



Transhumance: cortisol in milk as non-invasive tool to assess adaptation response

Session 7. New ways to maintain the heritage of grassland and livestock



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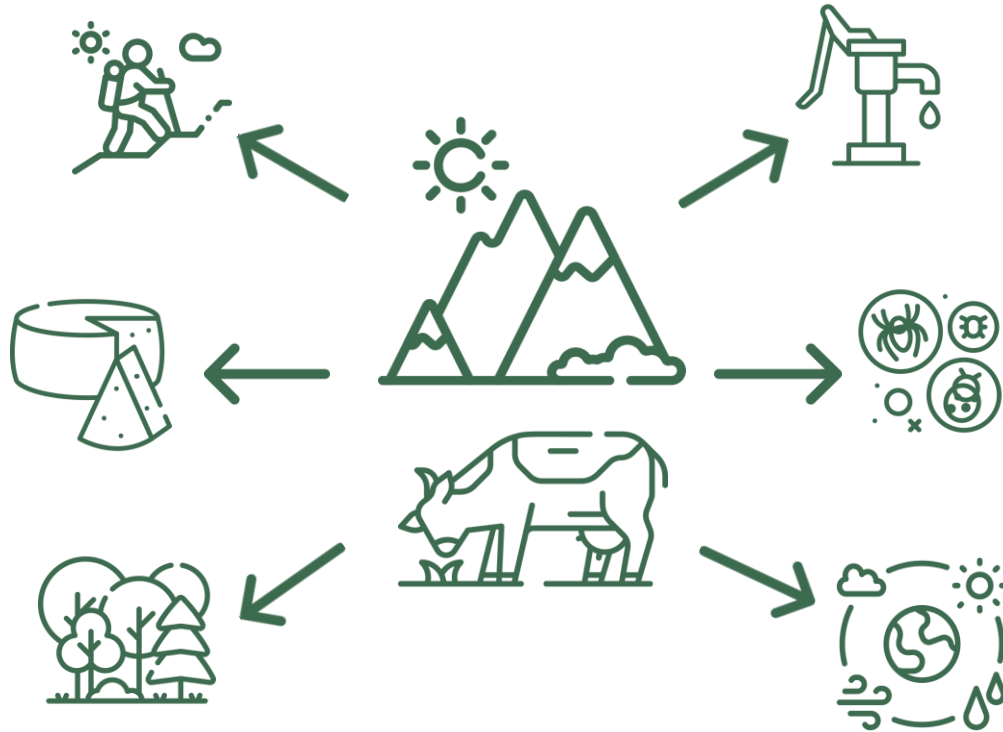


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Transhumance



Transhumance is a traditional mountain farming practice with a key role in maintaining ecosystem services

Transhumance and welfare



The **physical exertion**, combined with **environmental changes**, altered **daily rhythms**, and **dietary shifts**, may represent cumulative stressors for dairy cattle



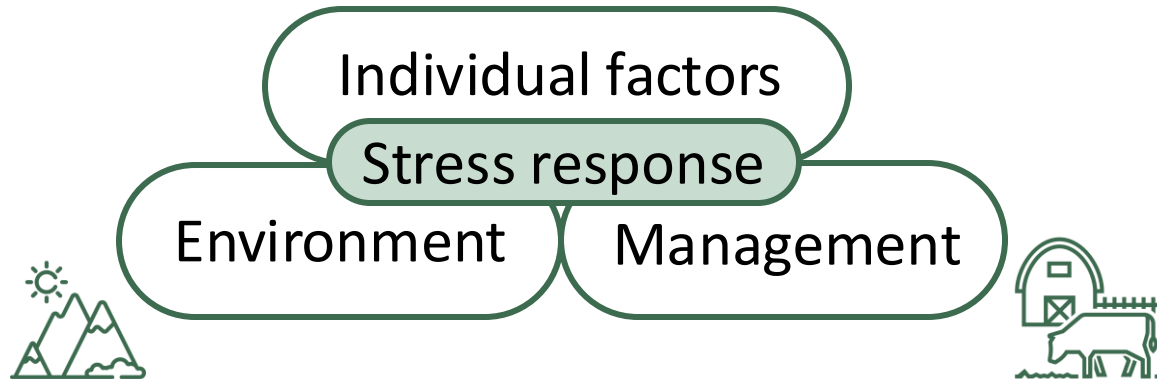
Welfare



Milk cortisol is a sensitive, non-invasive biomarker for assessing short-term physiological stress responses



