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Research Article

Stress Dynamics in Badminton Officials Through Heart Rate Variability Cognitive Load and Coping Mechanisms

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Abstract:
Background: Badminton officials play a crucial role in ensuring fair play and accurate decision-making during competitions. However, officiating tasks are performed under high cognitive demands, time pressure, and social stressors, which can influence physiological responses and cognitive performance. Empirical evidence examining stress dynamics in badminton officials using objective physiological indicators remains limited.
Methods: This study employed a descriptive repeated-measures design involving 102 certified badminton officials during a national-level competition. Heart rate data were recorded across five conditions: early morning rest, sitting near the referee table, during game intervals, between matches, and after competition. Data were analyzed using descriptive statistics, repeated-measures ANOVA, and Bonferroni post-hoc tests to identify differences in physiological responses across officiating situations.
Result: Heart rate values increased progressively from resting conditions to peak levels during game intervals and between matches, indicating heightened physiological stress, before decreasing after the competition. Significant differences were observed across all measurement conditions ($p < .001$). Key stressors included spectator noise, high cognitive load, time pressure, and interpersonal and organizational demands. Elevated arousal levels suggested delayed physiological recovery during continuous officiating duties.
Conclusion: Badminton officiating is associated with substantial physiological stress, particularly during critical match phases. Sustained stress may negatively affect cognitive and emotional functioning. The findings highlight the importance of implementing effective coping strategies, such as controlled breathing, mindfulness, and structured recovery routines, to support officials' performance, well-being, and long-term officiating capacity.

Keywords: Badminton Officials, Decision Making, Heart Rate Variability, Mental Health, Motor Skills

1. INTRODUCTION

The role of badminton technical officials in sports is a silent but heavy one. The decisions made by them are anticipated to be quick, unbiased, and equal in all the cases, frequently in front of thousands of spectators who are watching and commenting (Sivamani et al., 2022). In badminton, where the rallies are very short and the points won are very few, the situation demands all the attention, memory, and judgment from the referee (Sivamani et al., 2023). The present research tries to explore the real physiological stress of officiating, by heart rate monitoring at different times during an official's workday to show the points where the stress increases and where it decreases.

Stress is one of the factors that can impair judgment and executive control, particularly when the decision-making process is time-specific and uncertain (Sarmiento, 2024; Pizzera et al., 2022). The heart rate variability (HRV), being an indicator of stress and autonomic balance, is closely monitored and the low HRV indicates the sympathetic nervous system dominates (Kim et al., 2018; Georgieva Tsaneva et al., 2025). The presence of a large group with loud noise and social pressure can easily distort how people perceive and what decisions they make (Samuel et al., 2025; Sors et al., 2019), and anxiety will definitely cause a loss of accuracy in officiating (Zhang et al., 2024).

Accompanying acute performance, chronic stress is a factor in mental health issues experienced by referees (Palix et al., 2025; Lindsay et al., 2025) with one of the contributing physiological pathways being the neuroendocrine reactions (Knezevic, 2023).

Collectively, all these research results indicate that badminton officiating is a very relevant context for analyzing the interplay of stress and coping strategies.

1.1 Rationale and contribution

Although there is an increasing amount of research on umpires in field sports, the badminton referees remain mostly ignored notwithstanding their distinct task demands: rapid visual tracking, highly accurate rule enforcement, and constant match transitions with almost no recovery. We proposed a straightforward and direct measurement protocol based on five realistic situations: rest, pre-match proximity to the referee table, game interval, the period between the end of one game to the start of the next, and post-competition recovery. By associating the descriptive heart rate patterns with the existing stress literature, we provide an easy-to-understand profile of when stress is at its highest, how long it lasts, and what coping practices are most applicable within the regular operations of the tournament.

1.2 Physiological Responses

Stress has a profound effect on the body, activating the sympathetic nervous system, causing heart rate to increase, and cortisol secretion to rise (Knezevic, 2023; Groombridge, 2019). Heart Rate Variability (HRV) is used as a trustworthy indicator of the status of the autonomic nervous system (Kim et al., 2018). Low HRV reveals that the parasympathetic is less active while the sympathetic is more active, which collectively leads to poor focus and decision-making. In officiating, the effect of stress might be the same as causing even one's body to become tired, anxious, and eventually, burnt out (Porcelli, 2017; Wemm, 2017).

