

Original article. Thermal Stress and Athletic Performance: Lived Experiences of Student-Athletes in a Tropical Climate. Vol. 11, n. ° 3; p. 1-24, July 2025. <https://doi.org/10.17979/sportis.2025.11.3.11544>

Thermal stress and athletic performance: lived experiences of student-athletes in a tropical climate

Estrés térmico y rendimiento deportivo: experiencias vividas de estudiantes-atletas en un clima tropical

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Editorial schedule: Article received 27/12/2024 Accepted: 09/04/2025 Published: 01/07/2025

<https://doi.org/10.17979/sportis.2025.11.3.11544>

To cite this article use the following reference:

Panganiban, T.D.C. (2025). Thermal Stress and Athletic Performance: Lived Experiences of Student-Athletes in a Tropical Climate. Sportis Sci J, 11 (3), 1-24
<https://doi.org/10.17979/sportis.2025.11.3.11544>

Author contribution: The author was solely responsible for all aspects of this research, including conceptualization, design, data collection, analysis, interpretation of the results, and writing of the manuscript. There were no external contributions to the conduct of this study (The author solely conducted all aspects of this research, including the conceptualization, design, data collection, analysis, interpretation of results, and manuscript writing. No external contributions were involved in the completion of this study).

Funding: This research did not receive funding during its conduct. However, the author will receive publication incentives upon successful publication, in accordance with institutional policies.

Conflict of interest: The author declares no conflict of interest.

Ethical aspects: The study declares the ethical aspects.

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Abstract

Thermal stress significantly impacts the health, performance, and well-being of student-athletes, particularly in tropical climates like the Philippines. This study explores the lived experiences of student-athletes at Batangas State University The National Engineering University (BatStateU TNEU) regarding thermal stress and its physiological, psychological, and systemic dimensions. Using a phenomenological qualitative approach, data were gathered through semi-structured interviews with 15 participants from various outdoor sports disciplines. Results revealed that thermal stress manifests through physical symptoms such as dehydration and fatigue, alongside psychological challenges like frustration and reduced focus. Athletes relied on personal coping mechanisms, including hydration and scheduling adjustments, but identified gaps in institutional support, particularly the lack of cooling facilities and educational initiatives. The study underscores the need for a holistic health and performance optimization framework that integrates individual strategies, advanced technologies, and systemic interventions to safeguard athletes' well-being and performance. This framework is vital for addressing the multidimensional impacts of thermal stress, enhancing resilience, and fostering sustainable athletic participation in high-temperature environments.

Keywords: thermal stress, student-athletes, tropical climate, physiological impact, psychological resilience, health optimization framework

Resumen

El estrés térmico afecta significativamente la salud, el rendimiento y el bienestar de los estudiantes-atletas, especialmente en climas tropicales como el de Filipinas. Este estudio explora las experiencias vividas por los estudiantes-atletas de la Batangas State University The National Engineering University (BatStateU TNEU) en relación con el estrés térmico y sus dimensiones fisiológicas, psicológicas y sistémicas. Utilizando un enfoque cualitativo fenomenológico, se recopilaban datos a través de entrevistas semiestructuradas con 15 participantes de diversas disciplinas deportivas al aire libre. Los resultados revelaron que el estrés térmico se manifiesta a través de síntomas físicos como la deshidratación y la fatiga, junto con desafíos psicológicos como la frustración y la disminución de la concentración. Los atletas dependieron de mecanismos de afrontamiento personales, incluyendo la hidratación y ajustes en los horarios, pero identificaron deficiencias en el apoyo institucional, particularmente la falta de instalaciones de enfriamiento e iniciativas educativas. El estudio destaca la necesidad de un marco integral de optimización de la salud y el rendimiento que integre estrategias individuales, tecnologías avanzadas e intervenciones sistémicas para proteger el bienestar y el rendimiento de los atletas. Este marco es esencial para abordar los impactos multidimensionales del estrés térmico, mejorar la resiliencia y fomentar una participación atlética sostenible en entornos de altas temperaturas.

