Identification of chronic stress biomarkers in dairy cows

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ICAR welfare workshop 2022

HappyMoo project

Interreg North-West Europe
EUROPEAN UNION
HappyMoo
European Regional Development Fund

Partnership: farmers organizations (DHI) &

eleveo ensemble vers le meilleur élevage en Wallonie
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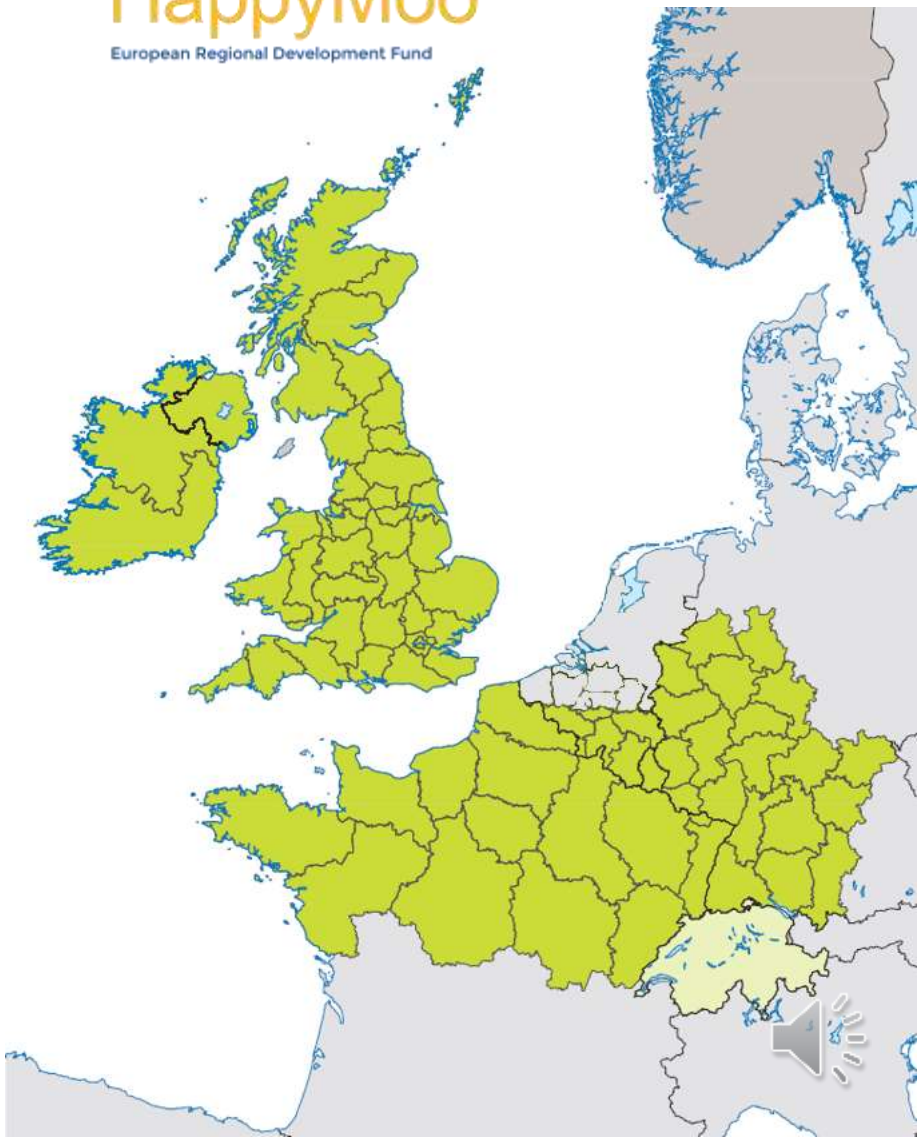

To develop monitoring tools for welfare of individual dairy cows.

→ alerts about the freedom from disease, hunger and stress.

