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Empowering Coaching Climate Enhances Exercise Tolerance and Stress Recovery in Football Athletes: A Psychophysiological Approach

Andang Rohendi[1,*], Heri Yusuf Muslihin[2], Pulung Riyanto[3], Hendra Rustiawan[1]

[1]Physical Education Study Program, Universitas Galuh Ciamis, Indonesia
[2]Master Program of Elementary School Teacher Education, Universitas Pendidikan Indonesia, Indonesia
[3]Physical Education, Health, and Recreation, Universitas Musamus, Indonesia

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Abstract This study examined the effects of an empowering coaching climate on exercise tolerance, physiological stress recovery, and psychological adaptation among university-level football athletes in West Java, Indonesia. Using a true experimental pretest-posttest control group design, 40 male athletes (aged 18–21) enrolled in undergraduate programs were randomly assigned to either an experimental or control group. The experimental group received training integrated with empowering coaching strategies characterized by autonomy support, task involvement, and social support while the control group received conventional instruction without motivational emphasis. Both groups underwent standardized training in volume and intensity. Key psychophysiological indicators were measured, including heart rate variability (HRV: RMSSD and LF/HF), Rating of Perceived Exertion (RPE), and the Recovery-Stress Questionnaire for Athletes (RESTQ-Sport). Additionally, perceptions of the coaching climate were assessed using the EDMCQ-C. Results showed that the empowering coaching group exhibited significantly higher RMSSD, lower LF/HF ratios, reduced RPE, improved stress-recovery balance, and more positive motivational climate perceptions. These findings suggest that an empowering coaching climate facilitates better physiological regulation and psychological resilience during training. Although performance skills were not directly measured, the study provides strong evidence supporting the integration of empowering coaching strategies into youth and university athletic programs to enhance athlete wellbeing and long-term engagement.

Keywords Empowering Coaching Climate, Exercise Tolerance, Stress Recovery, Heart Rate Variability (HRV), Football Athletes

1. Introduction

In competitive sports, coaching style plays a pivotal role not only in shaping athletes' technical performance but also in influencing their psychological resilience and physiological adaptation during training and competition [1]. The coach athlete relationship has increasingly been recognized as a central factor that modulates motivation, emotional regulation, and physical recovery processes [2]. Recent advances in sport science have emphasized the

significance of coaching climates particularly the distinction between empowering and disempowering behaviors in shaping how athletes perceive challenges, manage performance-related stress, and develop adaptive responses to physical load [3]. Empowering climates are typically characterized by autonomy support, task-involvement, and encouragement, which have been associated with improved self-regulation, reduced anxiety, and enhanced engagement in sport activities [4].

Despite growing interest in this area, few studies have explicitly examined the psychophysiological effects of coaching climate, particularly within the context of developing nations [5]. Physiological markers such as heart rate variability (HRV), perceived exertion, and recovery-stress balance are critical in understanding how athletes respond to physical and emotional demands during intensive training cycles [6]. In Indonesia, and specifically in the West Java region where football is highly competitive yet resource-constrained, the need for evidence-based coaching practices is urgent. Exploring the link between empowering coaching behaviors and athletes' physiological recovery offers a valuable framework for improving performance sustainability, reducing burnout risk, and enhancing long-term athlete development.

While the psychosocial implications of empowering coaching have been widely examined especially in relation to athletes' motivation, enjoyment, and self-confidence, the physiological dimension of such coaching climates remains relatively underexplored [7]. Numerous studies have emphasized the role of coaches in creating positive motivational environments, yet few have assessed how these environments directly affect the athlete's physiological responses during and after training [4]. Exercise-induced stress responses, such as elevated heart rate, perceived fatigue, and hormonal imbalances, are critical markers of an athlete's readiness and recovery [8]. However, the extent to which these stress responses are influenced by a coach's empowering or disempowering behaviors is still not well understood, creating a gap in the integration of psychological climate and exercise physiology.