Palabras clave: estrés térmico, estudiantes-atletas, clima tropical, impacto fisiológico, resiliencia psicológica, marco de optimización de la salud

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Introduction

Thermal stress has become an increasingly significant issue for athletes, particularly those training and competing in tropical climates such as the Philippines. For student-athletes at Batangas State University The National Engineering University (BatStateU TNEU), prolonged exposure to high environmental temperatures during physical activities can lead to both short-term and long-term negative health consequences. This exposure, combined with intense physical exertion, may result in conditions such as heat exhaustion, dehydration, or more severe forms of heat illness like exertional heat stroke (Périard et al., 2021). In fact, research consistently shows that the risk of heat-related illnesses is significantly higher in athletes who train and compete under extreme heat conditions, which can compromise both their health and athletic performance (Casa et al., 2022). The physiological demands of heat stress, coupled with the challenges posed by the psychological and environmental factors in tropical settings, present a complex issue for sports programs and athletes alike.

The consequences of thermal stress are not only physical but also psychological. While physiological responses to heat are well-documented, including thermoregulatory processes like sweating, increased heart rate, and peripheral vasodilation, the psychological toll of these stressors often goes underexamined. Athletes may experience mental fatigue, decreased focus, and even emotional distress, all of which further hinder performance (Norton et al., 2023). The psychological burden of heat stress is compounded by the fact that athletes often push their physical limits to meet the demands of their sport, sometimes at the expense of their health and well-being (Wendt et al., 2020). Understanding how these athletes perceive and cope with thermal stress is crucial for developing targeted interventions that address both the physical and mental aspects of heat exposure.

The importance of investigating the lived experiences of student-athletes under conditions of heat stress is underscored by the increasing emphasis on athlete safety, particularly in environments prone to heat stress. In university-level sports, where resources and support structures may vary, athletes often have to manage thermal stress on their own, without sufficient guidance or intervention strategies (Christopher et al., 2024). This gap in knowledge about how student-athletes experience heat stress,

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particularly in tropical climates, has made it difficult to formulate effective health and performance optimization strategies that are specifically tailored to their needs. Thus, this study aims to address this gap by exploring the lived experiences of student-athletes at BatStateU TNEU and analyzing how thermal stress impacts their physical performance, mental resilience, and overall well-being.

Research highlights the importance of heat acclimatization and hydration as primary factors in mitigating the effects of thermal stress (Izabelli et al., 2023). However, there is limited research on how student-athletes in tropical regions, like BatStateU TNEU, perceive and manage these factors in their daily routines. Thermal stress not only affects the physiological responses of athletes but also interacts with their psychological coping mechanisms, potentially influencing their motivation, decision-making, and team dynamics (Stephen et al., 2024). By focusing on the personal, subjective experiences of these athletes, the study seeks to uncover the factors that influence their ability to perform under heat stress, such as adaptation strategies, support systems, and mental health resilience.

This study is essential not only for filling the existing gap in the literature but also for contributing to the development of a Health and Performance Optimization Framework that can be applied to similar settings. Such a framework could be a practical tool to assist coaches, athletes, and sports administrators in designing more effective strategies to address thermal stress, enhance performance, and safeguard health in tropical climates. This research emphasizes the need for a holistic approach, considering both physiological and psychological dimensions, to optimize the performance and safety of student-athletes in challenging environmental conditions.

Thermal Stress and Its Impact on Athletic Performance

Thermal stress can be defined as the strain placed on the body due to elevated temperatures, leading to physiological responses that disrupt homeostasis. The body's core temperature rises in response to external heat, triggering thermoregulatory mechanisms such as increased sweating and blood flow to the skin, aiming to dissipate heat. However, when exposed to prolonged or extreme heat, these natural mechanisms may be overwhelmed, resulting in reduced endurance and performance efficiency

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(Izabelli et al., 2023). In a study on heat-related physiological adaptations, Pooja et al. (2023) found that heat exposure accelerates dehydration and glycogen depletion, both of which significantly reduce athletes' capacity for sustained physical exertion. This process is even more pronounced in tropical environments where humidity exacerbates thermal stress by inhibiting sweat evaporation. Kirsten et al. (2024) observed that, as body temperature continues to rise without adequate cooling, athletes face an increased risk of exertional heat illnesses, which range from heat exhaustion to potentially fatal heat stroke. Thus, thermal stress presents a physiological barrier to athletes in tropical regions, creating an urgent need for strategies that support heat adaptation and mitigate health risks.

For athletes, particularly those training in tropical climates, thermal stress directly influences performance outcomes. High temperatures have been shown to impair cardiovascular function and reduce muscle performance due to the increased metabolic demands of thermoregulation. Kirsten et al. (2024) highlight that under such conditions, athletes experience fatigue more rapidly, limiting their capacity to perform at optimal levels. This impairment is attributed to both the physical strain of heat dissipation and the body's allocation of resources away from muscular activity to focus on cooling. Moreover, the specific challenges of tropical climates—where humidity further complicates body cooling through sweating—make it especially difficult for athletes to maintain performance (Kirsten et al., 2024). This points to a vital need for interventions that address both the direct and indirect impacts of thermal stress on the body, enhancing athletic performance and safety in high-temperature environments.