1.3 Historical Background

Hans Selye, through his early investigations, came up with the definition of stress as a physiological reaction to changes in the environment in the course of the body's maintenance of homoeostasis. Gradually, HRV came to be acknowledged as a stress biomarker that could be evaluated non-invasively (Task Force of the ESC & NASPE, 1996). In athletics, HDR biofeedback is said to be one of the major factors that contribute to building up one's mental strength (Pagaduan et al., 2020). On the other hand, research that focuses on the officials' situation is still very limited even though stress evidence on referees and umpires as a result of cognitive load and external pressures is already well documented (Sjödin et al., 2023; Yamakawa, 2016).

2. MATERIAL AND METHOD

2.1 Participants

During a national-level competition, data were gathered from 102 officials of badminton. The officials carried out their usual responsibilities and followed their schedules; the measurements were taken without interfering with the match procedures. All the participants were qualified and had different experiences.

2.2 Procedure

Heart rate was measured in five situations:

1. Early morning resting pulse
2. Sitting freely near the referee table
3. Game interval
4. Between the end of the game to next game start
5. After competition

2.3 Analysis

Descriptive statistics were computed for each condition, individual differences among conditions were tested by repeated measures ANOVA, and Bonferroni-post-hoc comparisons, adjusted for multiple testing, were used afterward

3. RESULT AND DISCUSSION

3.1 Result

3.1.1 Descriptive Statistics

Table 1. Average Heart Rate Across Five Situations (N = 102)

Situation	M (bpm)	SD	Stress Level
Early Morning Rest	72	5	Normal
Sitting Near Referee Table	78	6	Mild Increase
Game Interval	92	7	High Stress
Between End of Game to Next Game Start	94	8	Elevated/High
After Competition	88	9	Moderate Stage

Table 2. Standard Heart Rate Ranges

Category	Range (bpm)	Interpretation
Normal	60–80	Resting baseline
Moderate	81–90	Elevated but manageable
High	≥91	Significant stress level

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3.1.2 Heart Rate Progression

The heart rates of the officials gradually increased from rest to during the games, reaching a maximum of 94 beats per minute, and then dropping to 88 beats per minute after the tournament. The trend indicates that there was some excitement left over between the games and the officials were able to recover a bit during the time of the game.

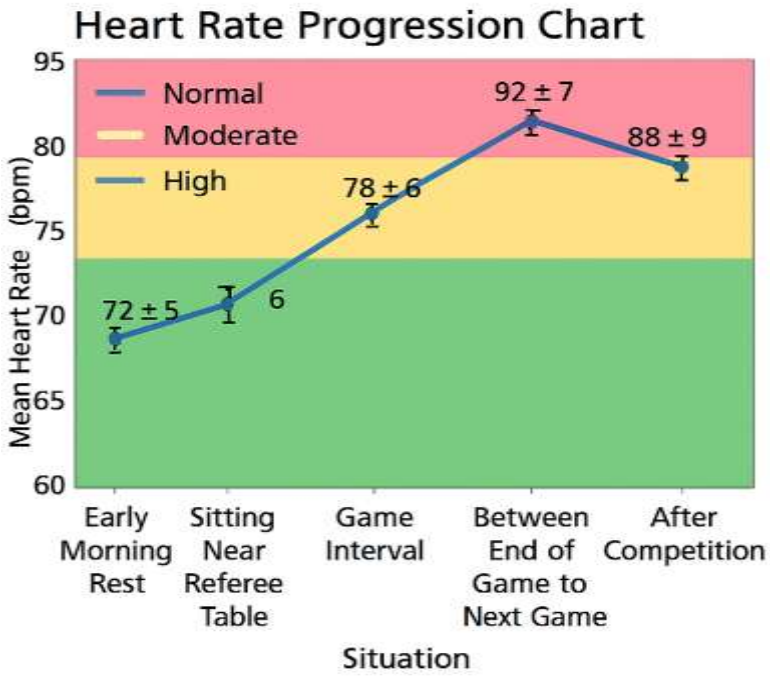

Figure 1. Heart Rate Progression Chart

Figure 1. The line chart shows a steady rise in average heart rate across the five conditions. Officials shifted from the normal zone to the moderate/high stress zone by the end of the competition.

