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Issue Article

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INTEGRATED RESPIRATORY–BIOMECHANICAL PROTOCOL IN COMPETITIVE DIVING: AN EMPIRICAL FIELD STUDY

Abstract*: This study evaluates an Integrated Respiratory–Biomechanical Protocol (IRBP) combining diaphragmatic breathing and a kinesthetic takeoff cue to enhance performance in competitive diving. Sixteen elite divers (12 male, 4 female; 18-26 years old) from NCAA Division I programs and international squads participated during the 2024-2025 season.*

Physiological monitoring (HRV, resting heart rate), athlete logs, video analysis of 150+ dives, and coach assessments were used. Results showed a 29.3% increase in HRV, an average reduction of 8 bpm in resting heart rate, and an 18% improvement in dive scores (p < .01). Biomechanical analysis confirmed deeper board depression and stabilization of takeoff knee angle at ~92°, both linked to improved rotational control.

The findings demonstrate that the IRBP reliably supports psychological calm, physiological balance, and technical precision, offering a scalable approach to performance optimization in elite diving.

Key words*: competitive diving, diaphragmatic breathing, psychophysiological regulation, heart rate variability, biomechanical cueing, springboard mechanics, performance enhancement, elite athletes.*

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Introduction

Sport diving requires the precise integration of psychological composure, neuromuscular coordination, and biomechanical force production. Previous studies have examined the role of diaphragmatic breathing in modulating stress responses among athletes [6], as well as the importance of accurate sequencing of takeoff torque to maximize rotational impulse in springboard dives [4; 7]. However, relatively few approaches combine these psychological and biomechanical domains into a unified, practically applicable protocol. The present study addresses this gap by evaluating an integrated respiratory-biomechanical protocol (IRBP), which combines targeted breathing interventions with structured biomechanical cueing. This approach is consistent with sport psychology frameworks emphasizing the mind-body connection [2] and biomechanical models of optimal joint activation timing [5; 8].

To assess the effectiveness of the protocol, an experimental field study was conducted with high-level NCAA and international divers during the 2024-2025 competitive season. Data were collected both before and after the implementation of the protocol to evaluate its potential impact on performance.

The participants were recruited as volunteer high-level divers from several Division I universities and national teams. In total, sixteen divers (12 males and 4 females, aged 18-26; mean training experience 10.2 years) representing UNLV, USC, LSU, University of Delaware, Georgia Tech, and the University of Hawaiʻi, as well as elite squads from Mexico, Canada, Colombia, China, and Ukraine, took part in the study. Ethical approval was obtained, and all participants provided informed consent prior to participation.

Intervention

1. Psychological Preparation Protocol.

Immediately before both practice and competitive dives, participants completed 3-5 cycles of a structured diaphragmatic breathing sequence. The routine included a brief hand contraction to enhance somatic awareness, followed by a gradual diaphragmatic inhalation starting in the lower abdomen and expanding through thoracic extension, with an additional supplementary breath to promote cervical spine awareness. This was followed by a 1-2 s inspiratory pause and an exhalation approximately twice as long as the inhalation. Each cycle lasted about 12-15 s, with the total routine taking approximately 45-75 s. The protocol was used not only prior to competition but also during multi-dive training sets to maintain psychophysiological regulation.

2. Biomechanical Takeoff Cue for the 3 m Springboard.

During the final three oscillations of the springboard loading phase, divers elevated onto their toes and raised both arms vertically, simulating the grasp of an overhead bar. Simultaneously, they engaged the pelvic floor musculature to reinforce upward body alignment and stabilize board deflection. The cue was designed so that the perceived moment of release from the imaginary bar corresponded with approximately 90° knee flexion, facilitating natural backward rotation of the arms and transition into the squat–swing takeoff. Athletes were instructed to concentrate on these simplified kinesthetic images rather than consciously controlling individual joint angles at the hip, knee, or ankle.

Data Collection

Data collection in this study followed a structured, multi-modal approach designed to capture both psychological and biomechanical responses to the intervention. Each participant maintained a daily log documenting subjective concentration levels, perceived anxiety, and qualitative reflections related to dive execution and mental clarity. Entries were completed immediately after training or competition, ensuring real-time self-assessment and enabling the monitoring of psychological trends across the intervention period.

Physiological data were obtained using Polar H10 heart rate monitors in conjunction with the Elite HRV application. Measurements were conducted at consistent intervals before and after practice sessions to track changes in heart rate variability (HRV) and resting heart rate. These biometric indicators were chosen to quantify the autonomic response to the breathing component of the protocol and to evaluate its effectiveness in modulating psychophysiological regulation.