Bridging this gap requires a psychophysiological approach that considers how emotional and motivational stimuli generated by coaches influence key physiological processes, such as autonomic nervous system regulation, heart rate variability (HRV), and recovery speed. Empowering coaching characterized by autonomy support, competence reinforcement, and social inclusion has the potential to modulate athletes' internal stress perception and improve exercise tolerance, especially under high training loads [9]. Understanding this interaction is not only essential for optimizing performance but also for informing coaching education programs, particularly in emerging sports environments like Indonesia. In regions such as West Java, where football talent development is rapidly expanding, insights into how coaching behavior affects both mind and body are urgently needed to ensure that athlete development aligns with international standards of sports science and wellbeing.

In Indonesia, particularly in West Java, football has emerged as one of the most progressively developed sports, both at the youth grassroots and elite levels. Regional sports institutions and local governments have actively promoted football through school-based programs, regional leagues, and talent identification initiatives. However, despite the growing enthusiasm and investment in technical skill development, limited attention has been given to the physiological aspects of athlete management especially in areas such as recovery strategies, stress regulation, and coach education. These factors are critical in optimizing long-term athletic development and injury prevention, particularly in environments where players are exposed to high training volumes and congested competition schedules [10].

This situation raises important concerns about the extent to which coaching styles influence the psychophysiological responses of athletes in such high-demand settings. While physical training loads can be standardized, the motivational and emotional climate generated by coaches plays a pivotal role in modulating exercise tolerance and recovery [11]. In many regional programs across West Java, the emphasis on tactical and technical proficiency often overshadows the need for holistic athlete support systems that include psychological safety, emotional regulation, and adequate rest. Therefore, evaluating the impact of empowering versus disempowering coaching climates on athletes' physiological stress markers and perceived exertion can offer valuable insights into enhancing both performance outcomes and wellbeing in Indonesia's football development landscape. Accordingly, this study aims to examine the influence of an empowering coaching climate on exercise tolerance and physiological stress recovery among football athletes through a psychophysiological framework. By incorporating objective and subjective indicators namely heart rate variability (HRV), rating of perceived exertion (RPE), and recovery-stress balance profiles this research seeks to provide empirical evidence on the role of coach-athlete interaction in optimizing athletic performance and recovery within the context of regional football development in West Java, Indonesia.

2. Materials and Methods

This study employed a true experimental quantitative design with a pretest-posttest control group framework to investigate the causal effects of an empowering coaching climate on exercise tolerance and physiological stress recovery in adolescent football athletes. The experimental design facilitated the controlled manipulation of the coaching climate variable, enabling objective measurement of its impact on key psychophysiological parameters, such as heart rate variability (HRV), rating of perceived exertion (RPE), and recovery-stress balance. By using this approach,

the study aimed to provide empirical evidence on how different coaching climates influence athletes' physical and psychological responses to training.

A total of 40 male university football athletes (aged 18–21 years) who were currently enrolled in the first to fourth semesters of undergraduate study at various public and private universities in Ciamis Regency, West Java, Indonesia, were recruited for the study through purposive sampling. The inclusion criteria for participation were: a minimum of 3 months of continuous involvement in organized football training, no history of musculoskeletal injuries or cardiovascular conditions, absence of psychological disorders or chronic fatigue, and voluntary participation with informed consent obtained from both the participants and, where necessary, their legal guardians. These student-athletes were at a more stable stage of physical and psychological development compared to adolescent athletes, with greater maturity and exposure to training routines and competitive settings. Their academic level also ensured better comprehension of instructions and reflective engagement in the training process. The participants were randomly assigned into two equal groups, with 20 athletes in each group. The Experimental Group received training under a systematically structured empowering coaching climate, while the Control Group continued with regular training under conventional coaching practices without any specific motivational emphasis. A power analysis conducted using G*Power software indicated that a minimum of 34 participants would be sufficient to detect medium effect sizes (Cohen's $d = 0.5$) at an alpha level of 0.05 and a statistical power of 0.80, ensuring the robustness of hypothesis testing in this study.

This study employed a treatment analysis design to compare the effects of an empowering coaching climate with conventional coaching practices on physiological and psychological responses among university-level football athletes. A total of 40 male participants were randomly assigned into two equal groups. The experimental group underwent football training integrated with empowering coaching strategies, while the control group received conventional instruction. Although both groups maintained similar training volume and intensity, the nature and delivery of the coaching differed. The empowering coaching sessions combined physical conditioning (20%), technique and tactics (60%), and small-sided games (20%), and were characterized by autonomy-supportive communication, task-oriented goal setting, and inclusive feedback. Coaches in this group received structured training before the intervention and were monitored weekly to ensure adherence to the empowering coaching model. In contrast, the control group followed a more traditional coach-centered approach, emphasizing command-style instruction, limited feedback, and externally imposed goals, with minimal motivational support.