3.1.3 Inferential Statistics

The repeated measures ANOVA verified that there were differences across the conditions, $F(4,404) = 138.26$, $p < .001$, $\eta^2 = .58$. The Bonferroni post-hoc tests indicated that all differences between the pairs were statistically significant ($p < .05$). The greatest difference occurred between the early morning rest and the between-game interval ($t = -22.61$, $p < .001$). Stress levels after the competition were significantly lower than those between games ($t = -3.06$, $p = .029$), which is in line with recovery.

3.2 Discussion

3.2.1 Stress Factors

Spectator Noise: The noise from a big crowd can alter the perception of the events and require more effort to control attention, thus raising the stress level and the risk of making mistakes during the moments that are most important (Sjödin et al., 2023; Samuel et al., 2025; Sors et al., 2019). Officials prone to higher anxiety are impacted by these disruptions to a greater extent (Zhang et al., 2024), which may be a downside of their noise-management strategies and mental skills training.

3.2.2 Cognitive Load and time pressure

The officials' obligation to impose rules at the same time as monitoring line calls and managing game flow surely strains their working memory and can lead to fatigue, which is in line with dual-process theories of decision-making under stress (Sarmiento, 2024; Pizzera et al., 2022). The rate of the heart being up during game intervals and the breaks between games are in accord with these elevated cognitive demands.

3.2.3 Interpersonal and organizational factors

According to Lishman et al. (2025), aggressive behavior from players, coaches, or fans corresponds to distraught and less favorable mental health conditions for referees. Damrah et al. (2023) and Aksu (2023) also mention that organizational settings susceptible to bias perception or peer evaluation might increase the stress level even more. Therefore, it is necessary to handle the matter of culture, education, and support systems.

3.2.4 Performance Pressure

Matches of a high level see the perceived threat and challenge to a greater extent (Kumar, P. et al., 2023). Officials' fear of making mistakes that could impact the match outcome or their future assignments correlates with the stress-induced performance impairment findings (Yu, 2024; Knezevic, 2023).

3.2.5 Negative Interactions

The presence of aggressive players, coaches, or spectators adds to the anxiety and depression. The activities of such athletes are one of the factors that irritate the officials so they take this measure to keep away from the matches with the poorly behaved athletes.

3.2.6 Interpersonal and organizational factors

Aggressive interactions among players, coaches, or spectators are associated with distress and poorer mental health outcomes among referees (Mojzisch, 2025; Lishman et al., 2025). The organizational contexts—like perceived bias risks or peer scrutiny—can further increase the pressure (Damrah et al., 2023; Aksu, 2023). To make things right, culture, training, and support systems should be addressed.

3.2.7 Impact of Stress (Physiological mechanisms)

Autonomic shifts associated with stress cause a decrease in HRV and an increase in arousal that subsequently affect the level of alertness and the stability of decisions made (Kim et al., 2018; Georgieva Tsaneva et al., 2025). One of the reasons why extended arousal between matches and its slow dissipation post-competition are observed is the neuroendocrine pathways, particularly the cortisol responses that have been advocated for this (Knezevic, 2023; Palix et al., 2025).

3.2.8 Coping strategies and practical guidance

As per the studies (Pagaduan et al., 2020; Storniolo et al., 2025), mindfulness and paced breathing can stabilize attention as well as balance autonomic nervous system during intervals. Tournament operations allow structured pre-match and between-game routines such as quiet zones, visual checks, and brief breathing sets. Aksu (2023) states that cognitive reframing and peer support reduce anticipatory anxiety, whereas training updates and well-defined organizational procedures can prevent stress right at the source.