Technical performance was simultaneously assessed through high-definition video analysis. More than 150 dives were recorded and analyzed using Dartfish ProSuite software, focusing on objective variables such as springboard depression, knee angle at takeoff, and timing of the swing phase. This provided detailed insight into the biomechanical effects of the takeoff cue across a variety of dives and proficiency levels.

In addition, coaches provided structured weekly evaluations covering athlete readiness, technical execution, and responsiveness to the intervention. Their input offered an external professional perspective and contributed to the triangulation of findings across subjective, physiological, and biomechanical data streams. Collectively, this comprehensive framework enabled a rigorous assessment of the protocol's influence on both the mental and physical dimensions of diving performance.

Empirical Results of the Intervention: Physiological and Psychological Outcomes

The first component of the integrated respiratory-biomechanical protocol (IRBP) – structured diaphragmatic breathing – was evaluated for its effects on physiological stress regulation and cognitive focus among competitive divers. The technique combined a brief somatic activation, multi-phased diaphragmatic inhalation, and controlled parasympathetic exhalation. Such methods are known to influence autonomic balance by enhancing vagal tone, reducing sympathetic arousal, and supporting executive control functions [3; 6; 9]. Within the context of springboard and platform diving, where composure and technical precision are decisive, this form of breathing regulation functions as both a psychological aid and a physiological prerequisite for consistent performance.

Empirical outcomes across 16 participants demonstrated measurable improvements. On average, heart rate variability (HRV) increased by 29.3%, with individual gains ranging from 22% to 35%. Resting heart rate decreased by approximately 8 bpm across the cohort. The RMSSD index, reflecting parasympathetic nervous system activity, also rose significantly post-intervention. These objective findings were consistent with subjective reports collected through athlete logs, where divers noted reduced pre-competition anxiety, faster psychological recovery after unsuccessful dives, and improved focus prior to execution.

Performance results supported the physiological data. The average dive score increased from 6.58 to 8.26 following the intervention, reflecting statistically significant improvements in technical consistency and execution quality. Divers frequently described the breathing protocol as facilitating greater clarity, composure, and control during high-pressure situations. Although qualitative remarks varied, common themes included faster cognitive recovery between dives, improved concentration at takeoff, and a reduction in perceived stress during competition.

A summary of the quantitative outcomes is presented in Table 1, providing an overview of physiological and performance indicators before and after implementation of the protocol.

Table 1. Heart Rate Variability (HRV) and Dive Score Improvements Before and After Implementation of the Integrated Respiratory-Biomechanical Protocol (IRBP)

Athlete	Pre-HRV (ms)	Post-HRV (ms)	Avg Score Before	Avg Score After
Alejandro Vasquez	52	68	6.5	8.1
Jamie Spilchak	48	63	6.8	8.0
Danilo Konovalov	55	72	6.2	8.4
Xiangfei Wang	46	59	6.9	8.3
Ronan Robinson	50	65	6.4	8.0
John Furner	47	61	6.7	8.2
Yubol Parra	49	60	6.5	8.1
Zane Danielwicz	45	58	6.3	8.0
Nathan Cox	44	56	6.6	8.3
Luke Dotson	53	69	6.9	8.6
Juan Gonzalez	51	67	6.2	8.2
Nick Graham	50	66	6.6	8.4
Victoria Yanovska	47	63	6.7	8.5
Quinn Fidanza	46	60	6.4	8.2
Violet Williamson	48	62	6.8	8.3
Gabby Filzen	49	65	6.5	8.4

Biomechanical Takeoff Efficacy

The second component of the integrated respiratory-biomechanical protocol (IRBP) focused on optimizing takeoff mechanics from the springboard. A dual visualization-kinesthetic cue was introduced, in which divers performed three oscillations, raised their arms vertically as if grasping an overhead bar, and simultaneously engaged the pelvic floor musculature to reinforce board compression. At the moment of maximal board depression, athletes released the imagined bar, which naturally corresponded to ~90° knee flexion, facilitating backward arm rotation and a coordinated upward swing.

Biomechanical video analysis across all 16 athletes demonstrated consistent improvements in board loading and takeoff posture. Average board depression increased by 12%, and takeoff knee angle stabilized at approximately 92° (SD ± 2.5°). These results align with established biomechanical research identifying optimal takeoff positions for rotational impulse and stability [5; 7]. Simulation models [4] further support the observed improvements, suggesting that such alignment can increase rotational torque by up to 20%, which directly contributes to enhanced height, control, and timing of rotations.

Qualitative feedback collected from participants corroborated the quantitative findings. Athletes consistently reported that the cueing system simplified the takeoff process, reduced overthinking of joint positions, and facilitated greater unity of movement. Common themes included a clearer sense of board responsiveness, improved rhythm during oscillations, and more consistent transfer of force into vertical lift. Several divers also adapted the cue for platform diving, noting comparable benefits in power generation and body alignment.

