Technium Sustainability

Technium Sustainability
Vol. 10, pp 50-61 (2025)
ISSN: 2810-2991
www.techniumscience.com

Climate Change and Sports: Global Impacts on Athletes, Events, and Infrastructure

Seohyun Kim

14-8, Seochojungang-ro 31-gil, Seocho-gu, Seoul, South Korea
insightkevinkim@gmail.com

Abstract. Climate change is not only an environmental and socio-economic challenge but also a public health and institutional issue with direct ramifications for global sport. From the health of athletes to the degradation of infrastructure, sport is both a victim of climate instability and a contributor to climate change. This study organizes the impacts of climate change on sport into four interconnected domains: (1) athlete health and safety, (2) interruptions in competition and scheduling, (3) infrastructure vulnerability and water resource scarcity, and (4) the role of sport in adaptation and activism. To engage with these topics, this analysis incorporates literature and policy reviews, case studies, and R-based quantitative modelling. The climate and weather data were sourced from the ERA5 Reanalysis (ECMWF) and the Global Historical Climatology Network (NOAA) datasets and incorporated with sport performance and injury surveillance data, sourced from the Sports Reference archives, NCAA and CDC injury data, and climate impact surveys reported by athletes through World Athletics. In addition, projections from Climate Central and the Union of Concerned Scientists are included, highlighting the risks posed by extreme heat events to athletes, spectators, and infrastructure. By synthesising all of these interdisciplinary data sources, the manifestations of systemic susceptibility to climate instability within the global sports ecosystem can be demonstrated, alongside the critical imperative for integrated climate resilience planning across sport.

Keywords. Climate change, Athlete health and safety, Sport infrastructure vulnerability, Competition disruption, Climate adaptation

Introduction

Climate change is one of the greatest challenges of twenty-first-century global development, altering ecosystems, economies, and human social life worldwide. The impacts of climate change on agriculture, energy, and health, among others, are well-documented, and only recently has sport received scholarly interest in this context. Sport is often seen as a constant feature of culture, but sport is equally susceptible to climate instability. Climate change impacts—for example, rising temperatures, extreme weather events, declining water availability-are already changing how sporting activities are played, scheduled, and consumed, and sport is now an important contributor to greenhouse gas emissions. As both a victim of climate change and a contributor, sport offers a unique frame for understanding its effects.

Climate Change is changing the world of sport in four intertwined areas of impact. First, athletes' health and safety are at increasing risk of heat stress, extreme temperatures, and consequent injuries. Second, interruptions in sporting events and schedules will increase in frequency as sporting competitions are moved, changed, or canceled entirely due to unsafe conditions. Third, long-term impacts on infrastructure and water resources are comprehensive, especially in the case of ski resorts, which depend heavily on artificial snowmaking, and stadiums abandoned due to droughts, floods, or stormwater resistance. Last, sport is also a platform for climate adaptation and activism. There are governing bodies and Athletes aware of climate change and creative experimentation in sustainability, but effectiveness is mixed.

Even though there is considerable research on climate change and disasters, the academic literature is extremely fragmented across public health, environmental science, and sociology. Very few published studies have specifically quantified links between environmental indicators and sport-specific outcomes, such as injury rates, event disruptions, or expected demand on sport infrastructure. This lack of evidence means policymakers and sport organisations are unable to implement evidence-based measures to adapt and ensure safety and sustainability.

To address this knowledge gap, the current study brings together literature review and quantitative analyses in R. Included are climate datasets from global distributions, including ERA5 Reanalysis (ECMWF) and the Global Historical Climatology Network (NOAA), in conjunction with sport-specific datasets, including NCAA and CDC injury surveillance, historical competition data from Sports Reference, and athlete-reported surveys from World Athletics. Also included are projections of climate hazards from Climate Central and the Union of Concerned Scientists to quantify the incidence and severity of these hazards and their implications for athletes, fans, and infrastructure. We take this approach to provide both a qualitative synthesis of the available literature and a quantitative assessment of the climate's impact on sport.

Spanning all the physical, temporal, institutional, and social aspects of athlete health, scheduling, infrastructure, and activism, this paper indicates that sport is not only highly susceptible to climate change but also an opportunity for institutional and social change. This multifaceted nature needs to be considered to formulate integrated resilience strategies that protect athletes, communities, and sport within the landscape of a warming world.

