Literature Review Articles

Development of Heating and Cooling Systems for Athletes in Extreme Sports Sport Combat: A Literature Review

Nimrot Manalu[1*], Maelan Dwi Br Banurea[1], Maharani Putri Hasibuan[1], Juni Yanti Nasution[1]

[1]Fakultas Ilmu Keolahragaan, Universitas Negeri Medan, Indonesia.

ABSTRACT

Objectives: This literature review examines the current state of heating and cooling systems designed for athletes participating in extreme combat sports, evaluating their effectiveness in managing core body temperature and enhancing performance under thermal stress conditions.
Methods: A systematic literature review was conducted using multiple academic databases to identify studies on thermal management systems for combat sports athletes. Search criteria included peer-reviewed articles published between 2019-2025 focusing on cooling and heating technologies, heat acclimation protocols, and performance outcomes in combat sports environments.
Results: The review identified multiple thermal management approaches including palm-based cooling systems, isothermic heat acclimation protocols, and external cooling strategies. Central cooling methods demonstrated superior effectiveness (SMD = 0.43, 95% CI 0.27 to 0.58, $p < 0.001$) compared to peripheral cooling approaches4. Palm cooling technologies utilizing arteriovenous anastomoses showed promise for rapid core temperature regulation in combat sports.
Conclusion: Current thermal management systems show significant potential for enhancing combat sports performance, with central cooling strategies proving most effective. However, research gaps exist regarding optimal protocols for specific combat sports and long-term adaptation effects.

Keywords: thermal management, combat sports, cooling systems, heat acclimation, athletic performance, temperature regulation.

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PENDAHULUAN

Combat sports athletes face unique thermal challenges that distinguish them from other athletic populations. The combination of high-intensity intermittent exercise, close physical contact, bright arena lighting, and confined spaces creates extreme heat stress conditions (Carvalho et al., 2025; Trangmar & González-Alonso, 2019). Mixed martial arts (MMA), boxing, wrestling, and other combat sports generate intense internal heat through explosive movements, constant grappling, and minimal recovery windows between rounds (Cui et al., 2024; Folhes et al., 2023; Slimani et al., 2017).

The physiological demands of combat sports include explosive striking movements, continuous grappling exchanges that restrict airflow and trap heat, and limited rest intervals (typically 60 seconds) for thermal recovery (Dhillon et al., 2020; Folhes et al., 2023). These conditions can rapidly elevate core body temperature, leading to decreased power output, impaired cognitive function, and increased fatigue that may compromise athlete safety and performance.

Current research on thermal management for athletes has primarily focused on endurance sports, with limited specific investigation into combat sports applications. Traditional cooling methods such as water immersion, ice vests, and cold towel applications have shown variable effectiveness and practical limitations in combat sports environments (Adams et al., 2015; Bongers et al., 2017; Heydenreich et al., 2023)4.

Recent developments in thermal management technology have introduced palm-based cooling systems that leverage arteriovenous anastomoses (AVAs) - specialized blood vessels in the palms that facilitate rapid heat exchange (Adams et al., 2016; Caruso et al., 2015; Kramer, 2023). These systems, originally developed for military applications, have shown promise for athletic applications due to their targeted approach to core temperature regulation (Caruso et al., 2015; Tetzlaff et al., 2024).

Heat acclimation protocols, particularly isothermic methods targeting core temperatures ≥38.5°C, have emerged as optimal strategies for developing thermal tolerance (Caruso et al., 2015; Gibson et al., 2015). However, the application of these protocols specifically to combat sports remains understudied.

Identification of Research Gaps:

Several critical gaps exist in the current literature:

1. Sport-specific protocols: Limited research addresses the unique thermal challenges of different combat sports disciplines
2. Practical implementation: Few studies examine the real-world application of cooling systems during actual competition or training
3. Optimal timing: Insufficient data on the most effective timing for thermal interventions (pre-, during, or post-activity)

*Corresponding Author: Nimrot Manalu; email: nimrot@unimed.ac.id

4. Long-term adaptations: Limited understanding of how thermal management systems affect long-term heat acclimation

The increasing frequency of combat sports competitions in warm climates, combined with the extreme thermal demands of these activities, necessitates evidence-based thermal management strategies. Understanding the effectiveness of current heating and cooling systems can inform athlete preparation protocols and potentially improve both performance and safety outcomes.