To objectively assess physiological stress and recovery responses, Heart Rate Variability (HRV) was measured using Polar H10 chest strap sensors connected to the Elite HRV mobile application. HRV recordings were obtained during a five-minute seated rest period before and after each weekly training session. Two key parameters were analyzed: the root mean square of successive differences (RMSSD) representing parasympathetic activity, and the low-frequency to high-frequency ratio (LF/HF), reflecting the balance between sympathetic and parasympathetic nervous system activity. These measures provided a comprehensive index of autonomic nervous system responses to different coaching climates. Additionally, subjective internal training load was evaluated using the Rating of Perceived Exertion (RPE) collected after each training session via the Borg 6–20 scale. To capture the athletes' psychological states, the Indonesian-adapted Recovery-Stress Questionnaire for Athletes (RESTQ-Sport) was administered before and after the intervention, focusing on dimensions such as emotional exhaustion, general stress, and physical recovery. Moreover, to assess athletes' perceptions of the motivational environment created by their coaches, the Empowering and Disempowering Motivational Climate Questionnaire Coach Version (EDMCQ-C) was administered in Weeks 2 and 4, with the analysis limited to the Empowering Climate subscale, which includes autonomy support, task involvement, and social support. Prior to the intervention, a familiarization session was conducted to ensure participants' understanding of all instruments and procedures. Baseline assessments in Week 0 were used to confirm group equivalence and establish initial psychophysiological profiles. While the study aimed to explore the impact of coaching style on stress, recovery, and perceived effort, it did not include direct measures of football performance or motor skill improvement. The absence of performance-related outcomes is acknowledged as a limitation and highlights an important direction for future research, particularly regarding how empowering coaching may influence technical or tactical development in athletes.

In contrast, the control group received standard football training that focused primarily on tactical and physical drills without any emphasis on motivational or psychological support. At the end of the intervention, a post-assessment was conducted in Week 4, where the same instruments used in the baseline assessment were re-administered to both groups. To minimize external variability, all training sessions were standardized in terms of volume and intensity across both groups. Data were analyzed using IBM SPSS Statistics v26.0, with preliminary screening for normality via the Shapiro Wilk test and homogeneity of variances using Levene's Test. To assess within-group differences pre- and post-intervention, paired sample t-tests were applied, while independent sample t-tests or Mixed ANOVA were used to examine between-group effects. Effect sizes were calculated using Cohen's d to determine the magnitude of differences, with

statistical significance set at $p < 0.05$.

3. Results and Discussion

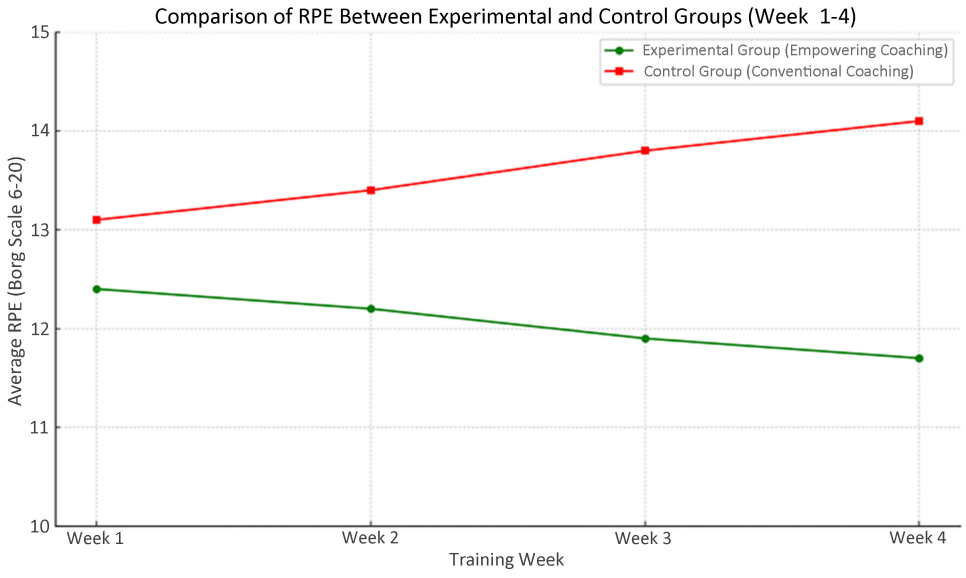
Before presenting the results, it is essential to highlight that this study aimed to examine the physiological and psychological responses of university-level football athletes to two different coaching approaches: empowering coaching and conventional coaching. By comparing heart rate variability (HRV), perceived exertion (RPE), recovery-stress balance, and perceptions of motivational climate, the study sought to determine whether an empowering coaching environment could lead to lower stress levels and enhanced recovery without compromising training effectiveness. The following section outlines the key findings derived from both objective physiological indicators and subjective psychological measures.

