Adaptation to Desert Life in the Bedouin to Inform Heat Stress Injury Risk

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Introduction

- **Exertional heat illness** remains one of the leading causes of preventable morbidity among service members.
- **The Bedouin** have lived for thousands of years in an extreme desert environment with high heat and limited water.
- **Hypothesis**: Evolved genetic variants in the Bedouin population may serve as predictive markers of heat stress tolerance in military personnel.

Methods

- **Data Source:** The Human Genome Diversity Project
- **Focus:** The Bedouin population as the focal group, with the Druze as a closely related comparison population and the Han Chinese as an outgroup.
- **Population Branch Statistic (PBS) Analysis:** To identify signals of population-specific positive selection in the Bedouin lineage.

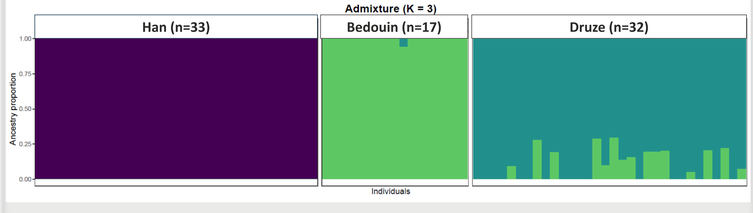


Figure 1. Admixture analysis shows that the Bedouin have distinct genetic ancestry that enables detection of evolved variants.

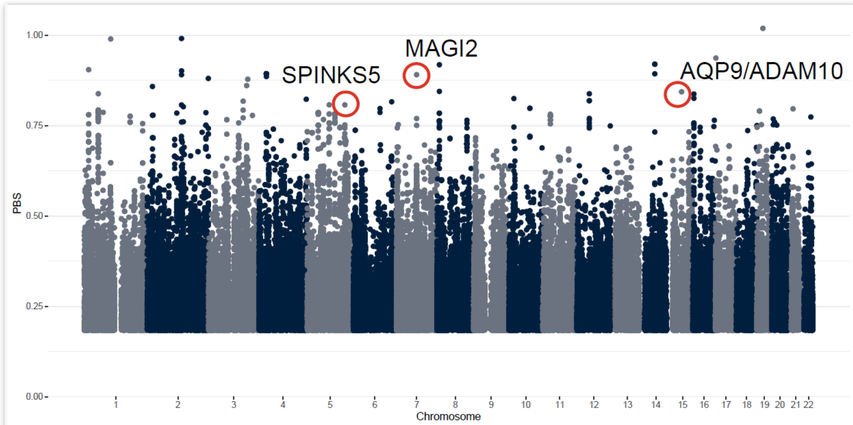


Figure 2. Genome-wide PBS scan highlighting loci with elevated Bedouin-specific selection signals, with top candidate genes (SPINK5, MAGI2, AQP9, ADAM10).

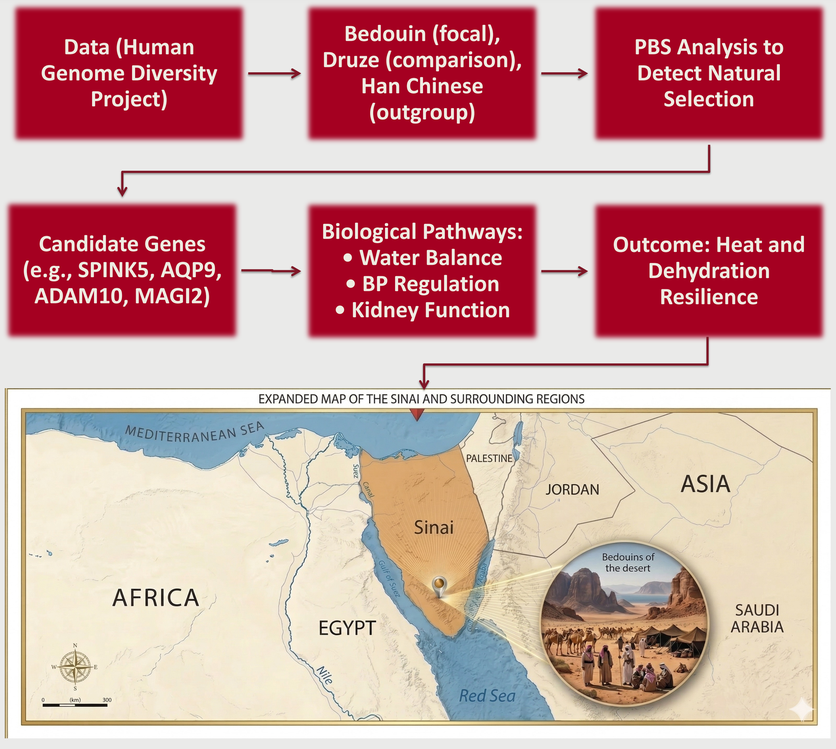
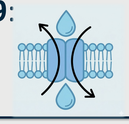


Figure 3. Geographic location of the Bedouin population in South Sinai, where future genomic and physiological data will be collected. "Created with Gemini"

Results: Evolved Genetic Loci

SPINKS5:  Increased expression improves skin barrier function and reduces transepidermal water loss.

AQP9:  The transport of water, glycerol, and urea, contributing to epidermal hydration and barrier function.

ADAM10:  Involved in renal tubular function; depletion impairs kidney and vascular function and leads to hypertension.

MAGI2:  Essential for podocyte structure and glomerular filtration barrier integrity; loss leads to severe renal dysfunction.

Conclusions

- Candidate loci converge on pathways involved in epidermal water conservation, vascular regulation, and renal filtration integrity.
- These loci provide mechanistic insight into protection against kidney injury and identify targets for heat stress resilience.

Translationally, the highlighted pathways provide candidate targets for risk stratification. Integrating these insights will enable precision strategies aimed at reducing exertional heat injury, mitigating AKI risk, and preserving operational readiness in hot environments.