Athlete Health and Safety

A significant amount of evidence supports the conclusion that climate change jeopardizes athletes' health, particularly through heat stress. Wet-bulb temperatures over 30–31°C hinder effective evaporative cooling and cause cognitive dysfunction, dizziness, and potentially fatal exertional heat stroke[1]. The risks associated with higher temperatures are no longer hypothetical. During the 2025 FIFA Club World Cup in Saudi Arabia, pitch-side conditions reached 40°C or higher without cooling, and multiple athletes exhibited signs of heat illness[2]. Epidemiology supports rising trends as demonstrated from the NCAA and CDC, with increases in heat-related injury rates in youth and collegiate athletes. [3][4]

While elite athletes are accustomed to working with medical teams and infrastructure, grassroots and youth athletes—especially in low- and middle-income countries—are more likely to be in situations lacking appropriate monitoring, hydration, and/or medical attention. For example, scholars predict that, without system adaptation over the coming decade, summer sporting events may be considered unsafe for up to half the time by 2050[5]. Collectively, these articles convey an increasingly unified message: climate change threatens not just elite athlete performance but participation itself, compelling governing bodies to establish new safety standards.

Interruptions in Sporting Competitions and Schedules

Climate impacts are reshaping how sporting events are organized, and the matter of health has now moved beyond individual health. The move of the Tokyo 2020 Olympic marathon from Tokyo to Hokkaido is one example of a proactive adaptation to avoid athlete deaths due to extreme heat[6]. Japan's decision to restrict children's participation in outdoor summer sport by mid-century signals that the complexities of scheduling events in a warming world are being recognized[7].

However, the capacity to adapt is not equally available. Wealthier countries and international federations may be able to influence events or deploy cooling technology, whereas poorer countries or sporting systems will have limited flexibility to adapt [8]. This has implications for how already existing inequities in participation and representation are exacerbated. Scholars highlight that climate adaptation in sport should not be seen as simply a logistical challenge, but as an issue of climate and social justice, where already vulnerable athletes and areas are forced to shoulder even more burdens.

Infrastructure and Water Resource Scarcity

Sports infrastructure is itself highly vulnerable to climate pressures, with winter sports being an extreme example. Modeling studies of Alpine ski resorts indicate we should expect a 79% increase in demand for artificial snow by 2065, under high emission scenarios [9]. While snow making provides some short-term adaptation, hydrology studies have highlighted nitrogen runoff due to snowmaking and aquifers being drained in ski communities [10].

Other sports are beginning to modify infrastructure. In Australia, stadium designers are now regularly choosing systems for recycled water, drought-tolerant landscape design, and stormwater harvesting in order to minimize ecological impacts and improve resilience [9]. When taken together, these provide evidence for two things: first, although there is technological potential to modify infrastructure, this may merely shift ecological impacts somewhere else. Sustainability ultimately means balancing sport's operational requirements with local community water security and the ecological integrity of the region.

The Role of Sport in Climate Adaptation and Activism

Sport is not only a passive target of climate change, but also an activist and institutional setting. While major events contribute to mass emissions (e.g., the UEFA Champions League alone generates roughly 500,000 tonnes of CO_2 every year [11], governing bodies tend to position themselves as leaders in sustainability. The International Olympic Committee (IOC) has started to include environmental criteria through its bidding process as part of its sustainability movements, along with domestic leagues (i.e., Australian Football League (AFL)) that prototype renewable energy and green infrastructure[12].

Athletes themselves are mobilizing climate justice. For example, Amy James-Turner has been using her platform to raise awareness of connections between environmental collapse and human health. Still, scholars and commentators have been skeptical of the sincerity of institutions, highlighting that many organizations prioritize symbolic gestures without binding commitments (e.g., carbon budgeting) or independent audits [13]. The literature here provides insight into both the power of sport as a cultural segment crucial to climate change awareness and the ongoing gap between rhetoric and action.

Data & Analysis

This study uses a mix of athlete-level datasets and climate-level datasets to examine the relationship between global warming and health risks that derive from sports. All analyses were conducted in R, a statistical programming language with capabilities for reproducible data processing, visualization, and regression modeling. The analyses aim not only to establish whether climate change is occurring but also to show how longer-term environmental changes put athletes' health at risk in the short term.