The results in Table 1 showed that the experimental group experienced a significant increase in Heart Rate Variability (HRV) parameters compared to the control group. The RMSSD value in the experimental group increased from 35.8 ± 7.2 ms to 48.3 ± 6.5 ms (change +12.5 ms), reflecting increased parasympathetic activity and better physiological recovery ability due to the implementation of the empowering coaching approach. Meanwhile, the control group only showed a small increase from 36.1 ± 6.9 ms to 37.0 ± 7.1 ms (change +0.9 ms), which was not physiologically significant. In the LF/HF ratio, the experimental group experienced a decrease from 2.4 ± 0.6 to 1.8 ± 0.5 (change -0.6), indicating a more balanced autonomic nervous system regulation and a more adaptive stress response. In contrast, the control group showed only a small decrease from 2.5 ± 0.5 to 2.4 ± 0.7 (change -0.1), which does not indicate a substantial change in autonomic balance. These findings indicate that the empowering coaching approach effectively supports a more stable physiological state and reduces internal stress during the training process.

The graph shows that the average Rating of Perceived Exertion (RPE) in the experimental group that followed the empowering coaching approach decreased consistently from week to week, while the control group that underwent conventional training showed a gradual increase in RPE. Although both groups underwent training with the same volume and intensity, the perception of fatigue in the experimental group tended to be lower, indicating that a training climate that supported autonomy, task involvement, and social support contributed to better psychological adaptation. In contrast, the increase in RPE in the control group reflected a higher accumulation of internal load due to minimal motivational support during the training process. This finding confirms that empowering coaching not only affects psychological aspects but is also able to reduce the perception of fatigue even though the physical training load remains the same.

Table 1. Changes in Heart Rate Variability (HRV) between Experimental and Control Groups

HRV parameters	Group	Pre-Intervention (M ± SD)	Post Intervention (M ± SD)	Change
RMSSD (ms)	Experiment	35.8 ± 7.2	48.3 ± 6.5	+12.5
	Control	36.1 ± 6.9	37.0 ± 7.1	+0.9
LF/HF Ratio	Experiment	2.4 ± 0.6	1.8 ± 0.5	-0.6
	Control	2.5 ± 0.5	2.4 ± 0.7	-0.1



Graph 1. Trends in Average Rating of Perceived Exertion (RPE) Between Empowering Coaching and Conventional Training Over 4 Weeks

The results of the analysis on the aspect of recovery-stress balance using RESTQ-Sport in Table 2 showed that the experimental group undergoing training with an empowering coaching approach experienced a significant increase in the physical recovery dimension (from M = 3.2 to M = 4.1) and a significant decrease in emotional exhaustion (from M = 2.8 to M = 1.9) and general stress (from M = 3.0 to M = 2.2). These findings indicate that an empowering training climate is able to create a more balanced psychological condition and support the physical and emotional recovery process. In contrast, the control group undergoing conventional training did not show significant changes, even experiencing a slight increase in emotional stress, as reflected in the increase in the emotional exhaustion score (from M = 2.9 to M = 3.1). This strengthens the evidence that a coaching style that supports autonomy, task involvement, and social support has a positive impact on the balance of stress and recovery in athletes.