Psychological and Emotional Impacts of Thermal Stress

Beyond physiological effects, thermal stress also impacts athletes' psychological well-being and emotional resilience. Psychological responses to extreme heat can include heightened stress, frustration, and cognitive fatigue, which all contribute to reduced performance. Samantha et al. (2024) argues that emotional responses to heat are often overlooked in sports research, even though they play a critical role in athletes' ability to cope with challenging conditions. When faced with prolonged exposure to heat, athletes may experience anxiety and irritability, affecting their concentration and decision-making

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skills. Mental fatigue, a common outcome of thermal stress, has been shown to reduce reaction times and impair focus, both of which are critical in sports requiring split-second decisions.

The impact of heat on cognitive performance and decision-making is particularly pertinent to high-stakes athletic environments, where even slight delays or errors can influence outcomes. For instance, studies by Stacey et al. (2024) suggest that cognitive performance declines in athletes when subjected to sustained heat exposure. Athletes may experience difficulty in sustaining attention and responding to tactical challenges, which can hinder performance in competitive settings. Christopher et al. (2024) further argue that the psychological strain of coping with heat can lead to decreased motivation, as athletes become mentally fatigued and less resilient. Therefore, understanding the psychological impact of thermal stress is essential to supporting athletes' mental preparedness and coping abilities, especially in high-temperature conditions.

Coping Mechanisms and Adaptation Strategies for Managing Thermal Stress

Effective coping mechanisms are crucial for athletes who regularly train in high-heat environments. Among the most widely recommended strategies for thermal stress mitigation are hydration protocols, which help maintain fluid balance and electrolyte levels during extended physical activity. Kaur and Mallick (2024) emphasize the importance of adequate hydration in combating heat stress, noting that even slight dehydration can impair thermoregulation and increase perceived exertion. Pre-competition hydration, coupled with ongoing hydration breaks, has been shown to reduce the incidence of heat-related illnesses and sustain performance. In addition, nutrition plays a supportive role, as proper intake of vitamins and minerals aids in bodily functions crucial for heat tolerance.

Acclimatization is another essential strategy, as it enables athletes to adapt their bodies to tolerate heat more effectively. Christopher et al. (2024) discusses the role of acclimatization in promoting heat tolerance, explaining that gradual exposure to heat stimulates physiological adaptations, such as increased plasma volume and enhanced sweat response. Training time adjustments are also common, as they allow athletes to train during cooler parts of the day, thereby reducing exposure to peak temperatures. For

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instance, studies suggest that training in the early morning or late evening can help athletes acclimate to heat without the heightened risk of mid-day exposure (Ghamdi et al., 2024). These adaptations underscore the importance of strategic planning in reducing heat-related stress and supporting sustained athletic performance.

The Role of Cooling Techniques and Technologies in Heat Stress Mitigation

Cooling methods have gained prominence as effective tools for managing thermal stress in athletes. Pre-cooling strategies, such as ice baths or cold vests, are commonly employed to lower body temperature before physical activity, extending the athlete's time to exhaustion in high heat. Stacey et al. (2024) found that pre-cooling can significantly improve endurance by reducing initial core body temperature, thus delaying the onset of heat-induced fatigue. Other methods, such as using cold towels or fans during breaks, help maintain lower body temperatures throughout activity, aiding in thermoregulation.

Recent technological advancements have introduced wearable cooling devices, which offer a convenient and portable solution for heat management. Wearable cooling vests or fabrics with embedded cooling mechanisms provide continuous cooling, helping athletes manage core body temperatures without disrupting performance. Studies by Ghamdi et al. (2024) demonstrate that such technologies are particularly beneficial in tropical climates, where high humidity complicates traditional cooling methods. These innovations not only enhance endurance but also offer psychological comfort, as athletes feel more confident and prepared to compete in heat-intensive environments.