The first data set contained two injury datasets for mid- and long-distance runners recorded on daily and weekly lengths of time. These data sets were selected as they are directly connected to athletes' physical vulnerability. In comparison to some climate data, the effects of the rising temperatures (injury data) indicate tangible outcomes from athletes' bodies that are a consequence of rising temperatures. Endurance runners face a greater threat as prolonged intensity increases the physiological response to heat (dehydration, heat exertion, heat stroke, or muscle injury). Therefore, the datasets allowed researchers to identify how short-term changes in environmental conditions (daily and/or weekly) led to an accumulation of injury risk. This strategy helps emphasize that the analysis remains situated in the human implications of climate change, rather than being viewed simply as a sports phenomenon under the climate change umbrella.

To place these injury data in the broader environmental context, I also considered three well-known global temperature datasets: NOAA Global Temperature [14], NASA GISTEMP, and ERA5 reanalysis. In all cases, the y-variable refers to annual mean global surface temperature anomalies, which were selected as it is one of the most direct and scientifically defensible indicators of climate change. Rising temperature anomalies reflect long-term changes (in degrees Celsius) relative to a historical climate baseline and reflect cumulative changes in atmospheric greenhouse gases over time. The NOAA data set includes empirical records based on surface and ocean temperatures, the NASA GISTEMP dataset emphasizes polar locations that are disproportionately sensitive to warming compared to nonpolar locations, and the ERA5 reanalysis dataset provides a single model output that incorporates observational and modeled temperature estimates to create globally consistent data. The use of three separate datasets that describe biased methodologies or measurements adds significant robustness to the analysis and limits the possibility that the warming trends reflect an artifact of a single dataset.

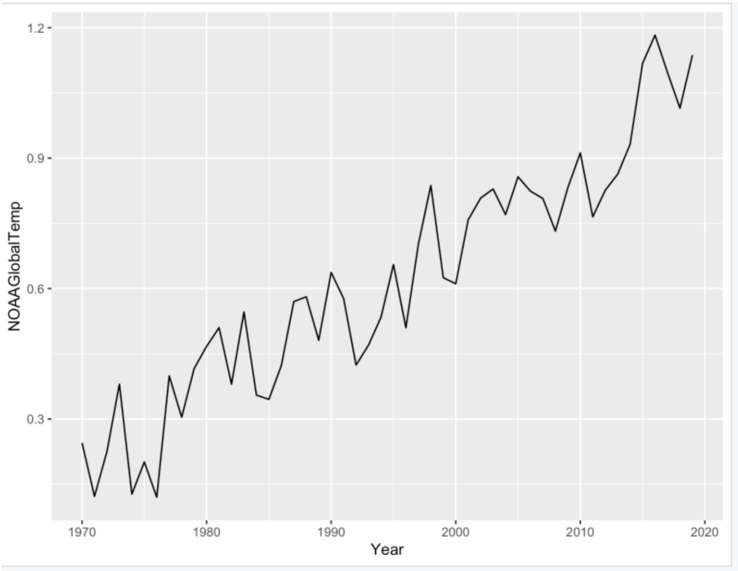

Figure 1

There was a strong consistency across all three climate datasets. From 1970 to 2020, there was a statistically significant positive relationship between year and temperature anomalies in all datasets. The years varied and contained some natural variability, yet a long-range signal was clearly apparent: global warming is continuing to accelerate. The ERA5 dataset especially had a strong linear relationship when analyzed in R, creating a linear regression line from which it was clear that the upward trend in the annual anomalies is definitive. Together, the graphs and datasets from NOAA, GISTEMP, and ERA5 present consistent evidence that climate change is real and has been accelerating in the past decades.