4. CONCLUSION

During competitions, badminton officials undergo gradual stress and the highest point of stress occurs during the game intervals and between games. Then their stress level drops after the competition. The sources of stress are noise, cognitive demands, interpersonal conflicts, and organizational pressures. However, stress not only affects performance and health but also coping strategies, such as mindfulness, breathing exercises, and structured routines can help reduce the stress's impact. It is recommended that future studies combine HRV metrics and recovery time to be able to optimize scheduling and on-site support. Providing the officials with training and psychological interventions is vital for the continued fair play and well-being.

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6. AUTHOR CONTRIBUTION STATEMENT

KP conceptualized the study, designed the methodology, supervised data collection, and prepared the original draft of the manuscript. RPA and JB contributed to data collection, statistical analysis, and interpretation of results. PK and SD assisted in literature review, manuscript organization, and critical revision of the content. GS and AL supported data processing, visualization, and validation of findings. KTP contributed to theoretical framing, discussion refinement, and final manuscript review. All authors read and approved the final version of the manuscript.

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REFERENCE

Aksu, A. (2023). Investigation of the relationship between methods of coping with stress and psychological resilience levels of referees. *Anemon Muş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, 11, 377–389. https://doi.org/10.18506/anemon.1317359

Damrah, Z., Muthahari, Z., Pitnawati, D. T., Astuti, Y., Zulbahri, & Ilham. (2023). Court tennis referee decision making: How does mastery of game rules, stress management, and concentration affect it? *International Journal of Human Movement and Sports Sciences,* 11(5), 1020–1027. https://doi.org/10.13189/saj.2023.110510

Georgieva-Tsaneva, G., Tsanev, Y.-A., Dechev, M., & Cheshmedzhiev, K. (2025). Impact on competitive performance and assessment of fatigue and stress based on heart rate variability. *Applied Sciences,* 15(20), 10892. https://doi.org/10.3390/app152010892

Groombridge, C. J., Kim, Y., Maini, A., Smit, D.V., & Fitzgerald, M.C. (2019). Stress and decision-making in resuscitation: A systematic review. *Applied Sciences*, 144, 115-122. https://doi.org/10.1016/j.resuscitation.2019.09.023

Lishman, T., Shannon, S., McDevitt-Petrovic, O., Breslin, G., & Brick, N. E. (2025). The impact of abuse experiences and coping responses on distress and mental health outcomes in sports officials. *International Journal of Sport and Exercise Psychology*, *23*(7), 1234-1255. https://doi.org/10.1080/1612197X.2024.2389218

Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H., & Koo, B. H. (2018). Stress and heart rate variability: A meta-analysis and review of the literature. *Psychiatry Investigation*, 15(3), 235–245. https://doi.org/10.30773/pi.2017.08.17

Knezevic, E.; Nenic, K.; Milanovic, V.; Knezevic, N.N. The Role of Cortisol in Chronic Stress, Neurodegenerative Diseases, and Psychological Disorders. (2023). Cells, 12, 2726. https://doi.org/10.3390/ cells12232726

Kumar, P., Singh, R. R. M., Ajithkumar, L., Thilagam, P. K., & Tiroumourougane, K. (2023). Comprehensive scientific examination of leg length discrepancy in junior badminton players. *Journal of Physical Education and Sport*, *23*(10), 2804-2812. https://doi.org/10.7752/jpes.2023.10320

Lindsay, R., Walton, C. C., Kittel, A., McNeil, D. G., Larkin, P., Spittle, M., & Cosh, S. M. (2025). The mental health of sporting officials: A systematic review and meta-analysis. *Sports Medicine*, 55, 3059–3091. https://doi.org/10.1007/s40279-025-02315-1

Mojzisch, A., Bahr, J.H., Roswag, M., Häusser, J.A. (2025). Effects of Acute Stress on Group Decision-Making: Taking Stock and Looking Ahead. *Gruppe. Interaktion. Organisation. Zeitschrift für angewandte Organisationspsychologie*, 56, 523–536. https://doi.org/10.1007/s11612-025-00824-1

Pagaduan, J. C., Chen, Y. S., Fell, J. W., & Wu, S. S. X. (2020). Can heart rate variability biofeedback improve athletic performance? A systematic review. *Journal of Human Kinetics*, 73, 103–114. https://doi.org/10.2478/hukin-2020-0004