Influence of Institutional Policies on Athlete Health and Performance Optimization

Institutional policies and support structures play a pivotal role in managing thermal stress among athletes. Universities and sports organizations are increasingly recognizing the need for heat management protocols, especially in regions with high temperatures. Health protocols implemented by institutions, such as scheduled hydration breaks and heat monitoring systems, are vital for protecting athletes from thermal stress. Bates et al. (2024) highlight the importance of organizational support, noting that institutions that prioritize athlete safety are more likely to see improved health and performance outcomes. At Batangas State University TNEU, for example, institutional

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policies geared toward heat management could include regular monitoring of heat indices during training sessions and providing cooling resources for athletes.

Furthermore, the development of a comprehensive Health and Performance Optimization Framework offers a systematic approach to addressing thermal stress. Such frameworks are designed to combine physiological, psychological, and strategic interventions, ensuring that athletes are equipped to manage the demands of their environment. Cherono (2024) discusses the value of institutional frameworks that prioritize athlete well-being through structured training and recovery programs. By integrating these policies into daily practice, institutions can create a supportive environment that reduces the risks associated with thermal stress, fostering both physical resilience and mental preparedness in athletes.

Theoretical Foundations in the Study of Thermal Stress and Coping in Athletes

The study of thermal stress and coping mechanisms among athletes is informed by several theoretical frameworks. Self-Determination Theory (SDT), developed by Giulia (2024), is particularly relevant, as it explores the role of motivation in athlete performance under stress. According to SDT, athletes who feel autonomous, competent, and connected to their peers are better equipped to cope with challenging conditions, such as heat stress. For example, athletes who perceive a sense of control over their training and feel supported by their team are more likely to adopt effective coping strategies. This theory highlights the psychological aspects of coping, underscoring the importance of motivation and self-efficacy in managing thermal stress.

Another applicable theory is the Environmental Stress Theory (EST), which examines how external stressors, such as extreme heat, impact individual performance. McCubbin's transactional model (2020) suggests that stress is a product of the interaction between environmental demands and personal coping resources. In the context of athletics, this model provides a lens for understanding how athletes assess and respond to thermal stress, using both physiological and psychological resources to cope. EST emphasizes the importance of adaptive responses and resilience, supporting the idea that tailored training and mental conditioning are essential for effective stress management.

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Gaps in the Current Literature and Directions for Future Research

Although substantial research has focused on the physiological aspects of thermal stress, there is a lack of qualitative insight into athletes' personal experiences. Few studies examine how individual athletes perceive and manage thermal stress, leaving a gap in understanding the subjective dimensions of heat exposure in sports. Samantha et al. (2024) underscores the need for qualitative research that captures the emotional and cognitive impacts of thermal stress on athletes. Such studies can inform more personalized approaches to managing heat stress, addressing both physical and psychological demands.

Emerging research directions include exploring personalized heat management strategies, advances in wearable cooling technology, and resilience training for athletes. The development of custom thermal stress management plans based on individual needs, as highlighted by Christopher et al. (2024), is a promising avenue for future studies. These approaches reflect a growing awareness of the complexities involved in heat tolerance, emphasizing the need for comprehensive strategies that support athletes in diverse climates and competitive environments.

In summary, the reviewed literature establishes the multifaceted nature of thermal stress and its impact on athletes' health, performance, and well-being. Both physiological and psychological factors play crucial roles in how athletes experience and manage heat, underscoring the need for holistic interventions that address these dimensions. This chapter highlights the importance of understanding athletes' lived experiences, particularly in tropical climates, to develop effective management frameworks. The findings from this literature review will inform the development of a Health and Performance Optimization Framework tailored to the unique challenges faced by student-athletes at Batangas State University TNEU, aiming to enhance both their health and performance under thermal stress conditions.

Methods

Research Design

A qualitative phenomenological research design is particularly suited for the current study on the Lived Experiences of Student-Athletes in BatStateU TNEU Regarding Thermal Stress. Phenomenology focuses on exploring how individuals

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perceive and interpret their personal experiences, making it ideal for capturing the subjective realities of thermal stress as encountered by student-athletes. This design allows for an in-depth understanding of the emotional, psychological, and physical impacts of thermal stress, emphasizing the meanings that participants attach to their experiences (Cherono, 2024). Through this approach, the study can effectively reveal the nuances of coping mechanisms and adaptation strategies used by student-athletes in high-temperature environments.