However,

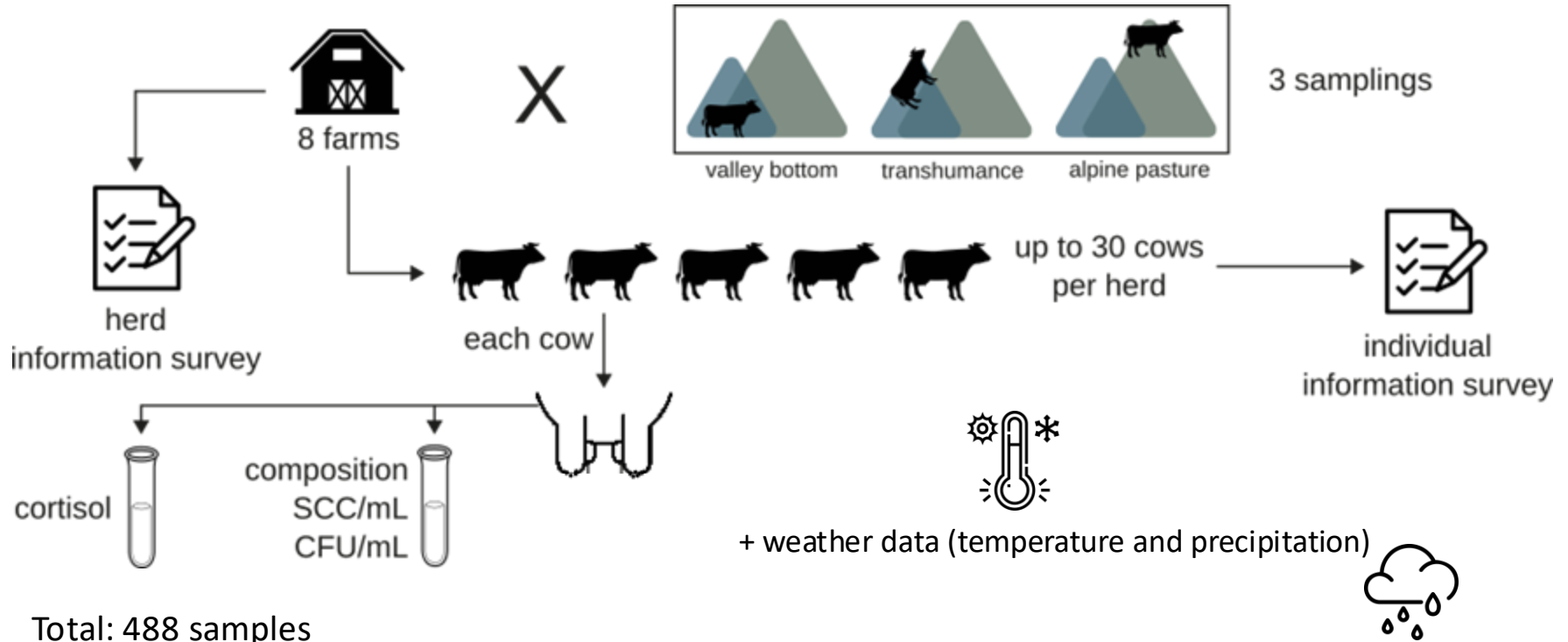


Aim



Assessing whether transhumance represents a physiological stressor for dairy cattle, using milk cortisol as a non-invasive biomarker, and to identify the main factors, including management practices, environmental conditions, and individual animal characteristics, associated with its variation.

Experimental design



Variables and statistical approach

**Outcome variable:**

Milk cortisol (ng/mL)

