

Ambient temperature related decrements in performance characteristics of NCAA D-I female soccer players

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ABSTRACT

Soccer players are exposed to various environments during outdoor play, thereby increasing their risk of heat-related performance decrements. **PURPOSE:** To examine the effects of heat stress on characteristics of performance during collegiate soccer matches. **METHODS:** Global positioning system (GPS) data from female soccer players within a Midwestern NCAA Division-I soccer program were collected during the 2023 regular season. All players were instructed to wear the GPS tracking system with the capability of heart rate (HR) monitoring throughout all the 18 games. All data were collected continuously, regardless of if players were substituted in or out of play, therefore all data were made relative to minutes played. Matches were further categorized into thirds based on temperature. Matches with temperatures exceeding 75°F were considered high heat, while matches with temperatures between 61–74°F were moderate heat, and temperatures less than 60°F were categorized as low heat. GPS data were then divided into 1st and 2nd halves for players who averaged more than 20 minutes of playing time over the course of the season. The performance characteristics measured were number of sprints, percent of time spent running at low speed (LSR) zones ≤ 12km/hr and high speed (HSR) zones (≥15 km/hr), total time spent in low heart rate (LHR) zones (≤ 70% HRmax) and high HR (HHR) zones (≥80% HRmax), total distance covered (TDC), and training load (TL). Repeated measures analysis of variance was used to analyze differences between the halves and temperature category (High vs low heat) with an alpha (α) set at ≤0.05. Post-hoc paired sample t-test were performed to further elucidate interactions. **Results:** A significant interaction was observed for the number of sprints (F=5.449, p=0.038) and duration of time spent within the HHR zone (F= 6.67, p=0.024). Post hoc comparisons indicated that the number of sprints completed in the 2nd half of the high heat matches were reduced when compared to the first half of the high heat matches (p=0.018), and the 2nd half of low heat matches (p=0.019). Additionally, data indicated that the time spent running in HHR zones during the 2nd half of the high temperature matches was higher than that of the 1st half in both conditions (p=0.011). Main effects of temperature indicate greater time HSR zones (F= 5.73, p=0.034) and in TL (F=6.40, p=0.026) in low temperatures compared to high temperatures. Main effects for half indicate more time spent in the LHR zones (F= 34.3, p ≤ 0.001) during the 2nd half. Data are presented in Table 1. **Conclusion:** The number of sprints performed was lower in high temperature matches while the duration of time spent in HHR zones was higher in high temperature matches. **Practical Application:** Coaches may utilize this information to optimize training loads leading to competition with higher temperatures.

BACKGROUND

- Soccer teams regularly compete in varying environmental conditions between home and away games(1).
- It has been demonstrated that heat stress plays a major role in athletic performance(4).
- Research suggested that there is a decline in sprint performance and distance covered during heat exposure in team sports(2)(5).
- Previous literature has predominantly focused on male soccer players or professional soccer players. Hence there is a need for studies that focus on collegiate level female soccer players(3).
- Additionally, while some studies have investigated the decline in general performance characteristics(5), there is a need to investigate the impact of hot environmental conditions on specific performance metrics.

PURPOSE

The purpose of this study is to examine the effects of heat stress on characteristics of performance in collegiate soccer matches during different periods of the game (1st half vs 2nd half).

METHODS

Table 1: GPS-derived Performance Characteristics

Characteristics of Performance	
Number of sprints	Number of explosive runs made > 15 km/hr
Low speed zone	Percentage of time spent running at low speed < 14 km/hr
High speed zone	Percent of time spent running at a high speed > 15 km/hr
Low heart rate zone	Percentage of time spent within a heart rate zone less than 60%
High heart rate zone	Percent of time spent within a HR zone greater than 75 %
Total distance covered	Total distance covered during each half in miles
Training load	The intensity of the activity relative to the duration

PRACTICAL APPLICATIONS

Coaches and trainers may utilize this information to optimize training loads leading to improved performance during competition in higher temperatures