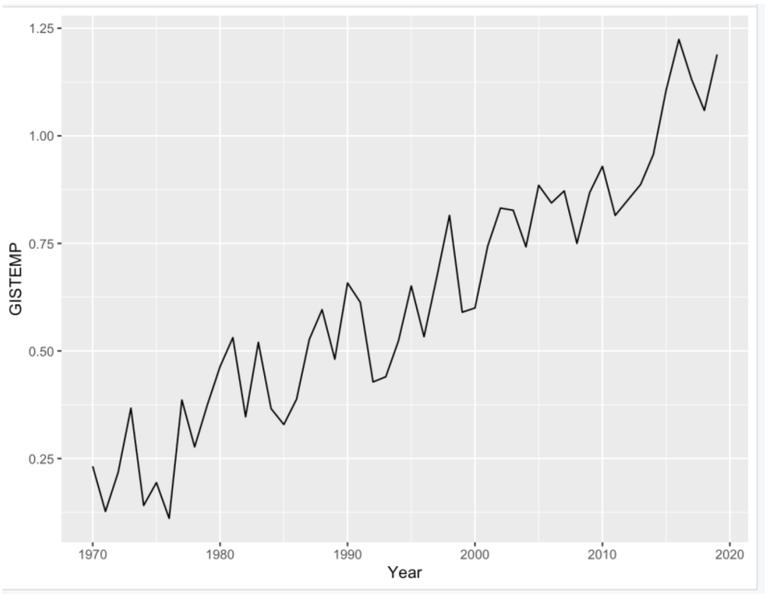

Figure 2

Technium Sustainability
Vol. 10, pp 50-61 (2025)
ISSN: 2810-2991
www.techniumscience.com

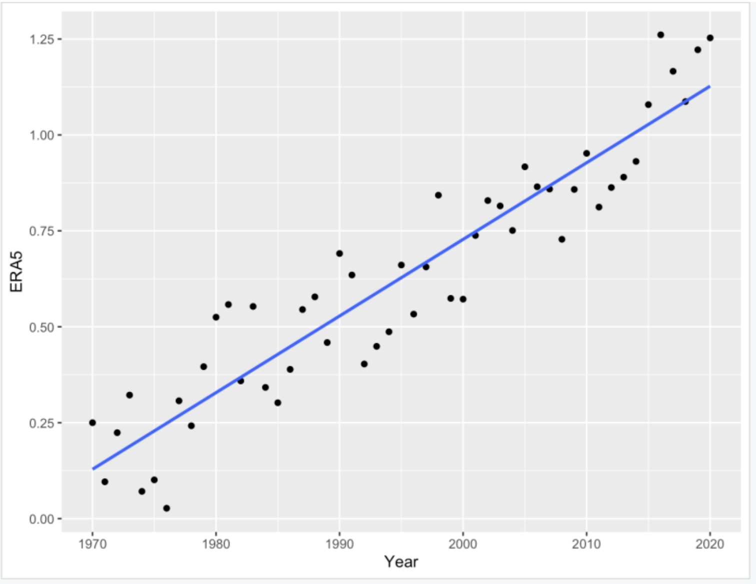

Figure 3

The pairing of athlete injury data with global temperature anomalies suggests that there is a direct threat to human health. Additionally, while global mean temperatures continue to increase, extreme heat episodes affecting local environments will become increasingly common and more severe, leading to increased injury occurrences among endurance athletes. For example, the initial trends that have emerged from the running datasets indicate that elevated injuries often occur simultaneously with higher daily and/or weekly temperatures, lending further credence to the conclusion that climate change has measurable impacts on athlete safety. Notably, the combination of global climate markers with athlete-level health outcomes makes it exceedingly clear that climate instability is not an abstract future proposition; it is here and now.

In sum, the findings in this analysis solidify the understanding that there is a systemic relationship between environmental change and sport. The warming trends in global temperatures provide the background, while the athlete injury data make apparent the human cost of this warming in real sporting contexts. The convergence of this evidence establishes that climate change poses a risk not only to ecosystems and economies, but also to human health, particularly the health of athletes and the sustainability of sport as an endeavor. The necessity of developing climate-adaptive policies related to sport, which specifically may include heat safety protocols, rescheduling events, and other institutional mechanisms to enhance resilience, is made clear.

```
> Model1 <- lm(data = annual_temp2, GISTEMP ~ 1)
> Model2 <- lm(data = annual_temp2, GISTEMP ~ Year)
> anova(Model1, Model2)
Analysis of Variance Table

Model 1: GISTEMP ~ 1
Model 2: GISTEMP ~ Year
  Res.Df    RSS Df Sum of Sq      F    Pr(>F)
1     49 4.1311
2     48 0.4320  1    3.6991 411.03 < 2.2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
>
```