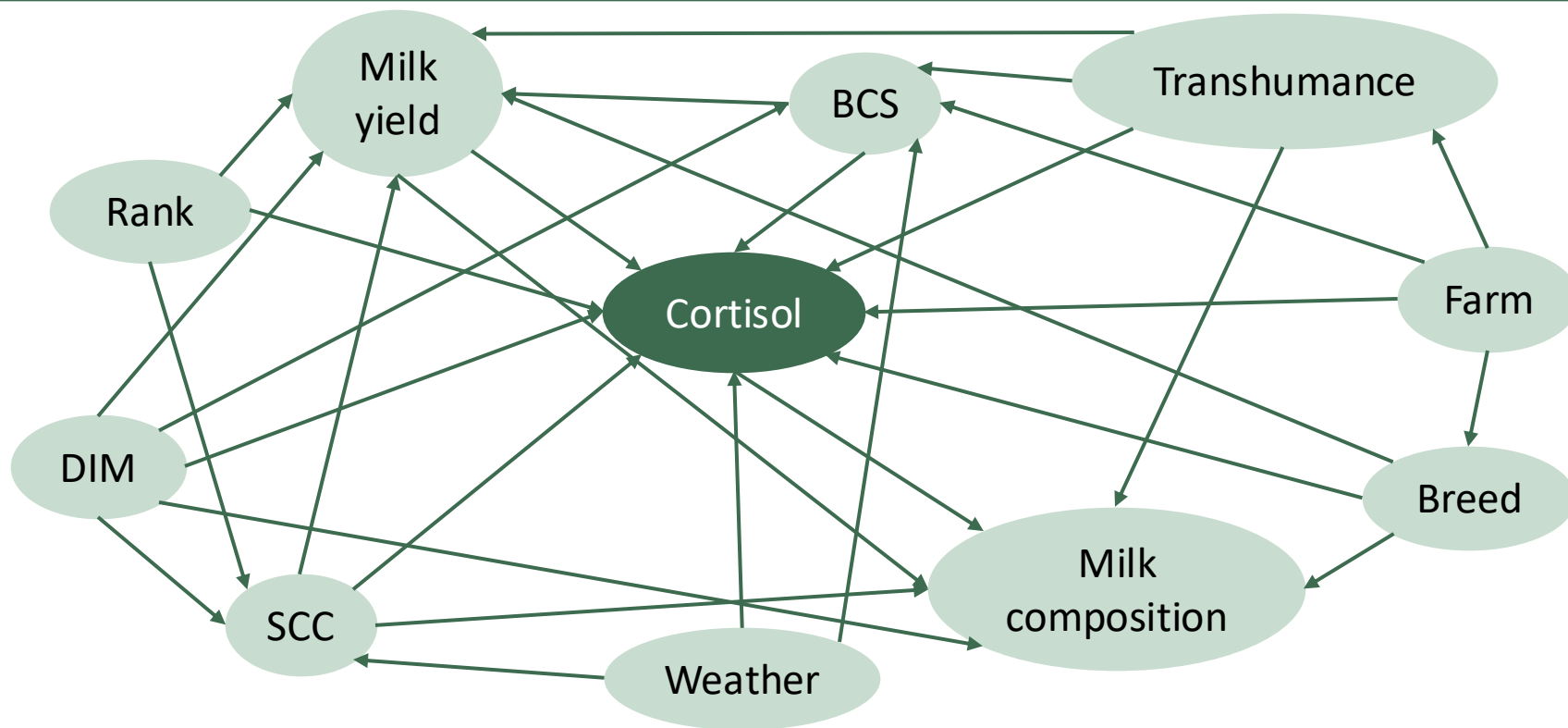
Predictors:

- Milk composition, somatic cell count, milk yield;
- Lactation rank and stage, BCS, breed;
- Temperature, precipitation