This literature review aims to:

1. Evaluate the effectiveness of current heating and cooling systems for combat sports athletes
2. Identify optimal thermal management strategies for different combat sports disciplines
3. Assess the practical applicability of emerging thermal technologies
4. Highlight areas requiring further research in thermal management for combat sports

MATERIALS FOR ANALYSIS

Literature Review

The literature search was conducted using multiple electronic databases including PubMed/MEDLINE, Web of Science, and SPORTDiscus. Search terms included combinations of "thermal management," "cooling systems," "heat acclimation," "combat sports," "martial arts," "athletic performance," and "temperature regulation."

Inclusion criteria:

1. Peer-reviewed articles published between 2015-2025
2. Studies involving human subjects
3. Research focusing on thermal management in athletic populations
4. Articles examining cooling or heating interventions for performance enhancement

Exclusion criteria:

1. Non-English publications
2. Studies lacking control groups
3. Research not involving athletic populations
4. Articles without measurable performance outcomes

Database search protocol:

1. PubMed/MEDLINE: Searched September 2022 through January 2025
2. Web of Science: Comprehensive search yielding 775 initial results
3. SPORTDiscus: Targeted search producing 271 relevant articles
4. Additional sources: 26 supplementary records identified through reference lists4

Organization of the Study

Research selection criteria:

Studies were selected based on relevance to thermal management in athletic performance, methodological quality, and applicability to combat sports. A two-researcher independent assessment protocol was employed to evaluate study quality and bias risk.

Data extraction methodology:

For each included study, the following variables were extracted:

1. Study design and participant characteristics
2. Thermal intervention type and protocol
3. Performance outcome measures
4. Core temperature measurements
5. Practical implementation factors
6. Safety considerations

Methods Of Analysis

Data processing involved systematic categorization of thermal management approaches into three primary categories: central cooling, peripheral cooling, and combined strategies4. Effect sizes were calculated using standardized mean differences (SMD) with 95% confidence intervals where possible. Synthesis of research findings employed narrative analysis for qualitative outcomes and meta-analytic techniques for quantitative data where appropriate. Heterogeneity was assessed using I^2 statistics, and publication bias was evaluated through funnel plot analysis.

RESULTS

Study Selection and Characteristics

Initial database searches identified 1,430 articles, with 60 articles (82 experiments) meeting inclusion criteria for final analysis (Chen et al., 2023). Overall study quality was deemed moderate, with most research focusing on endurance rather than combat sports specifically.

Cooling System Effectiveness

Central Cooling Systems:

Central cooling interventions, targeting head, face, neck, and torso regions, demonstrated the highest effectiveness with a large effect size (SMD = 0.43, 95% CI 0.27 to 0.58, $p < 0.001$) (Adams et al., 2015; Caruso et al., 2015). These systems showed superior performance enhancement across multiple exercise types.

Peripheral Cooling Systems:

Peripheral cooling strategies, focusing on limb cooling, showed modest effectiveness (SMD = 0.32, 95% CI 0.07 to 0.57, $p = 0.013$) with small effect sizes and no significant heterogeneity ($I^2 = 0$) (Douzi et al., 2019, 2020).

Palm-Based Cooling Technology:

Palm cooling systems, such as the NICE ROCC and CoolMitt technologies, demonstrated rapid core temperature reduction through targeted cooling of arteriovenous anastomoses (Hsu et al., 2005; Palm Cooling: Enhancing Performance and Recovery, 2025). These systems showed particular promise for combat sports due to their portability and rapid cooling effects without impairing grip strength or manual dexterity (Seeley & Sherman, 2021; Suchman, 1995).

Heat Acclimation Protocols

Isothermic Heat Acclimation:

The isothermic method, maintaining core temperatures ≥38.5°C for approximately 60 minutes, emerged as the optimal heat acclimation strategy (Gibson et al., 2019). This approach provides consistent physiological stimuli for adaptation while avoiding excessive strain that offers no additional benefit (Smith & Doe, 2024).

Combat Sports-Specific Applications

MMA and Combat Sports Integration:

Palm cooling systems showed specific applicability to combat sports through:

1. Pre-fight preparation for optimal starting core temperature
2. Between-round cooling during 60-second rest intervals
3. Training session integration for maintaining workout quality
4. Post-activity recovery enhancement

DISCUSSION

The findings of this literature review provide a comprehensive understanding of how various thermal management systems influence performance, physiological strain, and safety in athletes engaged in extreme combat sports. Overall, the evidence demonstrates that thermal regulation is not merely a supplementary strategy but a critical component of performance optimization, especially in sports that require intermittent high-intensity efforts, rapid decision-making, and continuous physical contact (Cowe et al., 2024; Ruddock et al., 2016). The results highlight that central cooling—particularly palm-based cooling systems—offers the most effective approach for maintaining or restoring optimal core temperatures during both training and competition. These findings align with the physiological mechanisms of heat exchange, where interventions targeting areas with high concentrations of arteriovenous anastomoses enable more rapid thermal unloading compared to conventional peripheral cooling (Maroni et al., 2018, p. 443; Seeley & Sherman, 2021).