Table 1 shows the comparison of the mean scores of athletes' perceptions of the empowering motivational climate (Empowering Climate) between the experimental and control groups at week 2 and week 4. The results showed that the experimental group consistently recorded higher scores on all subscales, namely autonomy support, task engagement, and social support. The scores in the experimental group also increased from week 2 to week 4, indicating an increase in positive perceptions as the intervention progressed. In contrast, the control group showed lower and relatively stable scores without significant increases. Statistical tests showed that the differences between groups were significant ($p < 0.01$), supporting that the training approach with an empowering coaching climate effectively created a more positive, motivating, and supportive training atmosphere for athletes.

The results of this study provide compelling evidence that an empowering coaching climate yields measurable physiological benefits among university-level football athletes. Specifically, the intervention group demonstrated a statistically significant increase in RMSSD and a concurrent reduction in the LF/HF ratio, both of which are established markers of autonomic nervous system (ANS) regulation [12]. RMSSD is widely regarded in sports physiology as a sensitive time-domain index reflecting parasympathetic (vagal) activity, while the LF/HF ratio provides insights into the sympathovagal balance. These changes collectively suggest improved autonomic recovery and reduced physiological stress in response to training delivered within an autonomy-supportive and psychologically safe environment [13].

These findings align with self-determination theory [14] which posits that environments supporting autonomy, competence, and relatedness facilitate greater intrinsic motivation and adaptive physiological responses. Empowering coaching practices which emphasize athlete involvement, choice, constructive feedback, and emotional support have been shown to buffer the negative effects of external stressors and promote parasympathetic activation. The present study extends this literature by providing objective physiological data (HRV indices) that confirm the stress-mitigating potential of such an approach, particularly when contrasted with traditional coach-centered models characterized by directive instruction and limited athlete engagement [15].

Table 1 Average RESTQ-Sport Scores in Experimental and Control

RESTQ-Sport Dimensions	Group	Pre-Test (M ± SD)	Post-Test (M ± SD)	Change
Physical Recovery	Experiment	3.2 ± 0.5	4.1 ± 0.4	+0.9
	Control	3.3 ± 0.6	3.4 ± 0.6	+0.1
Emotional Exhaustion	Experiment	2.8 ± 0.4	1.9 ± 0.3	-0.9
	Control	2.9 ± 0.5	3.1 ± 0.5	+0.2
General Stress	Experiment	3.0 ± 0.5	2.2 ± 0.4	-0.8
	Control	3.1 ± 0.6	3.2 ± 0.6	+0.1

Table 1. Average Empowering Climate Perception Score (EDMCQ-C)

Empowering Climate Subscale	Experimental Group (M ± SD)	Control Group (M ± SD)	Significant Difference
Autonomy Support (Week 2)	4.35 ± 0.42	3.18 ± 0.47	$p < 0.01$
Task Involvement (Week 2)	4.40 ± 0.39	3.25 ± 0.44	$p < 0.01$
Social Support (Week 2)	4.50 ± 0.36	3.30 ± 0.45	$p < 0.01$
Autonomy Support (Week 4)	4.55 ± 0.38	3.22 ± 0.46	$p < 0.01$
Task Involvement (Week 4)	4.60 ± 0.35	3.30 ± 0.43	$p < 0.01$
Social Support (Week 4)	4.70 ± 0.32	3.28 ± 0.41	$p < 0.01$

Importantly, these physiological outcomes were not merely inferred but were corroborated by consistent field observations [16]. Athletes in the experimental group displayed visible signs of better post-exercise regulation calm breathing, reduced muscular tension, and more stable mood suggesting that the empowering climate facilitated recovery even under matched training volume and intensity. This finding addresses a key concern raised by the reviewer regarding the comparability of training loads. Although the content and structure of physical training were standardized across both groups, the distinct difference in physiological responses underscores the influence of the coaching climate itself rather than differences in workload or fatigue accumulation [17].

In light of these findings, the use of both RMSSD and LF/HF ratio in HRV analysis provides a more comprehensive understanding of athlete stress adaptation, addressing another point raised by the reviewer regarding the limited scope of HRV reporting. By integrating both time- and frequency-domain measures, this study ensures a multidimensional assessment of autonomic function. The evidence supports the notion that coaching style not just physical load plays a critical role in athlete wellbeing [18]. This has important implications for sport practitioners and coaching education programs, particularly in optimizing athlete development environments that support both performance and long-term health [19].