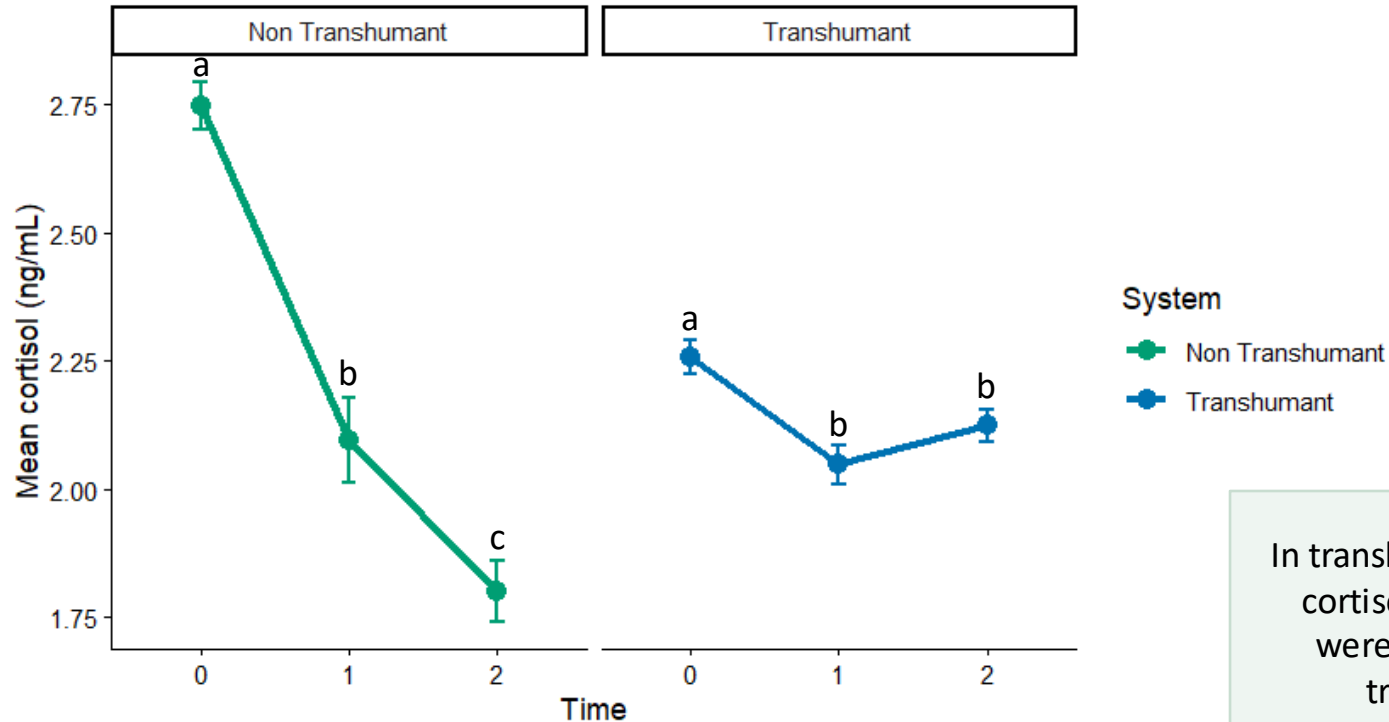
Modelling and inference framework:

- DAG-informed exposure-specific models
- GEE models with exchangeable correlation
- Animal ID as clustering factor
- Tukey-adjusted post-hoc breed comparisons

