, 86]. Second, group-based delivery proved effective and cost-efficient, suggesting scalable implementation for tennis academies and clubs [87]. Third, the comprehensive benefits observed across performance, mindfulness, passion, and well-being domains indicate that MAC training addresses multiple athlete development priorities simultaneously.

Tennis coaches may particularly benefit from MAC training principles in their daily interactions with athletes. Understanding acceptance-based approaches can help coaches avoid reinforcing control-oriented strategies that may paradoxically increase performance anxiety and emotional distress [88–90]. Sport psychologists working with tennis players should consider MAC protocols as evidence-based alternatives to traditional cognitive-behavioral approaches, especially for athletes who respond poorly to control-oriented interventions [91, 92].

Study Limitations

Several limitations warrant consideration. First, no follow-up assessment was conducted, preventing evaluation of the durability of intervention effects; future studies should include assessments at 3- and 6-month intervals. Second, the sample consisted exclusively of male tennis players, limiting generalizability to female athletes and mixed-sex populations [93, 94]. Third, all secondary outcomes relied on self-report measures, introducing shared-method variance and social desirability bias [95–97]; future studies should incorporate objective or physiological indicators where possible. Fourth, the passive control condition prevents attribution of effects to MAC-specific components versus general attention, social interaction, or expectancy factors; an active control condition (e.g., relaxation training) would strengthen causal inference [98, 99]. Fifth, tennis serve performance was assessed via coach ratings rather than objective biomechanical measures; although inter-rater reliability was acceptable ($ICC = 0.87$), future studies should incorporate motion-capture or ball-tracking technologies [100, 101]. Sixth, no systematic adverse-event monitoring was conducted; future RCTs should prospectively assess potential negative effects of mindfulness training, including increased anxiety or emotional dysregulation in vulnerable athletes. Seventh, the significant baseline differences observed in mindfulness ($p = .002$), obsessive passion ($p < .001$), and subjective well-being ($p = .032$) represent a major interpretive limitation; future studies should employ analysis of covariance (ANCOVA) with baseline scores as covariates to statistically control for pre-existing group differences. Finally, data on training hours per week, competitive level, and age of starting tennis were not systematically collected at baseline, preventing full pre-randomization equivalence testing; future studies should document and compare these variables to strengthen randomization reporting.

Future Research Directions

Several research priorities arise from these findings. Longitudinal investigations should evaluate the effects of MAC interventions across competitive seasons and multiple years to establish the durability of benefits and optimal retraining schedules [102, 103]. Mechanism studies should examine the mediating pathways linking MAC components to observed outcomes, potentially including neuroimaging investigations of attention-related brain networks [104, 105]. Dose-response research should determine the optimal intervention intensity, duration, and maintenance requirements for different athlete populations [106, 107].

Cross-cultural validation studies should examine the effects of MAC interventions across diverse athletic populations, with particular attention to cultural factors that may moderate their responsiveness [108, 109]. Gender-specific investigations should

evaluate whether observed benefits generalize to female athletes, who may exhibit different passion patterns and well-being profiles [110, 111]. Sport-specific adaptations should be developed and evaluated for tennis variants (singles vs. doubles) and other racquet sports with similar psychological demands [112, 113].

5. Conclusions

This randomized controlled study shows that the MAC intervention can significantly improve both athletic performance and psychological health in competitive tennis players. After a seven-week MAC training program, players experienced notable gains in tennis serve accuracy, mindfulness, harmonious passion, and overall well-being, while obsessive passion levels declined. These results underscore the effectiveness of acceptance-based psychological methods in addressing performance and mental health issues in competitive sports.

The findings support the idea that mindfulness and acceptance help improve attention control, emotional flexibility, and engagement driven by personal values in sports. By shifting athletes' focus from trying to control internal experiences to accepting them and committing to meaningful actions, MAC training may help athletes perform better under pressure and develop healthier motivation patterns. The simultaneous rise in harmonious passion and decrease in obsessive passion suggest that MAC can support more sustainable and adaptable athlete development.

Practically, the intervention was feasible within usual training routines and can be carried out by sport psychologists and coaches as part of comprehensive athlete support programs. Adding mindfulness-based mental training to tennis development can boost both performance and psychological well-being. Future research should examine how long these benefits last, include larger and more diverse groups, and explore the mechanisms that mediate the relationship between mindfulness training, passion regulation, and performance. Such studies will help clarify how mindfulness-based approaches can be used as reliable tools for enhancing athlete performance and mental health..

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