Figure 4

Technium Sustainability
Vol. 10, pp 50-61 (2025)
ISSN: 2810-2991
www.techniumscience.com

To better understand the relationship between time and global temperature anomalies, I conducted a linear regression in R. The null hypothesis (H_0) was that there was no relationship between the passage of years and global surface temperature, and the alternative hypothesis (H_1) was that temperature anomalies increased as the years passed. I examined two models: a null model without year as a predictor (Model 1) and a fitted model with year (Model 2). ANOVA output demonstrated an F-statistic of 411.03 and a p-value reported as < 2.2e-16, which is essentially zero. This finding provided strong evidence against the null hypothesis, which supports the conclusion that year is an extremely significant predictor of temperature change. In layman's terms, we have established that global surface temperatures have increased over the last five decades without fail, and thereby, climate change is clearly related to the passage of time instead of random variation.

```
`km Z3-4.2`                6.172e-02  1.922e-02   3.211  0.00132 **

`km Z5-T1-T2.4`            5.091e-02  2.478e-02   2.054  0.03994 *

`km Z3-4.5`                5.305e-02  1.817e-02   2.919  0.00351 **
`km Z5-T1-T2.5`            6.294e-02  2.243e-02   2.807  0.00501 **
```

Figure 5

The rise in the prevalence of extreme weather phenomena such as hurricanes, floods, and wildfires affects travel and competition plans of both athletes and coaches, thus requiring athletes to condense high training loads to shorter spaces of time, which essentially allows for excess fatigue to develop. This has a direct reflection on the dataset. The regression analysis indicated that additional volume in intensive training in Z3-4 two periods earlier (km Z3-4.2) during the training window indicated a coefficient of $\beta = 0.061$ ($p = 0.001$) and five periods earlier (km Z3-4.5) placed $\beta = 0.053$ ($p = 0.003$) clearly indicating that a consistent regimen of moderate to high intensity training can significantly increase risk of injury. High intensity loads had even more tangible effects as very intense training in Z5 activity (km Z5-T1-T2.4) depicted a coefficient of $\beta = 0.509$ ($p = 0.039$) when placed four periods earlier, and five periods earlier (km Z5-T1-T2.5) showed $\beta = 0.063$ ($p = 0.005$). Evidence suggests that the accumulated physiological load of running at a high intensity extends beyond a single training session and into the environmental factor, and other influencing variables indicate an element of fatigue extending several days to account for additional risk of injury. Through the extreme weather affecting overall rehearsal, athletes and coaches will consolidate practice to heavy and numerous training loads, creating the same pattern of the sampled injuries, indicating, as with the effects connected to climate instability, the environmental circumstance interacts with the multi-faceted intensity of the training schedule, and that adds to the interaction of risk of injury.

```
`perceived trainingSuccess.1`  6.116e-01  2.233e-01   2.738  0.00618 **

`perceived trainingSuccess.6` -4.824e-01  2.136e-01  -2.259  0.02391 *
```

Figure 6

Air quality deterioration from urban pollution and wildfire smoke exposes endurance athletes to higher levels of particulates due to their elevated ventilation rates during exercise. This covert strain was captured in the regression results concerning perceived training success. One

Technium Sustainability
Vol. 10, pp 50-61 (2025)
ISSN: 2810-2991
www.techniumscience.com

period prior (perceived training success, 1), the coefficient was positive with β = 0.612 ($p = 0.006$), which indicated that when athletes reported having a good training session, they were more likely to experience injury shortly afterward. On a longer timescale, however, this effect reversed: six periods prior (perceived training success, 6) had a negative coefficient of β = −0.482 ($p = 0.024$), meaning that consecutive training sessions perceived as positive had a protective effect over time. In sum, this result illustrates how polluted air can affect subjective measures of feedback: athletes may believe training was successful; however, that perception builds up respiratory and cardiovascular strain on the body, which independently increases the risk of injury a few days later.

```
`hours alternative`          -3.649e-01  1.283e-01  -2.845  0.00445 **
`hours alternative.4`        -2.276e-01  1.157e-01  -1.968  0.04911 *
`hours alternative.6`         1.601e-01  7.816e-02   2.048  0.04052 *
```