METHODS CONT

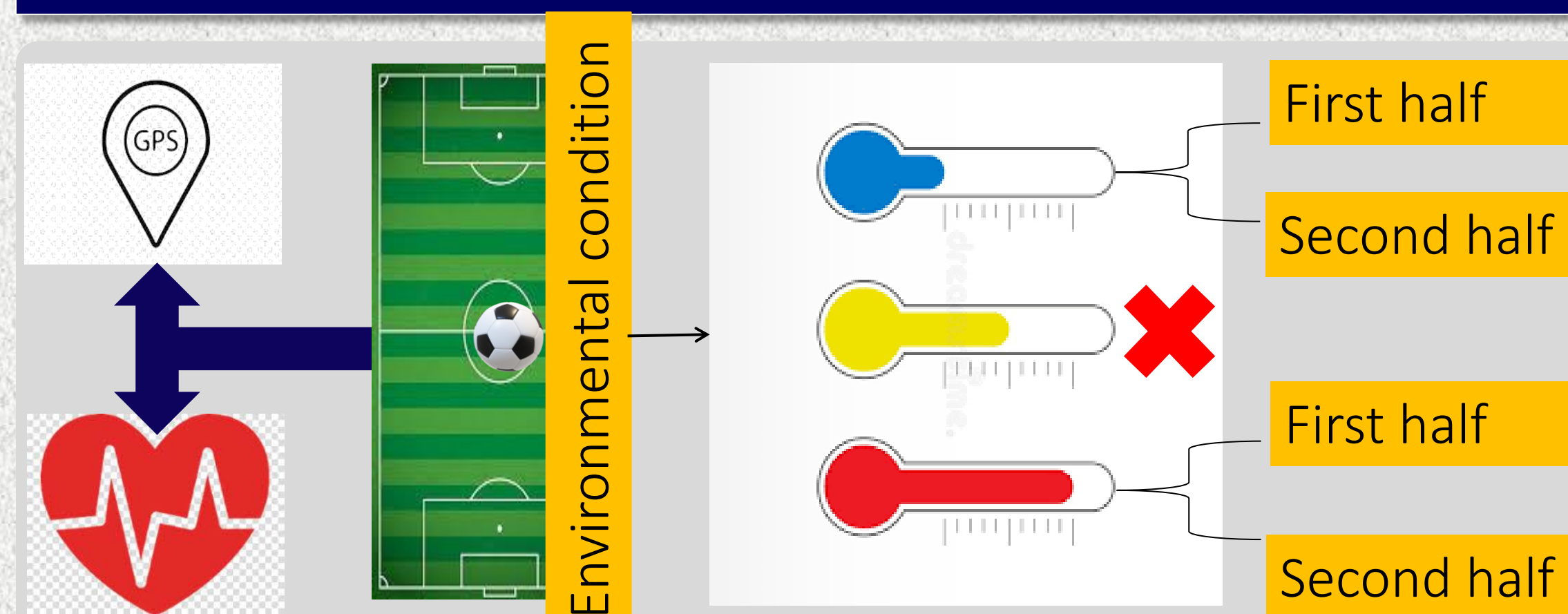


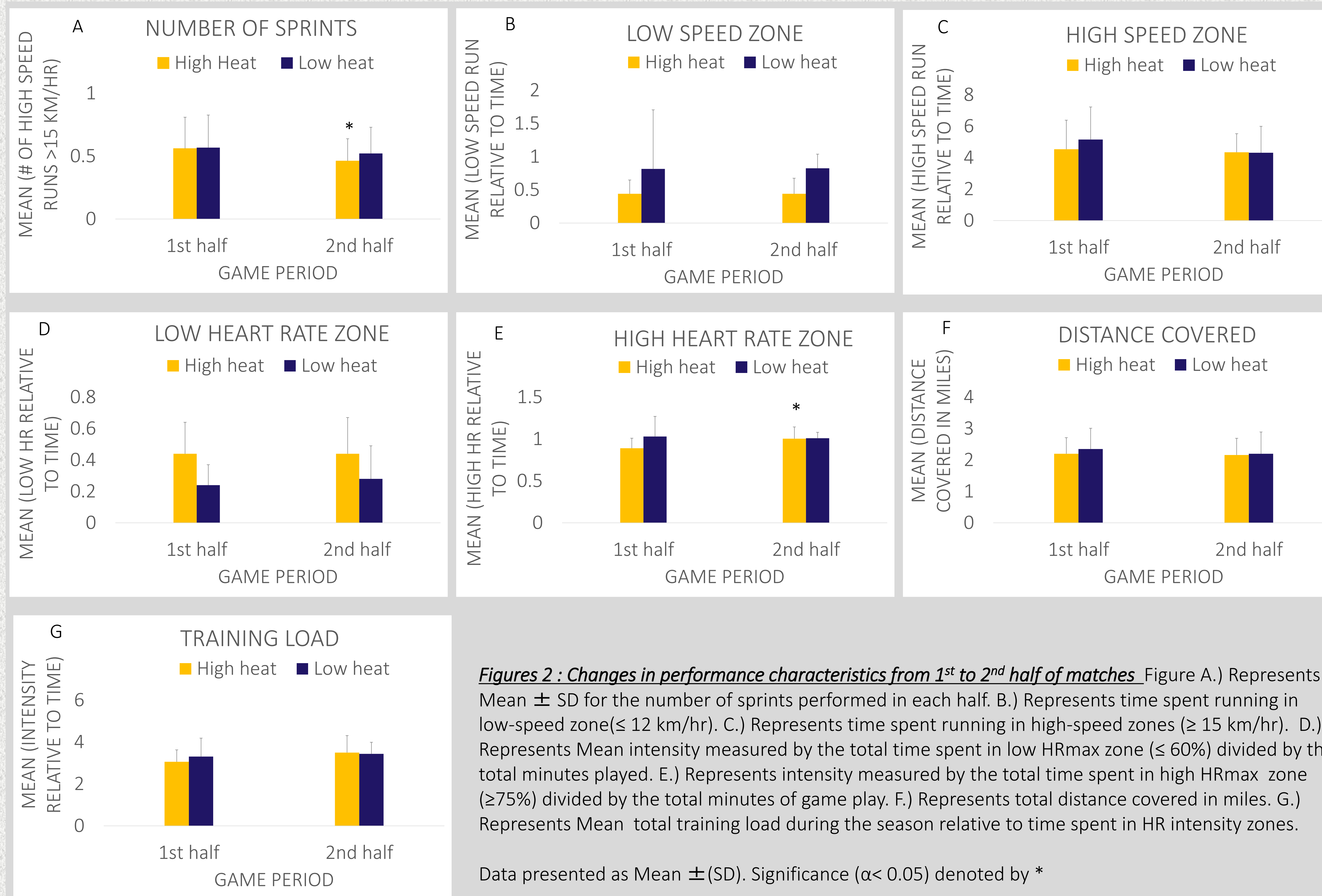
Figure 1: Study Design.

Performance data from 13 female soccer players were collected during the 2023 season. Only players who averaged 20 mins or greater of play-time were included. All players were instructed to wear the GPS tracker and HR monitor during the 18 games of the season. Games were categorized into three heat index conditions: high (> 75, n=6), moderate (61-74, n=6) and low (< 61, n=6) based on weather forecast. The data were then divided into 1st half and 2nd half for each condition and analyzed.

Statistical Analysis

Data were analyzed using repeated measures ANOVA to examine the difference in performance metrics between high heat and low heat conditions.

RESULTS



Data presented as Mean ± (SD). Significance (α < 0.05) denoted by *

RESULTS CONT

Table 2: Differences in performance characteristics

Performance	F	p-value
Number of sprints	0.59	0.455
High speed zone	4.36	0.059
Low HR zone	1.62	0.226
High HR zone	6.64	0.024*
Number of sprints	5.49	0.038*
Total distance covered	1.99	0.180
Training load	4.00	0.067

Significance set at an alpha (α) of 0.05. *denotes significant differences.

CONCLUSION

- Heat stress may lead to a reduction in number of sprints which is consistent with previous literature(1).
- Increased cardiovascular strain may be experienced in high heat conditions.
- The present study did not indicate any differences in total distance covered between environmental conditions and game periods which conflicts with previous findings(2).
- Future investigations should aim to include a larger sample size to further explore this topic.

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