Stress workshop: Brainstorming by experts on stress and its indicators

Interreg North-West Europe HappyMoo
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Outputs:

- ✓ Chronic stress is of major interest
- ✓ No consensus on biomarkers

Chronic stress

"stress is the non-specific response of the body to any demand made upon it" (Selye, 1976)

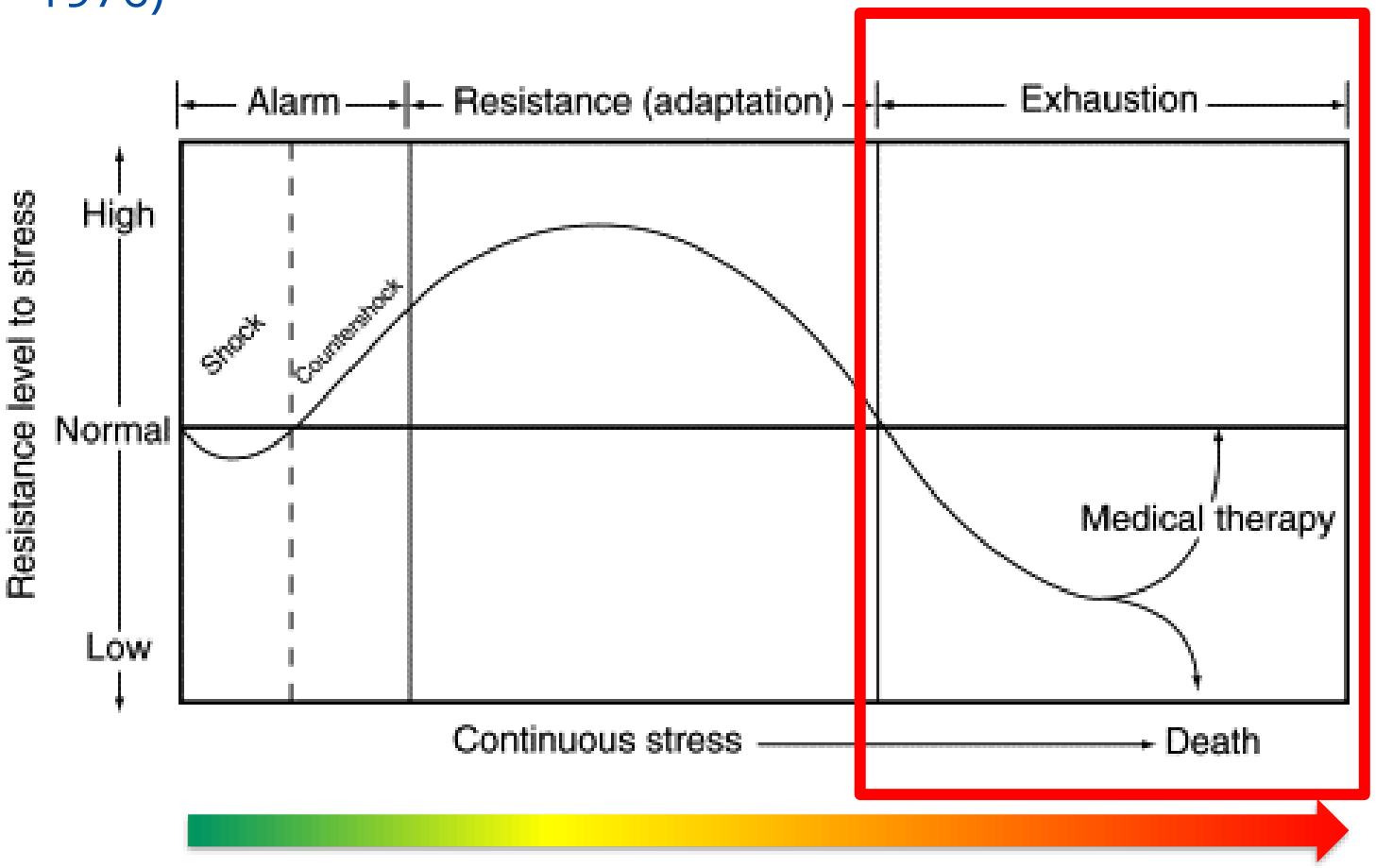


Figure of General adaption syndrome (from A.C. Brown, C.I. Waslien, in Encyclopedia of Food Sciences and Nutrition (Second Edition), 2003)

↗ susceptibility to metabolic, inflammatory and infectious diseases (Moberg et al., 1980; Romero, 2004).