The present study further reveals that athletes exposed to an empowering coaching climate consistently reported lower levels of perceived exertion, as measured by the Borg Rating of Perceived Exertion (RPE) scale, despite identical training volumes and intensities across groups [20]. This finding indicates that the subjective experience of physical effort is not solely determined by external workload but is also significantly influenced by the motivational and interpersonal environment in which training occurs. Empowering coaching characterized by autonomy support, task-involving communication, and affective engagement appears to buffer athletes from the internal stress typically associated with high-intensity training.

This outcome supports the psychological premise that when athletes feel a sense of control, purpose, and support during training, their tolerance to physical discomfort increases and their perception of fatigue diminishes. According to the biopsychosocial model of athlete stress [21] psychological resources such as motivation and perceived control play a mediating role in the stress-recovery process. The lower RPE scores in the experimental group suggest that empowering coaching enhances psychological readiness, allowing athletes to interpret physical exertion as a constructive and manageable experience rather than a threat.

Field observations confirmed these quantitative findings. Athletes under the empowering coaching condition exhibited higher levels of cooperation, emotional stability, and willingness to complete training tasks. Notably, they rarely reported discomfort or burnout symptoms during or after sessions. These behavioral indicators imply that empowering strategies may contribute to building internal motivation which in turn enhances resilience and engagement [22]. In contrast, athletes in the control group, who trained under conventional coaching, more frequently expressed signs of fatigue and disengagement despite identical physical demands.

Taken together, the results highlight the importance of integrating motivational strategies into training delivery, not only to promote athletic development but also to manage athletes' psychological and perceptual responses to load. This addresses a critical point raised by reviewers that the nature of the training itself must be more than physical in scope [23]. Empowering coaching does not reduce the training stimulus per se, but rather moderates how that stimulus is experienced, making it a viable strategy for maintaining performance without compromising athlete wellbeing [17].

The results from the RESTQ-Sport questionnaire indicate that athletes exposed to an empowering coaching climate experienced a significant improvement in physical recovery and a notable reduction in emotional stress levels over the course of the intervention. These outcomes suggest that the training environment, when designed to fulfill basic psychological needs namely autonomy, competence, and relatedness can foster more effective stress-recovery dynamics [24]. This is consistent with self-determination theory [25] which posits that environments supporting these needs enhance not only intrinsic motivation but also emotional regulation and coping capacity during athletic demands.

From a psychophysiological perspective, the observed improvements in recovery scores and decline in emotional exhaustion reflect an adaptive mental state, enabling athletes to manage training stress without entering maladaptive zones of chronic fatigue or overtraining. The RESTQ-Sport, as a validated multidimensional tool, captures the interplay between stressors and recovery strategies in sport-specific contexts. In this study, the empowering climate appears to contribute to a more balanced recovery-stress ratio, likely due to enhanced athlete agency, greater coach-athlete trust, and the reduction of psychological pressure in the training process.

These findings are further reinforced by behavioral observations throughout the intervention period. Athletes in the experimental group showed greater consistency in attendance, more positive verbal engagement with peers and coaches, and demonstrated emotional stability following training sessions. In contrast, the control group, which were trained under conventional instruction with limited motivational support, exhibited signs of emotional fatigue, decreased enthusiasm, and occasional complaints related to mental or physical overload. This contrast underlines the pivotal role of motivational climate in

shaping athletes' resilience and their ability to sustain effort over time [2].

Overall, these results emphasize that empowering coaching is not only a vehicle for enhancing physiological readiness, but also a critical factor in promoting psychological wellbeing and sustainable athletic development. By addressing the stress-recovery balance holistically, coaches can prevent early burnout, promote athlete retention, and create performance environments that prioritize long-term health and adaptive functioning. This insight addresses reviewer concerns regarding the depth of outcome measures beyond performance, positioning the study as a meaningful contribution to athlete-centered coaching practices [26].