DAG: Directed Acyclic Graph

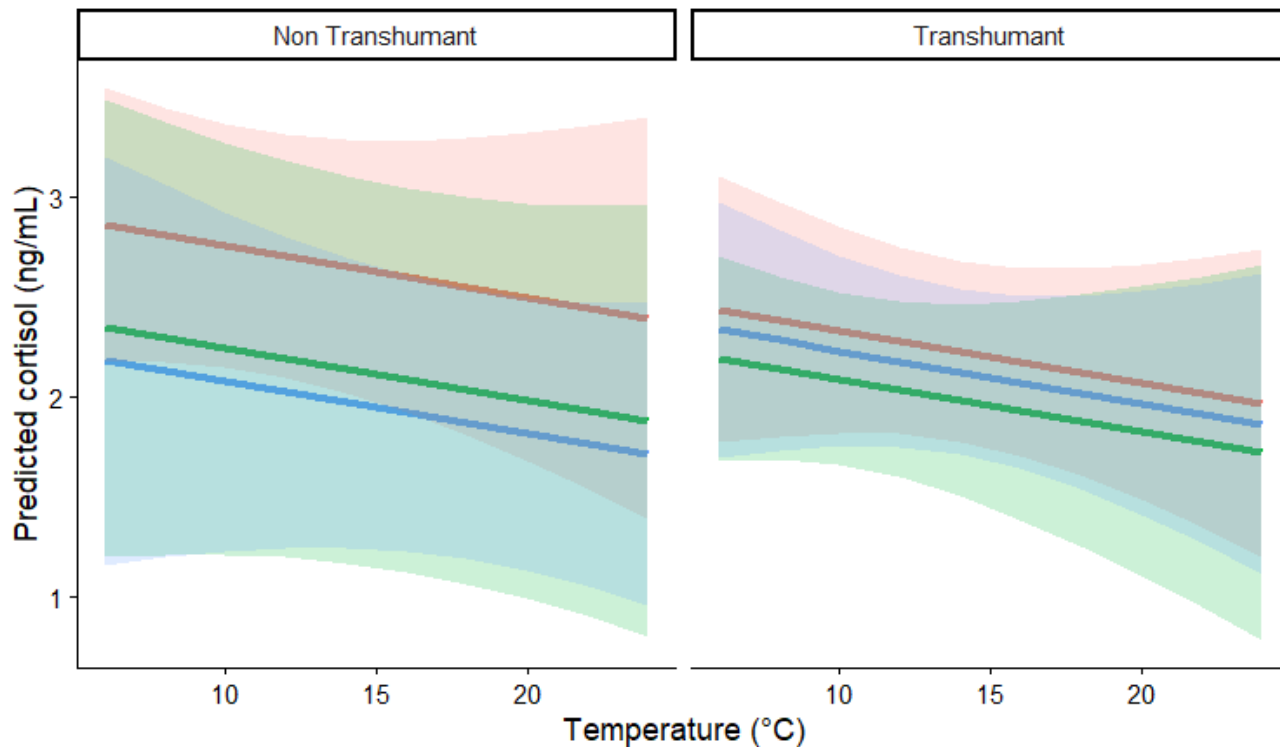


Results: cortisol and transhumance



In transhumant herds, milk cortisol concentrations were lower following transhumance