Participants, Sampling Technique, and Sample Size

In the context of this study, purposive sampling was particularly suitable, as it targeted individuals who had firsthand experience with the phenomenon of thermal stress. Purposive sampling, also known as judgmental sampling, allowed the researcher to select participants who could provide rich and relevant insights into the research question (KatieMarie et al., 2024). This study recruited 10-15 student-athletes from various sports disciplines at BatStateU TNEU who regularly trained in tropical outdoor environments. To qualify, participants had to (1) be enrolled as student-athletes at BatStateU TNEU, (2) actively compete or train in outdoor sports, and (3) have experience with the physical and psychological impacts of thermal stress. This approach enhanced the study's depth and specificity, ensuring that the collected data provided meaningful insights into the coping strategies and challenges associated with thermal stress.

Table 1: Distribution of Participants in the Study

Sports Event	Number of Athletes
Baseball	3
Softball	3
Athletics - Running Event	3
Athletics - Jumping Event	3
Athletics - Throwing Event	3
TOTAL	15

Table 1 outlines the breakdown of participants across various sports disciplines, with 3 student-athletes from each group, providing a well-rounded perspective on thermal stress across different athletic events.

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Generation of Data

The "Thermal Stress Lived Experiences Interview Guide" was the only instrument utilized in this study. This semi-structured guide, developed from a comprehensive review of related literature, consisted of five major open-ended questions designed to explore the essence of student-athletes' experiences with thermal stress. The questions were structured to encourage participants to reflect on their significant experiences, coping mechanisms, and perceived impacts of thermal stress on performance and well-being. Basic demographic information, including age, gender, and sport, was also gathered.

Interview Schedule

Data collection took place from November 2024 to December 2024. The interviews were conducted in person at a location convenient for the participants to foster a comfortable and open environment for sharing. Each interview was anticipated to last between 45 minutes and 1 hour. All interviews were audio-recorded (with participant consent) to ensure accuracy in data collection, and notes were taken for additional context. The researcher remained flexible and may have asked follow-up questions to deepen the discussion based on participants' responses.

Data Transcription

All audio-recorded interviews were transcribed verbatim. The researcher conducted an initial review of each transcript for accuracy and completeness. This process allowed for a faithful representation of participants' voices, ensuring that the data reflected the nuances of their lived experiences. Transcriptions were also double-checked against audio recordings to capture any subtleties in tone or emphasis.

Data Analysis

The researcher employed Colaizzi's seven-step method of qualitative data analysis, which was particularly suited to phenomenological studies seeking to uncover the essence of lived experiences (Colaizzi, 1978). This method included (1) reading and rereading each transcript, (2) identifying significant statements related to thermal stress experiences, (3) formulating meanings from these statements, (4) grouping formulated

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meanings into themes, (5) developing a comprehensive description of each theme, (6) producing a fundamental structure of the experience, and (7) validating findings with participants. Colaizzi's rigorous and systematic approach facilitated an accurate and holistic understanding of the student-athletes' experiences with thermal stress.

Ethical Statement

Upholding participant privacy, confidentiality, and anonymity was a primary ethical priority in this study. Informed consent was obtained from all participants, who were fully briefed on the study's objectives, procedures, and their right to withdraw at any time. Pseudonyms were used in all transcripts and reports, and data were securely stored in password-protected files, accessible only to the research team. To ensure emotional well-being, participants were given the option to pause or terminate the interview if they felt any discomfort, and referrals to counseling services were available if necessary.

Results

Table 2 shows the demographics of the participants. The demographic distribution highlights a significant presence of male athletes, comprising 67% of the sample, compared to 33% female athletes. This representation may reflect existing gender dynamics within the university's athletic programs. The higher number of male participants could suggest a greater involvement of males in outdoor sports activities or a potential disparity in sports opportunities or preferences between genders.

In terms of sports, there is an even distribution among the five outdoor disciplines represented: baseball, softball, running events, jumping events, and throwing events, each contributing 20% of the total participants. This balanced representation across sports ensures that the experiences of thermal stress captured in this study are not specific to one particular discipline but rather span a diverse range of athletic activities.

Such diversity strengthens the study's reliability, as it suggests that thermal stress is a common challenge faced by athletes regardless of the specific physical demands of their sport. For instance, running events may involve prolonged exposure to heat, while throwing events may demand short bursts of energy under intense sunlight. This

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distribution helps provide a comprehensive understanding of thermal stress across varied athletic contexts.