↗ fertility troubles (Dobson and Smith, 2000; Walker et al., 2008)

↘ growth disturbances (Elsasser et al., 1995)

↘ weight (Mormède et al., 2007)

↘ milk production (Tallo-Parra et al., 2018)

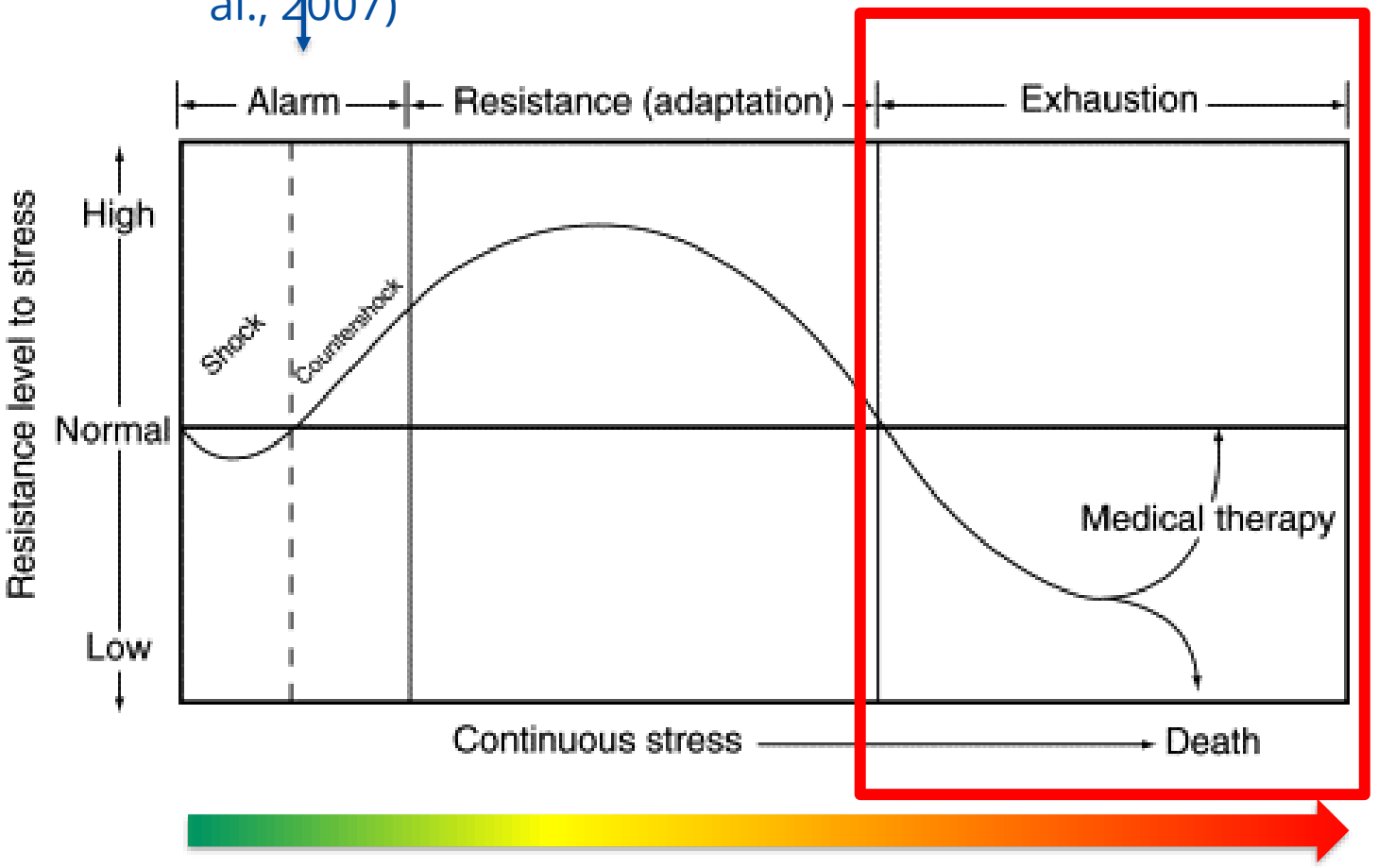
↘ production and economics of farms,

↘ welfare of cows

↘ societal perception of dairy production

Chronic stress

cortisol levels in blood (Mormède et al., 2007)



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Biomarkers of chronic stress???

- hair cortisol
- hearth rate variability
- glycated protein (fructosamine)
- β-endorphin
- lymphocyte profile
- thyroid hormones
- avoidance distance
- activity
- rumination

(Creutzinger et al., 2017; Vesel et al., 2020; Mormède et al., 2007; Comin et al., 2013; Burnett et al., 2015a; Meyer and Novak, 2012; Tallo-Parra et al., 2017; Burnett et al., 2015b; Braun et al., 2017; González-de-la-Vara et al., 2011; Trevisi and Bertoni, 2009; Mormède et al., 2007; von Borell et al., 2007; Trevisi and Bertoni, 2009; Kovács et al., 2015;Waiblinger et

Objective

Induce 4 week stress through

- severe overstocking
- restricted access to feed
- punctual unusual events

Evaluate and compare potential chronic stress biomarkers

Protocol was approved by the ethical commission of Liège University.
In accordance with the EU Directive 2010/63/EU for animal experiments

Experiment

Stress group (severe overstocking for 4 weeks)

- 15 cows
- < 5 m^2/cow
- 7 places at feed bunk

Experiment

Control group
- 15 cows
- >10 m² per cow
- more feed bunks than cows

Experiment (punctual unusual events)