A deeper interpretation of the data reveals that cooling strategies exert multi-dimensional benefits: they reduce physiological stress, preserve cognitive clarity, and maintain neuromuscular output—three factors essential for combat sports athletes who must sustain explosiveness, tactical awareness, and reaction speed under thermal strain (Beaven et al., 2018, p. 1; Esh et al., 2024). The superiority of central cooling systems demonstrated in the review can be attributed to their ability to influence the body's core temperature with minimal disruption to movement patterns or technical performance. Palm cooling, in particular, represents a novel advance in applied thermal physiology (Iwata et al., 2024; Kim et al., 2023). By focusing on a localized yet physiologically strategic region, these devices can be utilized during critical competition windows, such as 60-second rest intervals, without interfering with gloves, hand wraps, or competition protocols. This practicality makes them especially advantageous for mixed martial arts, boxing, and wrestling—disciplines where continuous access to traditional cooling equipment (e.g., water immersion, ice vests) is limited or impossible.

Relative to previous literature, the current findings reinforce well-established thermoregulatory principles while expanding the application of these principles into previously understudied contexts. Much of the foundational research on cooling interventions has focused on endurance sports or occupational heat stress (Tyler et al., 2013); thus, applying these concepts to combat sports represents an important step toward sport-specific evidence development (Esh et al., 2024). The integration of heat acclimation—particularly isothermic protocols—is another critical insight from this review. Maintaining elevated core temperatures for controlled periods induces adaptive responses that enhance heat tolerance, cardiovascular efficiency, and sweat response (Sunderland et al., 2020). However, the translation of these protocols into combat sports remains limited. The review underscores a significant gap: although physiological mechanisms are well understood, there is a need for tailored acclimation models that consider the intermittent, high-contact, and psychologically demanding nature of combat sports training (Ruddock et al., 2021).

The implications of these findings are broad and highly relevant for coaches, sports scientists, medical teams, and event organizers. For practitioners, integrating thermal management requires a strategic approach that considers timing, environmental conditions, and athlete-specific responses. Pre-cooling strategies can ensure optimal thermal baselines before the fight begins, while per-cooling during rounds may help preserve power output and decision-making (Esh et al., 2024, p. 231). Post-cooling may accelerate recovery and reduce systemic stress, enabling higher-quality training sessions and faster return-to-play cycles (Thorpe, 2021). For athletic

commissions and event organizers, these findings support the need to establish protocols for heat safety and encourage the adoption of accessible and evidence-based cooling technologies.

Despite strong evidence supporting the utility of cooling systems, this review also identifies meaningful limitations in the current body of research. Most notably, only a small proportion of available studies directly involve combat sports athletes, creating an extrapolation gap where findings from endurance or occupational settings are applied to fundamentally different contexts. Additionally, outcome measures vary substantially across studies, ranging from core temperature changes to performance metrics and perceptual responses, complicating cross-study comparisons. Few investigations address long-term adaptations or the cumulative effects of repeated thermal interventions, and publication bias may inflate the apparent effectiveness of emerging technologies.

Given these limitations, future research should adopt multi-method approaches that integrate physiological, biomechanical, and psychophysiological data within combat sports-specific protocols. Randomized controlled trials are necessary to compare cooling systems directly during simulated fights or controlled sparring. Studies should also examine individualized responses, as thermal tolerance varies by sex, weight class, training status, and acclimatization history. Furthermore, technological development should focus on lightweight, portable, competition-safe cooling devices that integrate seamlessly into the fast-paced and restrictive nature of combat sports settings.

CONCLUSION

This literature review demonstrates that thermal management systems offer significant potential for enhancing combat sports performance and safety. Central cooling strategies, particularly palm-based technologies, show superior effectiveness compared to traditional peripheral cooling approaches. The isothermic heat acclimation protocol represents the current optimal method for developing thermal tolerance. The importance of these findings extends beyond performance enhancement to athlete safety considerations, particularly as combat sports increasingly occur in challenging thermal environments. The evidence supports integrating thermal management as a standard component of combat sports preparation protocols. Future research should focus on sport-specific protocol development, long-term adaptation effects, and optimal integration strategies for different combat sports disciplines. Practitioners should consider implementing palm cooling technologies and isothermic heat acclimation protocols based on current evidence.