Table 2: Demographics of Participants

Category	Frequency	Percentage (%)
Gender		
Male	10	67%
Female	5	33%
Sports		
Baseball	3	20%
Softball	3	20%
Athletics (Running)	3	20%
Athletics (Jumping)	3	20%
Athletics (Throwing)	3	20%

Table 3 shows the emergent themes from significant statements. This reveal that thermal stress affects athletes across multiple dimensions, with physical impacts being the most frequently mentioned. This reflects the immediate physiological strain caused by heat during training and competitions. Psychological impacts, such as frustration and reduced focus, were also prevalent, demonstrating the comprehensive toll of thermal stress on athlete well-being. Coping mechanisms and institutional support systems were frequently discussed, highlighting both the proactive measures taken by athletes and the perceived gaps in institutional resources. The suggestions for improvement further emphasize the need for enhanced facilities and education to address these challenges comprehensively.

Table 3: Emergent Themes from Significant Statements

Themes	Frequency of Mentions	Percentage (%)
Physical Impacts	12	80%
Coping Mechanisms	10	67%
Support Systems	8	53%
Psychological Impacts	11	73%
Suggestions for Improvement	9	60%

Thermal stress is a multifaceted challenge that significantly impacts athletes' physical, psychological, and institutional experiences. The study revealed several interconnected themes, with physical impacts being the most commonly reported concern. These effects are not isolated; they often intersect with athletes' coping

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mechanisms, the availability of support systems, and areas where improvement is needed. Each aspect contributes to a broader understanding of how athletes navigate and endure heat-related challenges in their respective sports.

The most frequently mentioned issue was the physical toll of thermal stress, with 80% of participants describing the physiological strain they experienced during training or competitions. Symptoms such as dehydration, fatigue, and dizziness were commonly reported, directly hindering athletic performance. One athlete shared, “*The heat made me feel dizzy, and I couldn’t maintain my usual pace during the game.*” These accounts emphasize the immediate and visible effects of heat on the body, making it a central concern for athletes competing in tropical environments. The consistent reporting of these symptoms underscores the urgent need for interventions that address the health risks associated with prolonged heat exposure. For these athletes, managing these physical challenges is not just about performance—it is also about ensuring their overall safety and well-being.

Despite these physical challenges, participants demonstrated proactive efforts to mitigate the impacts of thermal stress through self-directed coping mechanisms. These strategies, mentioned by 67% of participants, included hydration, scheduling practices during cooler times of the day, and adopting mental focus techniques. For instance, one participant noted, “*I hydrate a lot before training and try to schedule practices in the early morning.*” Such approaches reflect an awareness among athletes of the importance of managing heat exposure. However, the reliance on these personal strategies highlights a gap in structured institutional support. While effective to some degree, these measures are often insufficient in extreme conditions, leaving athletes to bear much of the responsibility for addressing thermal stress on their own.

The role of support systems, discussed by 53% of participants, further highlights this dynamic. While some athletes acknowledged efforts by their coaches to adjust training schedules and encourage hydration, others pointed out significant gaps in institutional resources. One athlete remarked, “*Having more shaded areas or cooling stations would make a big difference.*” These statements illustrate a dual reality: individual efforts and occasional institutional adjustments exist but are often inadequate to meet the full scope of athletes' needs. The lack of critical resources, such as cooling

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stations or shaded recovery areas, underscores the importance of creating a supportive infrastructure. Bridging these gaps requires a collaborative approach that combines individual and systemic interventions to ensure that athletes can train and compete safely.

The physical and systemic challenges faced by athletes also have a significant psychological dimension. Thermal stress was reported to affect the mental and emotional well-being of 73% of participants. Athletes expressed feelings of frustration, irritability, and reduced motivation, which compounded the physical strain they experienced. One participant noted, *“It can be frustrating and distracting. Sometimes I feel irritable or stressed because it’s hard to concentrate.”* This interplay between physical discomfort and mental strain can lead to impaired focus, reduced decision-making ability, and diminished performance under pressure. The findings highlight the need for holistic interventions that address both the physical and psychological impacts of thermal stress, fostering resilience alongside performance optimization.

Participants also provided valuable suggestions for improvement, reflecting their experiences and insights into addressing thermal stress more effectively. These recommendations, mentioned by 60% of participants, included the introduction of advanced cooling technologies such as wearable cooling vests and cold towels to provide immediate relief during activities. Enhanced recovery areas, including shaded zones, misting systems, and air-conditioned lounges, were also identified as crucial additions to the existing infrastructure. Moreover, participants emphasized the need for educational initiatives to raise awareness about heat management strategies, including recognizing early symptoms, maintaining hydration, and using appropriate gear. One participant summarized these needs, stating, *“More education on managing heat stress would be useful, alongside better facilities for recovery.”* These suggestions offer actionable solutions that address both immediate concerns and long-term improvements in managing thermal stress.