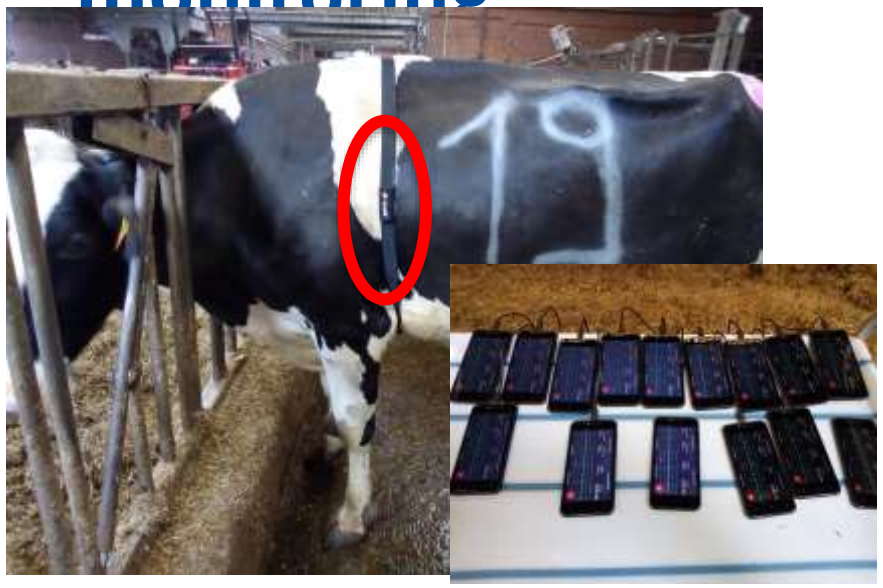
Global measures

-MY
-SCC
-milk composition
-weight
-BCS
-injuries, heat…

Behaviour

-observations
-avoidance distance
-rumination
-activity

Heart monitoring

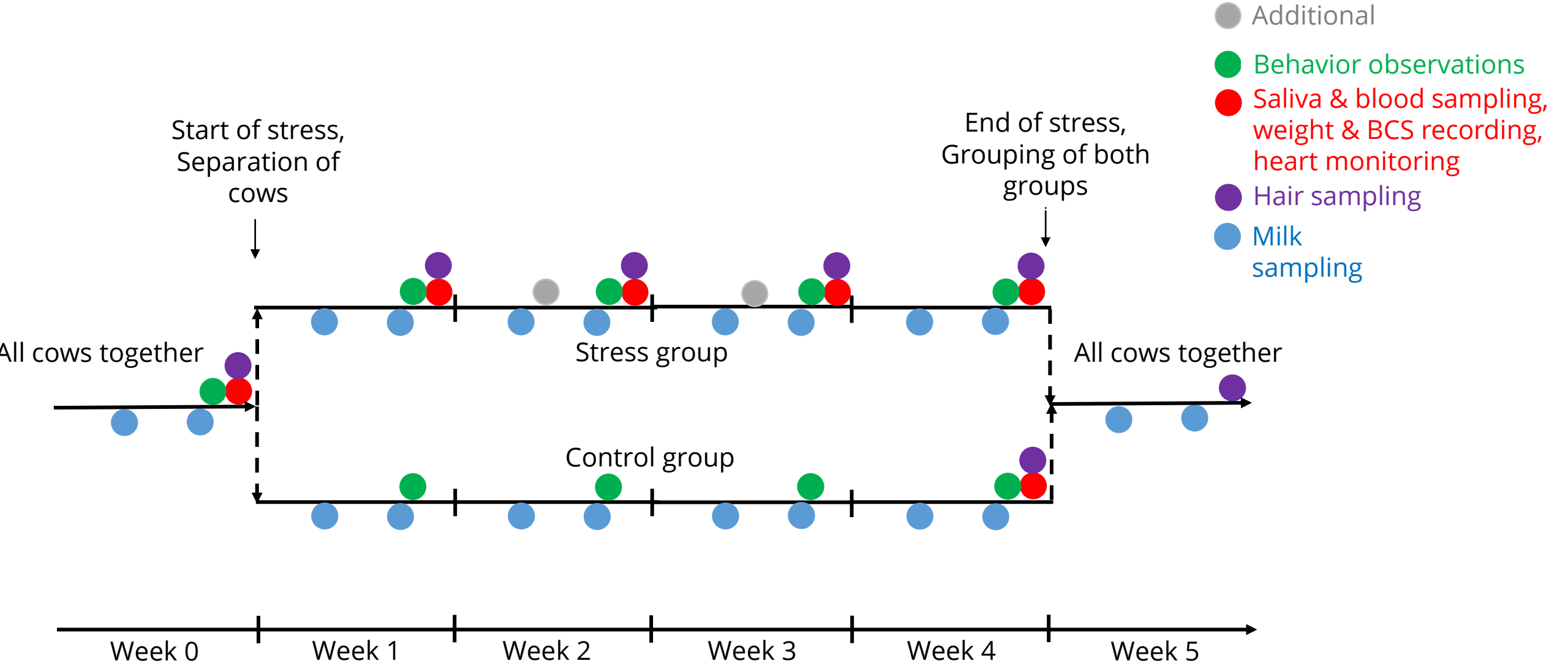


Blood (Glucose, Fructosamin ,T4, β-endorphine, leucocytes)

Saliva (cortisol)

Hair (cortisol)

Experiment


Additional
Behavior observations
Saliva & blood sampling, weight & BCS recording, heart monitoring
Hair sampling
Milk sampling
Start of stress, Separation of cows
End of stress, Grouping of both groups
All cows together
Stress group
All cows together
Control group
Week 0
Week 1
Week 2
Week 3
Week 4
Week 5