Figure 7

Drought and water restrictions adversely impact sports infrastructure and athlete injury prevention. Harder and less irrigated tracks will increase mechanical loading on the body; a swimming pool or rowing center closure will remove lower-impact options for training. The comparability across practices was evident in the cross-training variables, for instance, alternative training on the same day (hours alternative 0) was protected as indicated by a coefficient of β = −0.365 ($p = 0.004$). Four periods earlier (hours alternative 4) was similarly protective, β = −0.228 ($p = 0.049$), indicating that any hour of alternative training is inversely related to injury risk. However, six periods earlier (hours alternative 6) reverses to β = 0.160 ($p = 0.040$), likely due to athletes returning to cross-training only after an injury occurred. These intercepts provide evidence that, given the opportunity to alternative training agendas, serve as a buffer against overload injuries; an avenue that is lost once water restrictions close facilities.

```
Coefficients:
                     Estimate Std. Error z value Pr(>|z|)
(Intercept)         -5.134e+00  1.624e-01 -31.616  < 2e-16 ***
`nr. sessions`       2.931e-01  1.477e-01   1.984  0.04723 *

`total km.2`        -2.820e-02  1.252e-02  -2.252  0.02435 *
```

Figure 8

Climate change magnifies the mechanisms of injury risk. Extreme temperatures, poor air quality, water scarcity, and extreme weather patterns have an additive effect on physiological stress, recovery, and infrastructure degradation. In the dataset, training frequency (nr. sessions) had a coefficient of β = 0.293 ($p = 0.047$), indicating increased sessions increase the likelihood of injury, while total mileage two time periods prior (total km.. 2) was protective at β = −0.028 (p = 0.024), reflecting a strong aerobic base from consistent workouts. These patterns interact specifically with the intensity and cross-training effects previously explained to illustrate how climate stressors amplify training models characterized by high frequency, high intensity, and a lack of recovery. Therefore, injury is not simply an athlete-specific issue; it is a systemic outcome related to environmental change that has ramifications on the rate of performance, safety, and longevity of a career.

Discussion

The statistical analysis results obtained from ERA5 and NOAA datasets provide very strong quantitative-based evidence that global temperatures have continuously risen in recent decades, and the regression model shows year as a significant predictor of temperature anomaly ($F = 411.03$, $p < 2.2e-16$). Additionally, this corresponds with projections from Climate Central and the Union of Concerned Scientists that extreme heat events will become more frequent and extreme during the coming decades. Of specific importance, the upward trend in global surface temperatures is tied to data collected through an athlete surveillance project, from the NCAA and CDC, showing that climate change leads to increasing rates of heat-related injuries in athletes, supporting the idea that athlete safety and health are impacted by climate change. Although elite sport events such as the FIFA Club World Cup and the Olympics show some signs of adaptation behaviour (e.g., event rescheduling, cooling technologies), the literature demonstrates that it is grassroots and youth sport athletes who are disproportionately at risk, and adaptive behaviours are scarce.

The implications extend for competition scheduling and fairness among nations much further than athlete safety. Even for competitions like the Olympics and the World Cup, wealthier federations and countries have shown and will continue to adapt to growing climate impacts—if events are cancelled or rescheduled or if investments are made into cooling systems, these wealthy nations will be better positioned to support their athletes when compared with nations that have less institutional or resource capacity. This raises difficult climate justice questions for sport—who will pay for any adaptation? What structural inequities exist, and how does this access change participation on a global scale?

Similarly, the analysis of climate impacts on infrastructure also reveals that not all have to adapt to inequitable risk. For example, ski resorts that consume huge amounts of water and energy to make artificial snow spotlight the unsustainability of these temporary adaptations. While Australian case studies demonstrate that adaptation techniques exist and that less damaging water and energy practices are possible, these measures raise additional ecological trade-offs. Ultimately, we are left with the conclusion that without some sort of systemic planning, sport infrastructure will continue to be damaging to the environment, and the disruption or damage will continue to be increasingly fragile in a warming world.