In summary, the interconnected themes of physical impacts, coping mechanisms, support systems, psychological effects, and suggested improvements reveal the complex nature of thermal stress. Athletes navigate these challenges through a combination of personal strategies and available institutional resources, yet significant gaps remain. Addressing these dimensions comprehensively can create a safer, more supportive

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environment that enables athletes to perform at their best while safeguarding their health and well-being. This holistic approach ensures that thermal stress is managed effectively, allowing athletes to thrive even in challenging environmental conditions.

Discussion

The demographic analysis in this study highlights that male athlete comprised 67% of the participants, while female athletes accounted for 33%. This finding may reflect broader trends where male athletes are more involved in outdoor sports due to cultural norms, traditional gender roles, or greater opportunities. Similarly, Daniels et al. (2022) noted that societal expectations often lead to disparities in sports participation between genders, with females facing more barriers. These observations suggest that gender dynamics in sports programs deserve closer examination to ensure inclusivity and equitable access.

The study also ensured equal representation across five outdoor sports—baseball, softball, running events, jumping events, and throwing events—with each discipline contributing 20% of the participants. This balanced representation strengthens the findings, as it suggests that thermal stress is a universal challenge for athletes across different types of activities. For instance, endurance events like running might involve prolonged exposure to heat, while jumping and throwing events could expose athletes to short but intense heat stress. Such diversity provides a well-rounded understanding of how thermal stress affects various athletic disciplines, consistent with the observations of Martin et al. (2021), who highlighted the importance of including varied sports to capture broad trends in performance challenges.

The physical impacts of thermal stress were the most frequently mentioned issue, with 80% of participants reporting symptoms such as dehydration, fatigue, and dizziness. These effects directly hinder athletic performance and pose serious health risks if not addressed. One participant shared, *“The heat made me feel dizzy, and I couldn’t maintain my usual pace during the game.”* This aligns with the findings of Wilson et al. (2021), who reported that athletes often experience reduced endurance and increased discomfort when performing under high-temperature conditions. Managing these physical impacts is crucial not only for maintaining performance but also for preventing severe conditions

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such as heat exhaustion or heatstroke. Patel et al. (2022) emphasized that proper hydration and cooling measures are essential in mitigating these risks, especially in tropical climates.

To address these challenges, 67% of participants reported using personal coping mechanisms, such as drinking water before and during activities, scheduling practices during cooler times of the day, and focusing mentally to push through the discomfort. One participant explained, *“I hydrate a lot before training and try to schedule practices in the early morning.”* These findings align with Chen et al. (2021), who identified hydration and timing adjustments as key strategies for managing heat stress among athletes. However, the reliance on individual efforts highlights the limitations of self-directed strategies, especially under extreme heat conditions. Thompson et al. (2020) pointed out that individual coping mechanisms are often insufficient and need to be complemented by institutional support to ensure athlete safety.

Institutional support was discussed by 53% of participants, with mixed perceptions regarding its adequacy. While some participants appreciated their coaches' efforts to adjust training schedules and promote hydration, others noted significant gaps in resources, such as the lack of cooling stations or shaded recovery areas. One participant remarked, *“Having more shaded areas or cooling stations would make a big difference.”* This observation is consistent with the findings of Parker et al. (2022), who argued that access to supportive infrastructure, such as cooling zones and recovery facilities, plays a critical role in mitigating the adverse effects of thermal stress. On the other hand, the absence of such resources in this study highlights areas where institutions can enhance their support systems to improve athlete safety and performance.

The psychological impacts of thermal stress were another critical theme, reported by 73% of participants. Athletes described feelings of frustration, irritability, and reduced motivation, which compounded the physical challenges they experienced. One participant noted, *“It can be frustrating and distracting. Sometimes I feel irritable or stressed because it's hard to concentrate.”* This finding aligns with Zhang et al. (2021), who found that heat stress significantly affects athletes' mental resilience and cognitive performance, leading to impaired focus and decision-making. The interplay between physical and

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psychological stress underscores the need for holistic interventions that address both dimensions to optimize athlete well-being and performance.