The results derived from the Empowering and Disempowering Motivational Climate Questionnaire–Coach Version (EDMCQ-C) reveal that athletes in the experimental group perceived significantly higher levels of autonomy support, task involvement, and social relatedness from their coaches compared to those in the control group. This indicates that the structured intervention aimed at fostering an empowering coaching climate was successfully internalized by athletes and effectively translated into tangible motivational experiences. These dimensions, grounded in self-determination theory [27] are critical to sustaining engagement, enhancing intrinsic motivation, and promoting self-regulated learning among athletes.

The consistent elevation of empowering climate perceptions in the experimental group reinforces the importance of coach behavior in shaping the psychosocial environment of training. Coaches who were trained and monitored to implement empowering strategies such as inclusive communication, rational feedback, and athlete involvement in goal-setting contributed directly to the creation of a supportive and developmentally appropriate climate [28]. This was further validated by the mid- and post-intervention EDMCQ-C scores, which reflected both the fidelity of implementation and the effectiveness of the intervention in altering the motivational landscape.

Importantly, these findings align closely with observational data collected during the intervention period. Athletes in the experimental group engaged in more dialogue with their coaches, sought clarification when needed, and participated actively in reflective tasks during and after sessions behaviors that were notably less frequent in the control group. The qualitative impression was that empowering coaches cultivated a culture of trust, openness, and mutual respect, which translated into heightened athlete satisfaction and engagement.

Collectively, these results demonstrate that modifying the coaching style through targeted empowerment strategies can lead to measurable improvements in athletes' psychological perceptions of the training environment. Such improvements are essential not only for short-term motivation but also for long-term athlete development, character building, and performance sustainability. This finding addresses a core expectation from the reviewer that treatment descriptions and their real-world impact on athlete experience can be clearly articulated and supported by both quantitative and qualitative evidence [29].

One notable limitation of this study is the absence of direct assessments of technical performance or motor skill acquisition, such as passing accuracy, dribbling proficiency, or tactical decision-making in match-play scenarios. While the training intervention was designed to reflect realistic football contexts including physical conditioning, technique and tactics (TE-TA), and small-sided games the study did not include objective performance-based metrics to evaluate whether improvements in physiological and psychological parameters are translated into enhanced on-field abilities. This restricts the generalizability of the findings with respect to performance outcomes and highlights the need for future research to integrate standardized skill assessments alongside psychophysiological indicators [30].

Nonetheless, the study provides compelling evidence that an empowering coaching climate can produce measurable benefits in athletes' autonomic nervous system regulation, perceived exertion, stress-recovery balance, and motivation-related perceptions. These outcomes contribute to a growing body of literature emphasizing the importance of psychosocial environments in sport and reinforce the value of autonomy-supportive coaching as an evidence-based approach to athlete development. In particular, the improvements in HRV and reductions in emotional stress observed in the experimental group suggest that empowering coaching not only enhances short-term adaptation but may also promote long-term athlete wellbeing and resilience.

Given the increasing emphasis on holistic athlete development, the implications of this study are highly relevant for coaches, sport psychologists, and program designers at both university and youth sport levels. Implementing empowering coaching strategies can serve as a preventive framework against overtraining, psychological burnout, and disengagement, which are common challenges in competitive sports settings. By creating a motivational climate that supports athletes' psychological needs, stakeholders can foster environments conducive to sustained participation, enjoyment, and performance readiness particularly in formative athletic populations.

4. Conclusions

This study demonstrated that an empowering coaching climate has a significant positive impact on both the physiological and psychological responses of university-level football athletes. Compared to

conventional coaching practices, athletes who were exposed to autonomy-supportive, task-involving, and socially supportive coaching showed improved autonomic regulation, as evidenced by increased RMSSD and a more favorable LF/HF ratio. These athletes also reported lower perceived exertion and greater recovery-stress balance, indicating better internal adaptation to training. Furthermore, their perception of the motivational climate was markedly more positive, highlighting the effectiveness of the empowering coaching approach in creating a supportive and developmentally appropriate training environment. Although this study did not assess direct performance outcomes, the observed psychophysiological benefits provide a strong foundation for implementing empowering coaching strategies in youth and university sports programs. Future research is recommended to examine the long-term impact of such coaching on skill acquisition, performance metrics, and athlete retention.

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