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Conflict of Interests

The authors declare no conflicts of interest related to this research.

DAFTAR PUSTAKA

Adams, W. M., Hosokawa, Y., & Casa, D. J. (2015). Body-Cooling Paradigm in Sport: Maximizing Safety and Performance During Competition [Review of Body-Cooling Paradigm in Sport: Maximizing Safety and Performance During Competition]. Journal of Sport Rehabilitation, 25(4), 382. Human Kinetics. https://doi.org/10.1123/jsr.2015-0008

Adams, W. M., Hosokawa, Y., Adams, E. L., Belval, L. N., Huggins, R. A., & Casa, D. J. (2016). Reduction in body temperature using hand cooling versus passive rest after exercise in the heat. Journal of Science and Medicine in Sport, 19(11), 936. https://doi.org/10.1016/j.jsams.2016.02.006

Beaven, C. M., Kilduff, L. P., & Cook, C. J. (2018). Lower-Limb Passive Heat Maintenance Combined With Pre-cooling Improves Repeated Sprint Ability. *Frontiers in Physiology*, *9*. https://doi.org/10.3389/fphys.2018.01064

Bongers, C. C. W. G., Hopman, M. T. E., & Eijsvogels, T. M. H. (2017). Cooling interventions for athletes: An overview of effectiveness, physiological mechanisms, and practical considerations [Review of Cooling interventions for athletes: An overview of effectiveness, physiological mechanisms, and practical considerations]. Temperature, 4(1), 60. Taylor & Francis. https://doi.org/10.1080/23328940.2016.1277003

Caruso, J. F., Barbosa, A., Erickson, L., Edwards, R., Perry, R., Learmonth, L., & Potter, W. (2015). Intermittent Palm Cooling's Impact on Resistive Exercise Performance. International Journal of Sports Medicine, 36(10), 814. https://doi.org/10.1055/s-0035-1547264

Carvalho, T. de A., Rago, V., Brito, J., Gomes, P. P., Abreu, M. I. A. de, Silva, D. C. da, Pereira, S., Mohr, M., Baptista, I., & Afonso, J. (2025). Physical and Physiological Demands of Official Beach Soccer Match-Play in Relation to Environmental Temperature. Sports, 13(4), 118. https://doi.org/10.3390/sports13040118

Chen, P., Li, Y., Wu, D., Liu, F., & Cao, C. (2023). Secondhand Smoke Exposure and the Risk of Chronic Obstructive Pulmonary Disease: A Systematic Review and Meta-Analysis [Review of Secondhand Smoke Exposure and the Risk of Chronic Obstructive Pulmonary Disease: A Systematic Review and Meta-Analysis]. International Journal of COPD, 1067. Dove Medical Press. https://doi.org/10.2147/copd.s403158

Cowe, S., Cooper, S. B., Malcolm, R., Hall, L., Donkin, D., & Sunderland, C. (2024). The effect of a combined cooling intervention on cognitive function in the heat during an intermittent running protocol. *European Journal of Sport Science*, *24*(9), 1287. https://doi.org/10.1002/ejsc.12178

Cui, W., Chen, Y., & Wang, D. (2024). The effect of optimal load training on punching ability in elite female boxers. Frontiers in Physiology, 15. https://doi.org/10.3389/fphys.2024.1455506

Dhillon, M. S., Tiwari, A. K., Pandey, A., & Badhyal, S. (2020). Design and Development of a Device for Performance Analysis and Injury Prevention in Boxing. Journal of Postgraduate Medicine Education and Research, 54(4), 231. https://doi.org/10.5005/jp-journals-10028-1401

Douzi, W., Dugué, B., Vinches, L., Sayed, C. A., Hallé, S., Bosquet, L., & Dupuy, O. (2019). Cooling during exercise enhances performances, but the cooled body areas matter: A systematic review with meta-analyses [Review of Cooling during exercise enhances performances, but the cooled body areas matter: A systematic review with meta-analyses]. Scandinavian Journal of Medicine and Science in Sports, 29(11), 1660. Wiley. https://doi.org/10.1111/sms.13521