Results: cortisol and temperature



↓ 1°C = ↑ 0.05
ng/mL cortisol

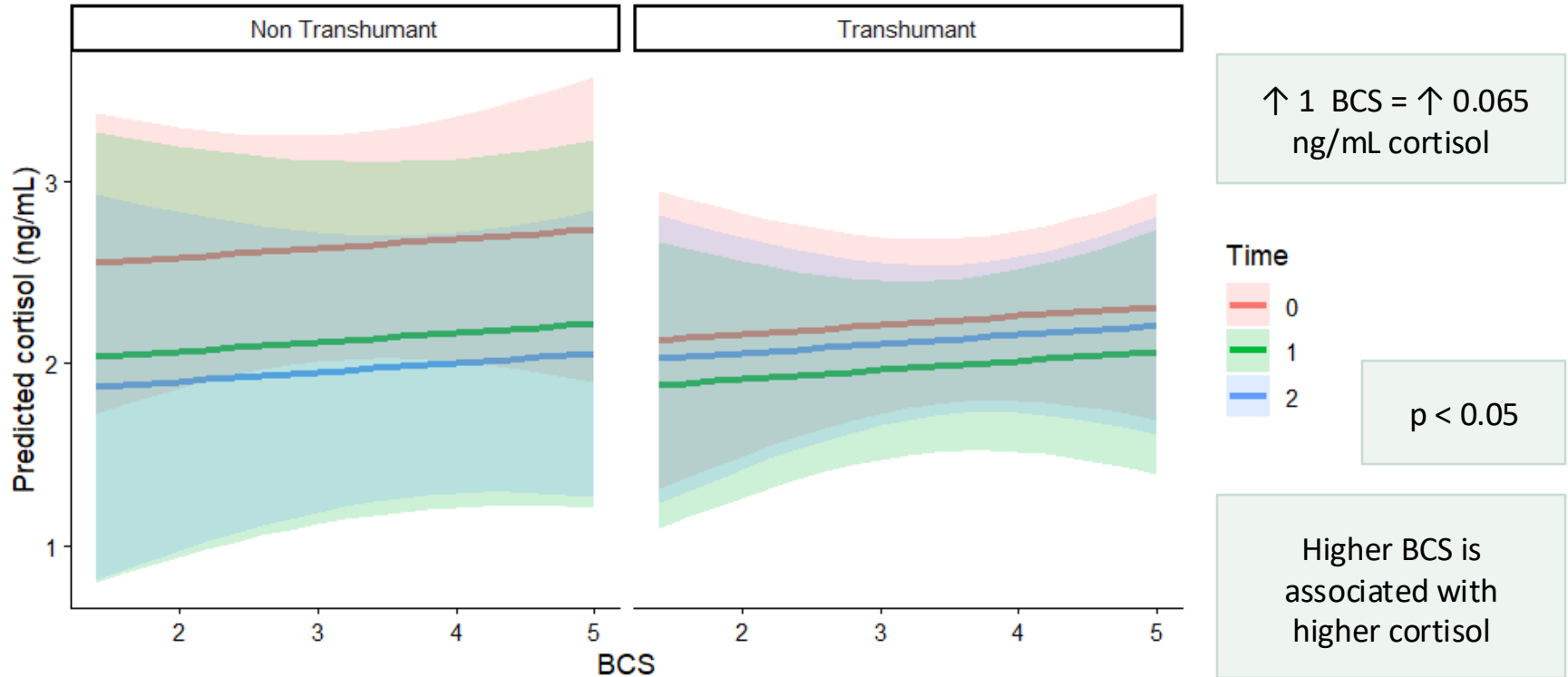
Time



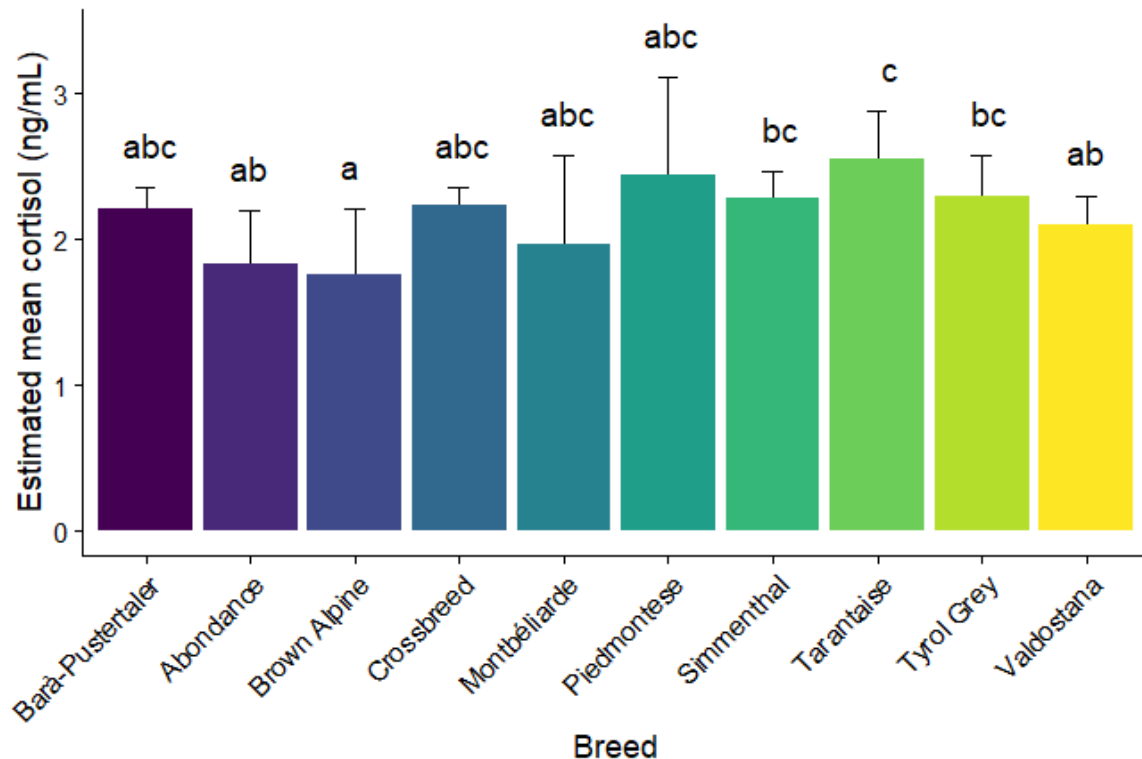
$p < 0.0001$

Higher
temperatures were
associated with
lower milk cortisol
concentrations

Results: cortisol and BCS



Results: cortisol and breeds



Differences in cortisol production were observed among breeds.

Discussion



...milk cortisol rose with
temperature-humidity load

...there are differences by
breed

Literature reported
that...

...transport stress increases
cortisol

...cortisol rises after abrupt
group relocation

Considerations



- Lack of comparable studies available
- Small sample size (8 herds)
- Breed effects confounded by specific herd
- Post-transhumance sampling within 5 days

Repeated sampling provided a unique opportunity to investigate physiological responses to transhumance



Mountain environments and challenging conditions do not necessarily imply poor welfare in **well-adapted** animals.



And our results?



Transhumance

Lower milk cortisol after transhumance suggests rapid acclimation rather than sustained HPA axis activation.

Temperature and BCS

In mountain systems, rising temperatures may reduce cold stress, while BCS remains within normal physiological ranges.

Cortisol is sensitive, not specific

Milk cortisol is a sensitive but context-dependent biomarker influenced by environmental, management, and individual factors.



Conclusion

*Transhumance may be better framed as a **mixed physiological challenge**.*

*Whether transhumance is experienced as **stress** or **adaptation** likely depends on management, environmental conditions, and individual factors.*



Thank you

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