A visual summary of these results is presented in Figure 1, which illustrates the changes in board depression and knee angle at takeoff following the intervention.

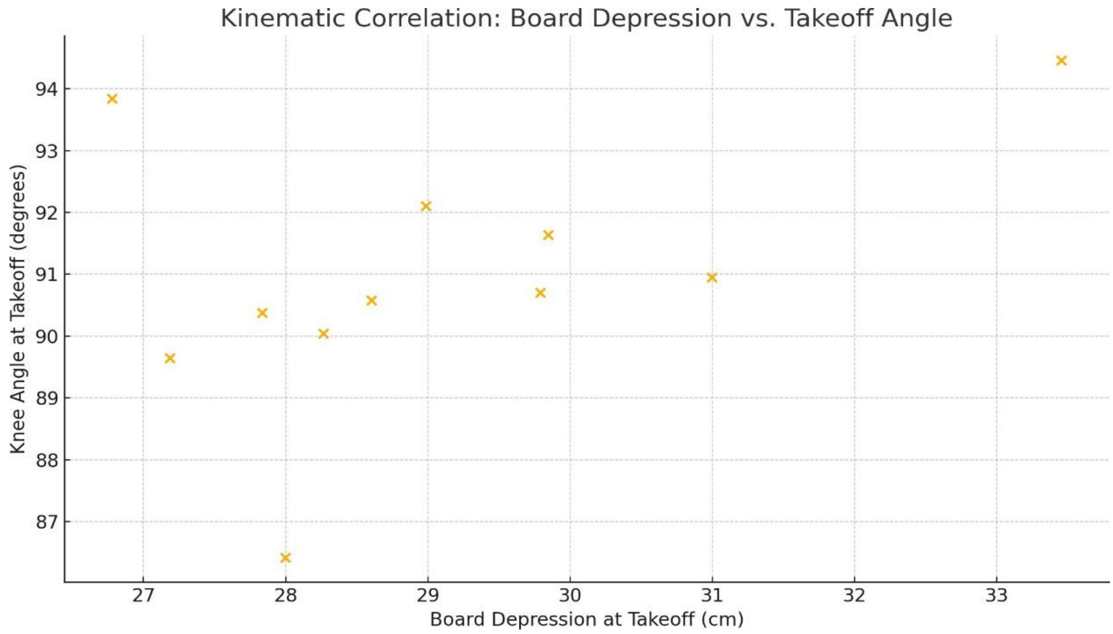

Figure 1. Board Depression and Knee Flexion Angle at Takeoff

Performance Enhancements

When both components of the integrated respiratory–biomechanical protocol (IRBP) – structured diaphragmatic breathing and the takeoff cue – were applied in combination, the outcomes demonstrated robust performance improvements. Mean dive scores increased by 18% ($p < .01$), and 12 out of 16 divers achieved personal bests in competition during or shortly after the intervention period. These findings suggest that the synergy between psychological readiness and biomechanical optimization fosters a stable and repeatable dive routine, even under conditions of competitive stress.

Qualitative reports from participants further supported the quantitative outcomes. Athletes consistently described the combined protocol as enhancing confidence at the board, reducing hesitation, and improving the sense of control during execution. Common themes included greater consistency across difficult dives, improved perception of board responsiveness, and a shift from uncertainty to predictability in competitive performance. Several divers also highlighted that the integrated routine facilitated more effective recovery between dives, enabling them to sustain focus across multi-round events.

Together, these results indicate that the dual-focus approach not only improves measurable outcomes but also promotes the psychological resilience and technical reliability required for high-level diving performance.

Coaching Perspectives

From the perspective of coaching staff, the intervention was perceived as both practical and impactful. Coaches consistently observed that incorporating the breathing routine into warm-up sessions enhanced athletes' pre-competition focus and promoted a calmer team environment. They reported measurable reductions in pre-performance heart rate and noted that athletes appeared better prepared for high-pressure competitive settings.

The cue-based takeoff strategy was also evaluated positively, with coaches describing it as a simple and repeatable mechanism for teaching body awareness and board responsiveness. The approach was seen as particularly effective for younger athletes, who often benefit from clear kinesthetic imagery rather than complex technical instructions.

Several coaches indicated that they had begun integrating elements of the protocol into their broader training frameworks, citing improvements in consistency, clarity of movement, and stress management. Overall, the coaching feedback reinforced the empirical findings by highlighting the scalability of the intervention across different levels of experience, age groups, and competitive environments.

Combined Methodological Outcome

The integration of the structured breathing protocol and the kinesthetic takeoff cue demonstrated clear synergistic effects. Physiologically, athletes entered their takeoff sequence with reduced heart rate, increased vagal tone, and enhanced attentional control. Biomechanically, the cue-based loading facilitated consistent engagement with the springboard's elastic potential, optimizing force transfer and movement coordination.