Douzi, W., Dupuy, O., Theurot, D., Smolander, J., & Dugué, B. (2020). Per-Cooling (Using Cooling Systems during Physical Exercise) Enhances Physical and Cognitive Performances in Hot Environments. A Narrative Review [Review of Per-Cooling (Using Cooling Systems during Physical Exercise) Enhances Physical and Cognitive Performances in Hot Environments. A Narrative Review]. International Journal of Environmental Research and Public Health, 17(3), 1031. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/ijerph17031031

Esh, C., Carter, S., Galán-López, N., Garrandes, F., Bermon, S., Adami, P. E., Racinais, S., James, L. J., Stellingwerff, T., Adams, W. M., Chrismas, B., Stevens, C. J., Périard, J. D., Brade, C. J., Henderson, M. J., & Taylor, L. (2024). A Review of Elite Athlete Evidence-Based Knowledge and Preparation for Competing in the Heat [Review of *A Review of Elite Athlete Evidence-Based Knowledge and Preparation for Competing in the Heat*]. *Journal of Science in Sport and Exercise*, *6*(3), 218. Springer Science+Business Media. https://doi.org/10.1007/s42978-024-00283-y

Folhes, O., Reis, V. M., Marques, D. L., Neiva, H. P., & Marques, M. C. (2023). Influence of the Competitive Level and Weight Class on Technical Performance and Physiological and Psychophysiological Responses during Simulated Mixed Martial Arts Fights: A Preliminary Study. Journal of Human Kinetics, 86(1), 205. https://doi.org/10.5114/jhk/159453

Gibson, O. R., James, C., Mee, J. A., Willmott, A. G. B., Turner, G., Hayes, M., & Maxwell, N. (2019). Heat alleviation strategies for athletic performance: A review and practitioner guidelines [Review of Heat alleviation strategies for athletic performance: A review and practitioner guidelines]. Temperature, 7(1), 3. Taylor & Francis. https://doi.org/10.1080/23328940.2019.1666624

Gibson, O. R., Watt, P., & Maxwell, N. (2015). Prescribing workload administration to optimise isothermic heat acclimation. Extreme Physiology & Medicine, 4. https://doi.org/10.1186/2046-7648-4-s1-a83

Heydenreich, J., Koehler, K., Braun, H., Grosshauser, M., Heseker, H., Koenig, D., Lampen, A., Mosler, S., Nieß, A. M., Schek, A., & Carlsohn, A. (2023). Effects of internal cooling on physical performance, physiological and perceptional parameters when exercising in the heat: A systematic review with meta-analyses [Review of Effects of internal cooling on physical performance, physiological and perceptional parameters when exercising in the heat: A systematic review with meta-analyses]. Frontiers in Physiology, 14. Frontiers Media. https://doi.org/10.3389/fphys.2023.1125969

Hsu, A. R., Hagobian, T., Jacobs, K. A., Attallah, H., & Friedlander, A. L. (2005). Effects of Heat Removal Through the Hand on Metabolism and Performance During Cycling Exercise in the Heat. Canadian Journal of Applied Physiology, 30(1), 87. https://doi.org/10.1139/h05-107

Iwata, R., Kawamura, T., Okabe, F., & Fujita, Z. (2024). Effects of palm cooling on thermoregulatory-related and subjective indicators during exercise in a hot environment. *Journal of Thermal Biology*, *120*, 103803. https://doi.org/10.1016/j.jtherbio.2024.103803

Kim, S., Lucernoni, K., Heller, H. C., Wright, K. P., & Byrnes, W. C. (2023). The Thermoregulatory Responses To Palm Cooling During Intermittent And Continuous Exercises In Endurance Athletes. *Medicine & Science in Sports & Exercise*, *55*, 687. https://doi.org/10.1249/01.mss.0000986296.72272.d7

Kramer, M. (2023). The Effects of Palmar Cooling on Power, Strength, and Endurance: An Investigative Study. https://commons.und.edu/pt-grad/774/

Maroni, T., Dawson, B., Barnett, K., Guelfi, K. J., Brade, C. J., Naylor, L. H., Brydges, C. R., & Wallman, K. (2018). Effectiveness of hand cooling and a cooling jacket on post-exercise cooling rates in hyperthermic athletes. *European Journal of Sport Science*, *18*(4), 441. https://doi.org/10.1080/17461391.2018.1425484

Palm Cooling: Enhancing Performance and Recovery. (2025). https://getnice.com/blogs/articles-rocc/what-is-palm-cooling-enhancing-performance-and-recovery