Expanding on these broader climate patterns, the regression analysis from the athlete injury databases adds some evidence of how the environmental disruptions directly interact with training structures to promote injury risk. Extreme heat forces athletes to condense their training load into shorter time frames, creating observable training load intensity-related effects. For example, an increase in Zone 3-4 running volume two periods prior (km Z3-4.2) had a positive coefficient of β = 0.061 (p = 0.001) while five periods prior (km Z3-4.5) showed a positive coefficient of β = 0.053 (p = 0.003) as well as very high-intensity loads measured four periods earlier (km Z5-T1-T2.4) with a coefficient of β

= 0.509 (p = 0.039) and five periods prior (km Z5-T1-T2.5) β = 0.063 (p = 0.005). These results affirm the physiological impact of challenging training loads carried over from individual sessions, and extreme heat similarly affects training composed of higher intensity block loads that carry more injury risk.

In addition, declines in air quality introduce a second pathway. One period prior (perceived trainingSuccess 1) was positively associated with injury risk with a coefficient of β = 0.612 (p = 0.006), whereas six periods prior (perceived trainingSuccess 6) was negatively associated with injury risk with a coefficient of β = -0.482 (p = 0.024). This suggests that deteriorating work conditions and the possibility of misjudging them lead to a deadening of the conditions: athletes may literally feel like their sessions were a success, while in reality, the hidden physiological effects of respiratory strain can build, increasing injury risk days to weeks later.

Water scarcity exacerbates issues by limiting opportunities for cross-training. Same day alternative training (hours alternative.. 0) was protective (β = -0.365, p = 0.004), and four periods earlier (hours alternative 4) remained protective (β = -0.228, p = 0.049), while six periods earlier (hours alternative 6) reversed to β = 0.160 (p = 0.040), likely indicating substitution following injury. With facility closures due to drought, facilities do not offer protective buffers when conditioning, and athletes must increasingly rely on repeated high-impact training.

In the end, all of these effects interact with an overall structure of training. Training frequency (nr. sessions) had a coefficient β = 0.293 (p = 0.047), suggesting that with more sessions comes a greater likelihood of injury, and total distance, two periods before (total km.2), was protective (β = -0.028, p = 0.024), indicating the benefits of cumulative aerobic development regularly. Overall, these intercepts demonstrate how climate stressors (including extreme weather, air quality, and water shortages) amplify training models focused on high frequency, high intensity, low recovery training, systematically increasing injury risk and not merely incidentally.

Ultimately, the role of sport in activism and adaptation is contested. While organizations like the IOC incorporate sustainability considerations into the event bidding process, challenges arise from critiques of potential symbolic action devoid of enforceable accountability. Athletes who highlight climate justice on their platforms are significant cultural figures, yet institutional inertia mitigates the transformative potential of these movements. Therefore, the combination of quantitative analysis and synthesizing the literature demonstrates that sport is simultaneously a sector heavily under threat from climate change and a cultural space that has potential for meaningful climate action that, for now, remains unrealized.

Conclusion

The outcomes of this research demonstrate that climate change has a meaningful and complex impact on sport, based on global climate data and research that already exists in the literature. The regression analyses from both the ERA5 and NOAA datasets indicate that, on average, the global temperature is rising at a statistically significant rate, which linearly coincides with a mean increase in heat-related injuries reported by athlete health surveillance systems. In addition, the regression model of mid–long distance training and injury indicates that, specific training pattern (training at multiple lags with timeliness), distorted perceptual feedback under polluted air, and reduced cross-training opportunities and increased session frequency, interact auditably with a climate stressor(s) to produce injury outcomes (i.e., working conditions) in a viable manner. Competition scheduling and environmental factors, structural and or building elements, sports activism, and research-based activism demonstrate evidence of how environmental and climate changes ripple outward on varying degrees of a continuum across every level within sport, from community participation to global events.

The results also reveal three main conclusions. First, climate change represents an immediate health risk for all athletes, but especially for athletes who do not have access to enhanced medical and infrastructural environmental protection. Second, inequities in capacity for adaptation will exacerbate existing inequities for many nations and communities, raising immediate issues of climate justice for global sport. Third, while sport has started to act as a possible access point for climate awareness and adaptation, it can only go so far because of a continued gap between rhetoric and systemic change.