Data treatment

Week averages

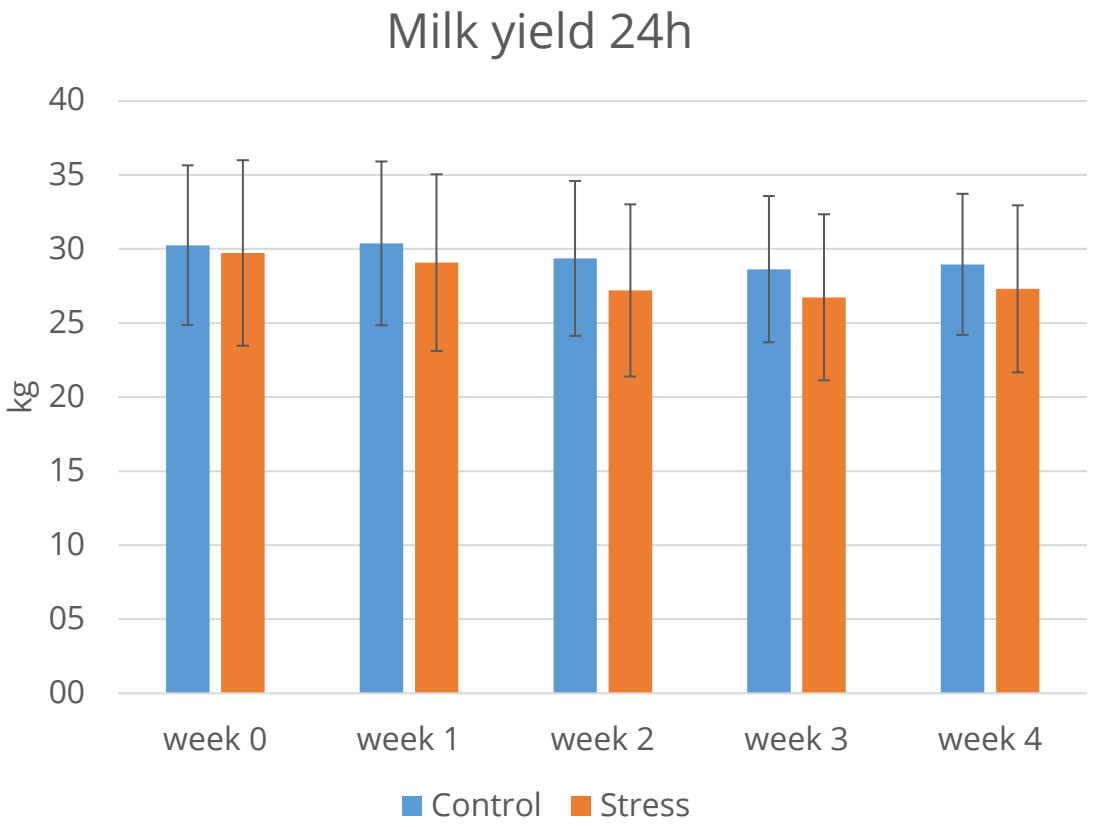
Linear mixed repeated models (PROC MIXED procedure of SAS) with random effect of cow being REPEATED along the weeks:

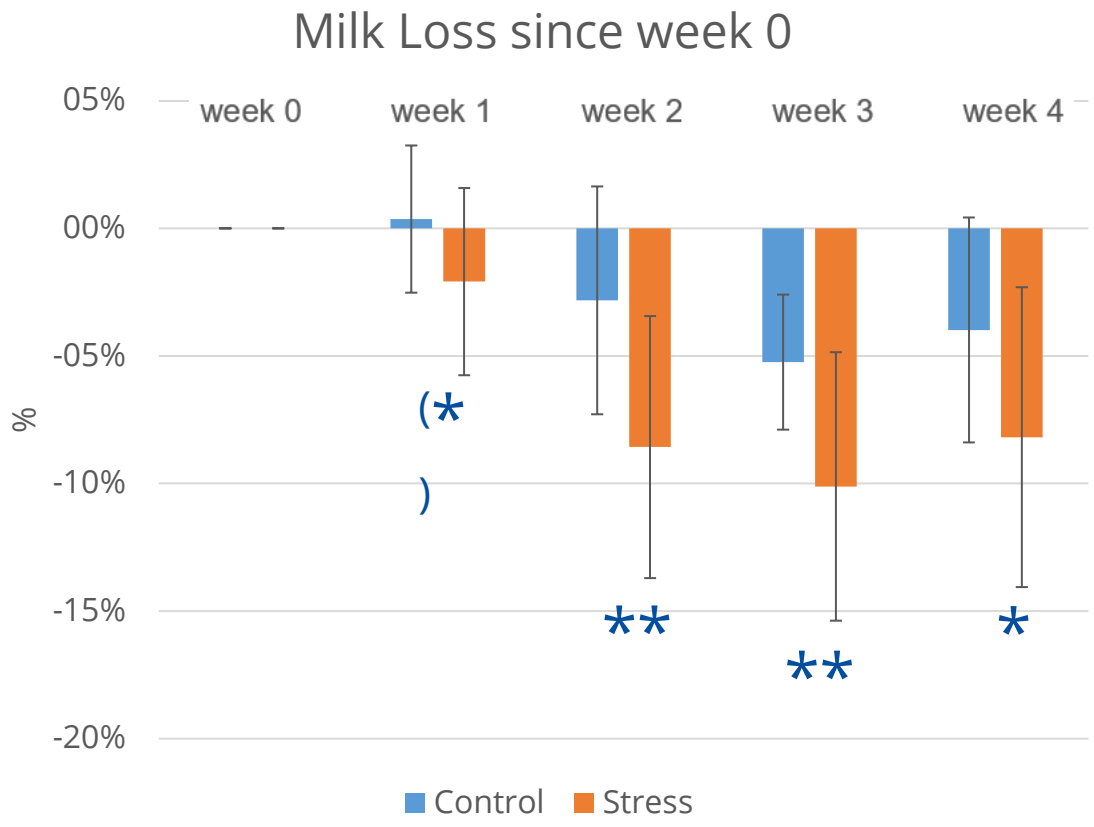
$$Y_{ijklmn} = \mu + group_i + week_j + group_i*week_j + cow_k + e_{ijklmn}$$

Objective: highlight biomarkers having a different level in week 4 (but similar in week 0)

→ level modification due to stress induction.