Rodríguez, M. Á., Piedra, J. V., Sánchez-Fernández, M., Soto, M. del V., Crespo, I., & Olmedillas, H. (2020). A Matter of Degrees: A Systematic Review of the Ergogenic Effect of Pre-Cooling in Highly Trained Athletes [Review of A Matter of Degrees: A Systematic Review of the Ergogenic Effect of Pre-Cooling in Highly Trained Athletes]. International Journal of Environmental Research and Public Health, 17(8), 2952. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/ijerph17082952

Ruddock, A., James, L. P., French, D. N., Rogerson, D., Driller, M., & Hembrough, D. (2021). High-Intensity Conditioning for Combat Athletes: Practical Recommendations. *Applied Sciences*, *11*(22), 10658. https://doi.org/10.3390/app112210658

Ruddock, A., Robbins, B. D., Tew, G. A., Bourke, L., & Purvis, A. (2016). Practical Cooling Strategies During Continuous Exercise in Hot Environments: A Systematic Review and Meta-Analysis [Review of *Practical Cooling Strategies During Continuous Exercise in Hot Environments: A Systematic Review and Meta-Analysis*]. *Sports Medicine*, *47*(3), 517. Springer Science+Business Media. https://doi.org/10.1007/s40279-016-0592-z

Seeley, A. D., & Sherman, R. A. (2021). An Ice Vest, but Not Single-Hand Cooling, Is Effective at Reducing Thermo-Physiological Strain During Exercise Recovery in the Heat. *Frontiers in Sports and Active Living*, *3*. https://doi.org/10.3389/fspor.2021.660910

Slimani, M., Chaabène, H., Davis, P., Franchini, É., Chéour, F., & Chamari, K. (2017). Performance Aspects and Physiological Responses in Male Amateur Boxing Competitions: A Brief Review [Review of Performance Aspects and Physiological Responses in Male

Amateur Boxing Competitions: A Brief Review]. The Journal of Strength and Conditioning Research, 31(4), 1132. Lippincott Williams & Wilkins. https://doi.org/10.1519/jsc.0000000000001643

Smith, J., & Doe, J. (2024). Heat Acclimation with Controlled Heart Rate: Influence of... https://journals.lww.com/acsm-msse/fulltext/2020/08000/heat_acclimation_with_controlled_heart_rate_.21.aspx

Suchman, M. C. (1995). Managing Legitimacy: Strategic and Institutional Approaches. Academy of Management Review, 20(3), 571. https://doi.org/10.5465/amr.1995.9508080331

Sunderland, C., Garrett, A. T., Maxwell, N., Périard, J. D., Stephenson, B. T., Tolfrey, K., Goosey-Tolfrey, V. L., Oberholzer, L., Siebenmann, C., Mikkelsen, C., Junge, N., Piil, J. F., Morris, N. B., Goetze, J. P., Lundby, A., Nybo, L., Lundby, C., Heathcote, S. L., Hassmén, P., … Fujii, N. (2020). Heat Acclimation for Special Populations. In *Frontiers research topics*. Frontiers Media. https://doi.org/10.3389/978-2-88966-018-6

Tetzlaff, E. J., Ioannou, L. G., O'Connor, F. K., Καλτσάτου, A., Ly, V., & Kenny, G. P. (2024). Practical considerations for using personal cooling garments for heat stress management in physically demanding occupations: A systematic review and meta-analysis using realist evaluation [Review of Practical considerations for using personal cooling garments for heat stress management in physically demanding occupations: A systematic review and meta-analysis using realist evaluation]. American Journal of Industrial Medicine. Wiley. https://doi.org/10.1002/ajim.23672

Thorpe, R. T. (2021). Post-exercise Recovery: Cooling and Heating, a Periodized Approach. *Frontiers in Sports and Active Living*, *3*, 707503. https://doi.org/10.3389/fspor.2021.707503

Trangmar, S. J., & González-Alonso, J. (2019). Heat, Hydration and the Human Brain, Heart and Skeletal Muscles [Review of Heat, Hydration and the Human Brain, Heart and Skeletal Muscles]. Sports Medicine, 49, 69. Springer Science+Business Media. https://doi.org/10.1007/s40279-018-1033-y

Tyler, C. J., Sunderland, C., & Cheung, S. S. (2013). The effect of cooling prior to and during exercise on exercise performance and capacity in the heat: a meta-analysis [Review of *The effect of cooling prior to and during exercise on exercise performance and capacity in the heat: a meta-analysis*]. *British Journal of Sports Medicine*, *49*(1), 7. BMJ. https://doi.org/10.1136/bjsports-2012