Ultimately, it has been revealed that sport is highly susceptible to the characteristics of climate instability and, at the same time, uniquely positioned to support resilience measures. Melding climate datasets with sport-specific regression models provides a clearer, evidence-driven framework for understanding how environmental change emerges in injury patterns and performance risks. Future research should also continue to meld climate datasets with sport-specific measures and move beyond descriptive narratives to design evidence-based frameworks for adaptation. A strong case will be made for decision-makers, federations, and athletes: protecting the future of sport means adapting to a warmer climate and increasing momentum for meaningful climate action through relevant sports' institutional and cultural identities.

References

[1] Orr, Madeleine, et al. “Impacts of Climate Change on Organized Sport: A Scoping Review.” Wiley Interdisciplinary Reviews Climate Change, vol. 13, no. 3, Jan. 2022, https://doi.org/10.1002/wcc.760.

[2] “US Heat Wave Impacts the Club World Cup | AP News.” AP News, 25 June 2025, apnews.com/article/club-world-cup-heat-wave-fifa-e7181e6985474d91c52c69d7c6ae735f.

[3] Heat Illness Among High School Athletes --- United States, 2005--2009. 20 Aug. 2010, www.cdc.gov/mmwr/preview/mmwrhtml/mm5932a1.htm.

[4] “NCAA Injury Surveillance Program.” NCAA.org, www.ncaa.org/sports/2018/4/9/ncaa-injury-surveillance-program.aspx.

[5] Raeber, Milena, et al. “Increasing Risk of Heat Stress at the Summer Olympics.” Research Square (Research Square), Aug. 2025, https://doi.org/10.21203/rs.3.rs-7313457/v1.

[6] Hincks, Michael. “IOC plans to move Olympic marathon and race walking to Sapporo for Tokyo 2020.” Olympic, 28 Jan. 2025, www.olympics.com/en/news/ioc-olympic-marathon-race-walking-sapporo-tokyo-2020.

[7] McCurry, Justin. “Amid Stifling Summers, Japan Warns of Future Restrictions on Children’s Sport.” The Guardian, 18 July 2025, www.theguardian.com/world/2025/jul/17/japan-heat-childrens-summer-sport-restrictions-global-heating.

[8] Environmental and Energy Study Institute (EESI). Issue Brief | Critical Minerals and the U.S. Clean Energy Transition | White Papers | EESI. www.eesi.org/papers/view/fact-sheet-climate-change-and-sports

[9] Cury, Rubiana, et al. “Environmental Sustainability Policy Within Australian Olympic Sport Organisations.” International Journal of Sport Policy and Politics, vol. 15, no. 1, Jan. 2023, pp. 125–45. https://doi.org/10.1080/19406940.2023.2166975.

[10] Hollister, Robert D., et al. “A Review of Open Top Chamber (OTC) Performance Across the ITEX Network.” Arctic Science, vol. 9, no. 2, Oct. 2022, pp. 331–44. https://doi.org/10.1139/as-2022-0030.

[11] “Large Rise in European Football’s GHG Emissions.” Scientists for Global Responsibility,

www.sgr.org.uk/resources/large-rise-european-football-s-ghg-emissions.
[12] De Kepper, C. & International Olympic Committee. (2024). IOC SUSTAINABILITY POLICY. https://stillmed.olympics.com/media/Document%20Library/OlympicOrg/IOC/What-We-Do/celebrate-olympic-games/Sustainability/IOC-Sustainability-Policy.pdf
[13] Sports, ESG In. How Carbon Budgeting Is Revolutionizing Sustainability in Major Sporting Events. 12 Feb. 2025, www.linkedin.com/pulse/how-carbon-budgeting-revolutionizing-sustainability-major-vfjqe
[14] Datasets "Climate Change Global Temperature Data." Kaggle, 27 Dec. 2021, www.kaggle.com/datasets/sachinsarkar/climate-change-global-temperature-data.
[15] Josedv. "Public_Sport_Science_Datasets/Mid-Long Distance Runners Injuries at Main · Josedv82/Public_Sport_Science_Datasets." GitHub, github.com/josedv82/public_sport_science_datasets/tree/main/Mid-Long%20Distance%20Runners%20Injuries.