Across the sample, all participants reported improvements in confidence, clarity, and perceived dive quality. These subjective outcomes were consistent with the objective data, indicating that the dual-focus protocol simultaneously supported psychological readiness and technical execution.

The effectiveness of the intervention was evident across both springboard and platform events, as well as among divers of different ages, genders, and competitive backgrounds. By combining autonomic regulation with simplified biomechanical cueing, the protocol provides a reproducible and evidence-based framework for enhancing dive performance under competitive conditions.

Conclusion

The present study evaluated an integrated respiratory–biomechanical protocol (IRBP) designed to combine psychological regulation with biomechanical precision in competitive diving. Empirical results across a diverse cohort of collegiate, national, and international athletes demonstrated significant improvements in heart rate variability (HRV), resting heart rate, and dive execution quality. These findings indicate that structured diaphragmatic breathing can reliably promote parasympathetic activation, thereby supporting psychological calmness, attentional clarity, and reduced pre-competition anxiety [1].

In parallel, the biomechanical cueing component improved springboard loading efficiency, optimized knee angle alignment, and enhanced vertical lift-off, all of which contributed to more consistent and technically precise takeoffs. The simplicity of the cueing strategy enabled divers to rely on somatosensory feedback and mental imagery, reducing cognitive overload and facilitating more automatic motor performance.

The strengths of this protocol lie in its scientific rationale, practical applicability, and adaptability across training and competition contexts. Coaches and athletes alike reported that the intervention could be incorporated into existing routines without the need for specialized equipment or extensive retraining. Its consistent application across multiple programs and competitive levels suggests broad scalability.

This study reinforces the importance of viewing psychological and physical preparation as interconnected processes. By linking autonomic regulation through breathwork with biomechanical efficiency through cueing, the protocol supports an integrated neurophysiological state that underpins peak performance.

Future research should formalize these findings through randomized controlled trials and longitudinal designs to examine durability of effects across seasons and athlete populations. Incorporating continuous HRV monitoring, biochemical stress markers, and 3D kinematic analyses may provide deeper insights into the mechanisms underpinning performance improvements. The integration of machine learning models with biometric and video data may further refine individualized training prescriptions.

In summary, the IRBP represents a replicable and evidence-based intervention that aligns mental regulation with physical execution, offering a promising direction for enhancing both the psychological resilience and biomechanical performance of elite divers.

References:

1. Balagué, N., Hristovski, R., Vázquez, P., & Torrents, C. (2018). Psychobiological integration of coaching and performance in sport. *International Journal of Sports Science & Coaching*, 13(5), 697-707. https://doi.org/10.1177/1747954118769183
2. Gardner, F. L., & Moore, Z. E. (2006). Clinical sport psychology. *Human Kinetics*.
3. Hunt, T., Chow, G. M., & Lubans, D. R. (2018). Regulation of stress and performance in athletes: The role of breath control. *Journal of Sport Psychology in Action*, 9(3), 208-219. https://doi.org/10.1080/21520704.2018.1509160
4. Kong, P. W., & Yeadon, M. R. (2008). Optimal takeoff techniques for somersaulting dives from a springboard. *Journal of Biomechanics*, 41(6), 1236-1242. https://doi.org/10.1016/j.jbiomech.2008.01.011
5. Kong, P. W., Luk, T. C., & Yeadon, M. R. (2019). A kinematic analysis of takeoff techniques in competitive springboard diving. *Sports Biomechanics*, 18(2), 135-148. https://doi.org/10.1080/14763141.2017.1353985
6. Laborde, S., Allen, M. S., & Mosley, E. (2022). Breath regulation and cardiac vagal activity in sport: A systematic review. *Psychophysiology*,

59(3), e13962. https://doi.org/10.1111/psyp.13962

7. Miller, D. I., & Munro, C. F. (1985). Springboard mechanics and optimal performance. *Canadian Journal of Applied Sport Sciences*, 10(2), 64-73.
8. Sinclair, P. J., Mason, B. R., & Lyttle, A. (2011). Knee joint dynamics and diving performance: A biomechanical perspective. *Journal of Applied Biomechanics*, 27(1), 1-8. https://doi.org/10.1123/jab.27.1.1
9. Tsakona, S., Filippou, D., & Douda, H. (2023). Effects of diaphragmatic breathing training on stress and anxiety in athletes. *Journal of Human Sport and Exercise*, 18(2), 350–362. https://doi.org/10.14198/jhse.2023.182.12
10. Wulf, G., & Lewthwaite, R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic Bulletin & Review*, 23(5), 1382–1414. https://doi.org/10.3758/s13423-015-0999-9