Palix C, Chauveau L, Felisatti F, Chocat A, Coulbault L, Hébert O, Mézenge F, Landeau B, Haudry S, Fauvel S, Collette F, Klimecki O, Marchant NL, De La Sayette V, Vivien D, Chételat G, Poisnel G and the Medit-Ageing Research Group. (2025). Allostatic load, a measure of cumulative physiological stress, impairs brain structure but not β-accumulation in older adults: an exploratory study. *Front. Aging Neurosci*. 17:1508677. https://doi.org/10.3389/fnagi.2025.1508677

Porcelli, A.J., Delgado, M.D. (2017). Stress and Decision Making: Effects on Valuation, Learning, and Risk-taking. *HHS Public Access*. 14, 33–39. https://doi.org/10.1016/j.cobeha.2016.11.015

Pizzera, A., Laborde, S., Lahey, J., & Wahl, P. (2022). Influence of physical and psychological stress on decision-making performance of soccer referees. *Journal of sports sciences*, *40*(18), 2037-2046. https://doi.org/10.1080/02640414.2022.2127516

Sarmiento, L.P., Cunha, P.L.D., Tabares, S., Tafet, G., Gouveia Jr., A. (2022). Decision-Making Under Stress: A Psychological and Neurobiological Integrative Model. *Brain, Behavior, & Immunity-Health*, *9*(4), 1–13.

https://doi.org/10.1016/j.bbih.2024.100766

Samuel, R. D., Galily, Y., & Hochman, G. (2025). The "silent" noise: moving forward from bias to noise in football referees' decision-making. *International Journal of Sport and Exercise Psychology*, 1-26. https://doi.org/10.1080/1612197X.2025.2453462

Sivamani, P. Kumar, & P. Kasthuri Thilagam. (2022). The Basic Facts of Badminton Game: An Overview S. Sivamani1,. *Asian Pacific Journal of Health Sciences*, *38*, 100–102. https://doi.org/10.21276/apjhs.2022.9.4S.45

Sivamani, P. Kumar, & P. Kasthuri Thilagam. (2023). Physical Fitness Training and Psychological Strategies for Improving Swimming Performance. *Indian Journal of Natural Sciences, 14(80*), 60814-60824. https://www.researchgate.net/publication/375029503.

Sjödin, F., Felder, H., Holmström, S., & Fahlström, M. (2023). Hearing the roar: Spectator noise and umpires stress in major badminton tournaments. *International Journal of Racket Sports Science*, 5(1), 57–64. https://doi.org/10.30827/ijrss.33249

Sors, F., Grassi, M., Agostini, T., & Murgia, M. (2019). Pressing crowd noise impairs the ability of anxious basketball referees to make accurate decisions. *Frontiers in Psychology*, 10, 2380. https://doi.org/10.3389/fpsyg.2019.02380

Storniolo, J. L., Correale, L., Buzzachera, C. F., & Peyré-Tartaruga, L. A. (2025). Editorial: New perspectives and insights on heart rate variability in exercise and sports. *Frontiers in Sports and Active Living, 7, 1574087.* https://doi.org/10.3389/fspor.2025.1574087

Wemm, S.E., Wulfert, E. (2018). Effects of Acute Stress on Decision Making. *HHS Public Access*. 14, 42(1): 1–12. https://doi.org/10.1007/s10484-016-9347-8

Yamakawa, K., Ohira, H., Matsunaga, M., & Isowa, T. (2016). Prolonged Effects of Acute Stress on Decision-Making under Risk: A Human Psychophysiological Study. Front. *Hum. Neurosci*. 10:444. https://doi.org/10.3389/fnhum.2016.00444

Yu, R. (2024). Stress Potentiates Decision Biases: A Stress Induced Deliberation-To Intuition (SIDI) Model. *Neurobiology of Stress*, 3. http://dx.doi.org/10.1016/j.ynstr.2015.12.006

Zhang, L., Shi, H., Zhang, H., Ding, J., & Wang, Z. (2024). How do anxiety and stress affect soccer referees? An ERPs study. *Frontiers in Psychology*, 15, 1294864. https://doi.org/10.3389/fpsyg.2024.1294864