Results – production variables





Milk Yield

Weight

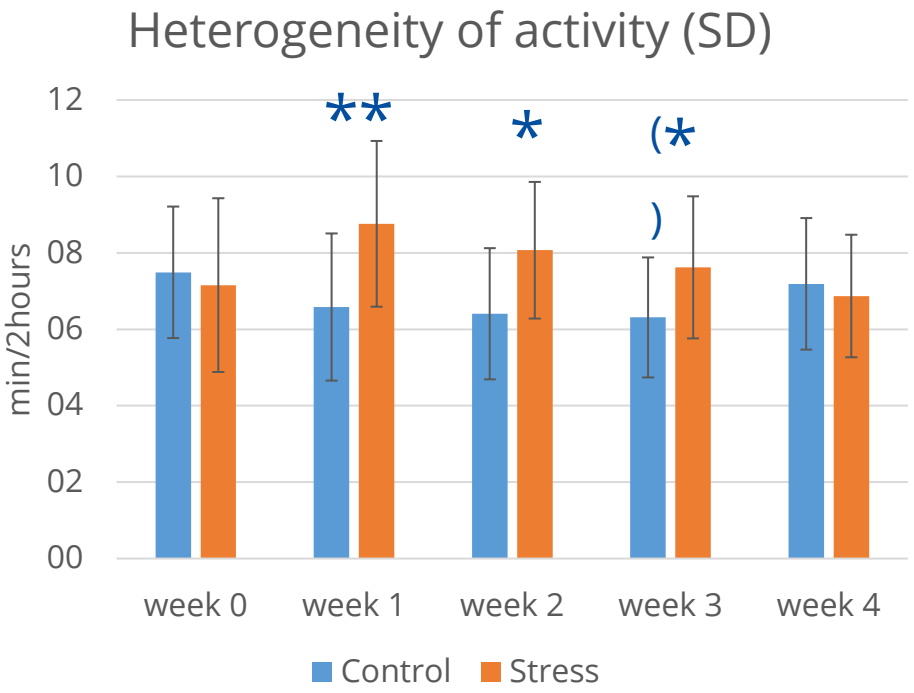
BCS

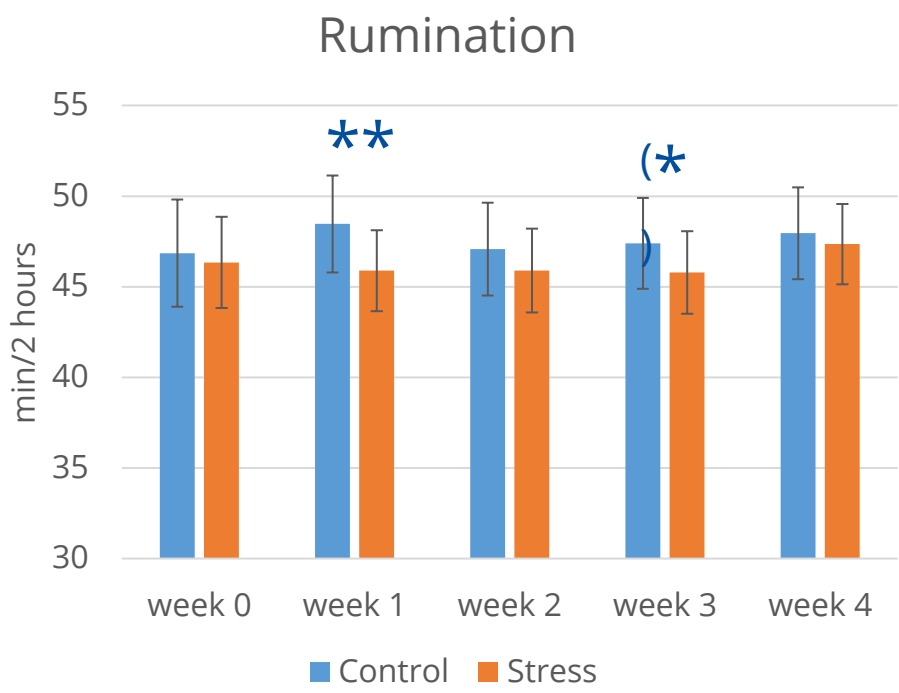
no difference between groups

(*) P ≤ 0.1
* P ≤ 0.05