Participants also provided actionable suggestions for improvement, with 60% recommending advanced cooling technologies, enhanced recovery areas, and educational initiatives. These included wearable cooling vests, misting systems, and air-conditioned lounges to provide immediate relief during activities. Educational programs focused on teaching athletes about heat management strategies, such as recognizing early symptoms of heat stress and maintaining proper hydration, were also highlighted. One participant summarized, *“More education on managing heat stress would be useful, alongside better facilities for recovery.”* These recommendations align with Alvarez et al. (2023), who emphasized the importance of combining technological advancements with educational programs to equip athletes with the knowledge and tools needed to cope with thermal stress effectively.

In conclusion, the findings reveal that thermal stress significantly impacts athletes across physical, psychological, and systemic dimensions. While self-directed coping mechanisms and limited institutional support are currently in place, significant gaps remain. Addressing these challenges requires a comprehensive approach that integrates individual efforts, institutional support, and infrastructural improvements. Future research should explore the effectiveness of these integrated interventions to ensure that athletes can perform at their best while safeguarding their health in high-temperature environments.

Conclusion

This study explored the lived experiences of student-athletes at Batangas State University The National Engineering University (BatStateU TNEU) in managing thermal stress. By using a qualitative phenomenological approach, the research uncovered how thermal stress affects athletes in multiple ways, including their physical health, psychological well-being, and access to systemic support. The findings demonstrated that thermal stress is not a localized issue but a widespread challenge that affects athletes across various outdoor sports disciplines, regardless of the specific demands of their sport.

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The demographic analysis revealed significant gender disparities among the participants, with male athletes representing 67% of the sample and females only 33%. This difference may point to unequal opportunities or participation trends in outdoor sports, potentially influenced by cultural norms, societal expectations, or institutional factors. Such disparities call for further investigation to ensure inclusivity and equal access for all athletes. Despite this, the study ensured a balanced representation across five sports—baseball, softball, running events, jumping events, and throwing events—providing a diverse perspective on how thermal stress affects athletes in different activities. This distribution highlights that thermal stress impacts athletes across various sports, from endurance-based activities like running to high-intensity efforts in throwing and jumping.

The study identified physical impacts as the most common challenge athletes faced due to thermal stress. Participants frequently reported symptoms such as dehydration, fatigue, and dizziness, which not only reduced their ability to perform but also posed serious health risks. These findings stress the importance of addressing the physical toll of heat exposure, especially in tropical climates where high temperatures are a constant concern. Although 67% of athletes implemented personal strategies like staying hydrated and adjusting practice schedules to cooler times of the day, these self-directed efforts were often insufficient under extreme heat conditions. This highlights the need for institutions to provide additional support systems that can complement these individual actions and better protect athletes from the adverse effects of heat.

Institutional support was acknowledged by participants but was often considered inadequate. Many athletes pointed out the absence of basic facilities like cooling stations and shaded recovery areas, which are critical for mitigating the effects of heat exposure. These gaps underscore the significant role institutions must play in creating safer and more supportive environments for athletes. Coaches' efforts to adjust training schedules and encourage hydration were appreciated, but they alone were not enough to meet athletes' needs. Beyond physical impacts, the study also revealed the psychological toll of thermal stress. Participants reported feelings of frustration, irritability, and difficulty maintaining focus, which compounded their physical challenges and further hindered their performance. These findings highlight the need for solutions that address both the

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physical and mental aspects of thermal stress, ensuring athletes develop resilience alongside strategies to manage heat.

The participants provided practical recommendations to improve their experiences and reduce the effects of thermal stress. They suggested incorporating advanced cooling technologies, such as wearable cooling vests and misting systems, which can offer immediate relief during practices and competitions. They also emphasized the need for shaded recovery areas and air-conditioned lounges to help them cool down effectively after physical activity. Additionally, athletes expressed the importance of educational programs to teach them how to manage heat stress, recognize early symptoms, and adopt proper hydration practices. These recommendations reflect a comprehensive approach to tackling thermal stress, combining individual strategies, technological advancements, and systemic interventions.

In conclusion, this study reveals that thermal stress significantly impacts the well-being and performance of student-athletes, affecting them physically, psychologically, and systemically. Addressing these challenges requires a coordinated approach that integrates infrastructure improvements, such as cooling facilities and recovery areas, with educational initiatives and supportive policies. Institutions must take proactive steps to ensure that athletes are equipped with the resources, knowledge, and support needed to manage thermal stress effectively. By implementing these measures, athletes can perform at their best while safeguarding their health, particularly in high-temperature environments. Future research should build on these findings by exploring how these interventions can be applied in broader contexts and investigating innovative strategies to further enhance support systems for athletes facing thermal stress.

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