** P ≤ 0.01
*** P ≤ 0.001

Results - behaviour

(*) P ≤ 0.1
* P ≤ 0.05
** P ≤ 0.01
*** P ≤ 0.001





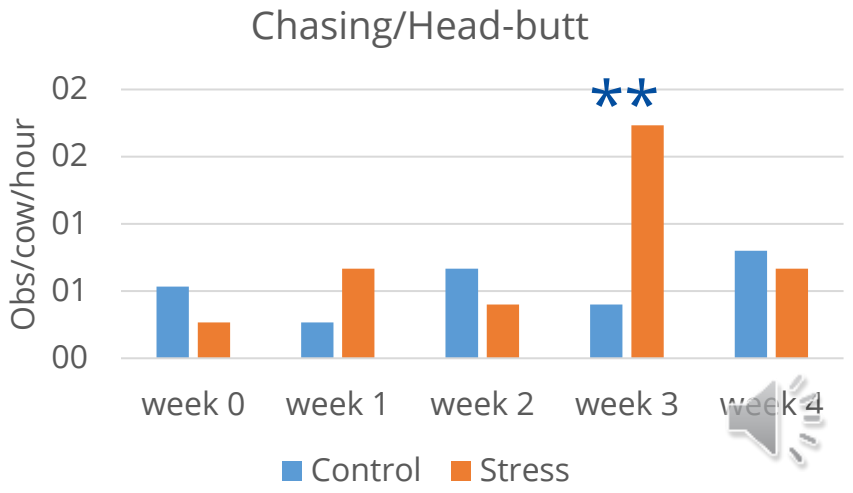
Activity (min/2 hours)

Rumination SD (min/2 hour)

Human fear distance (cm)

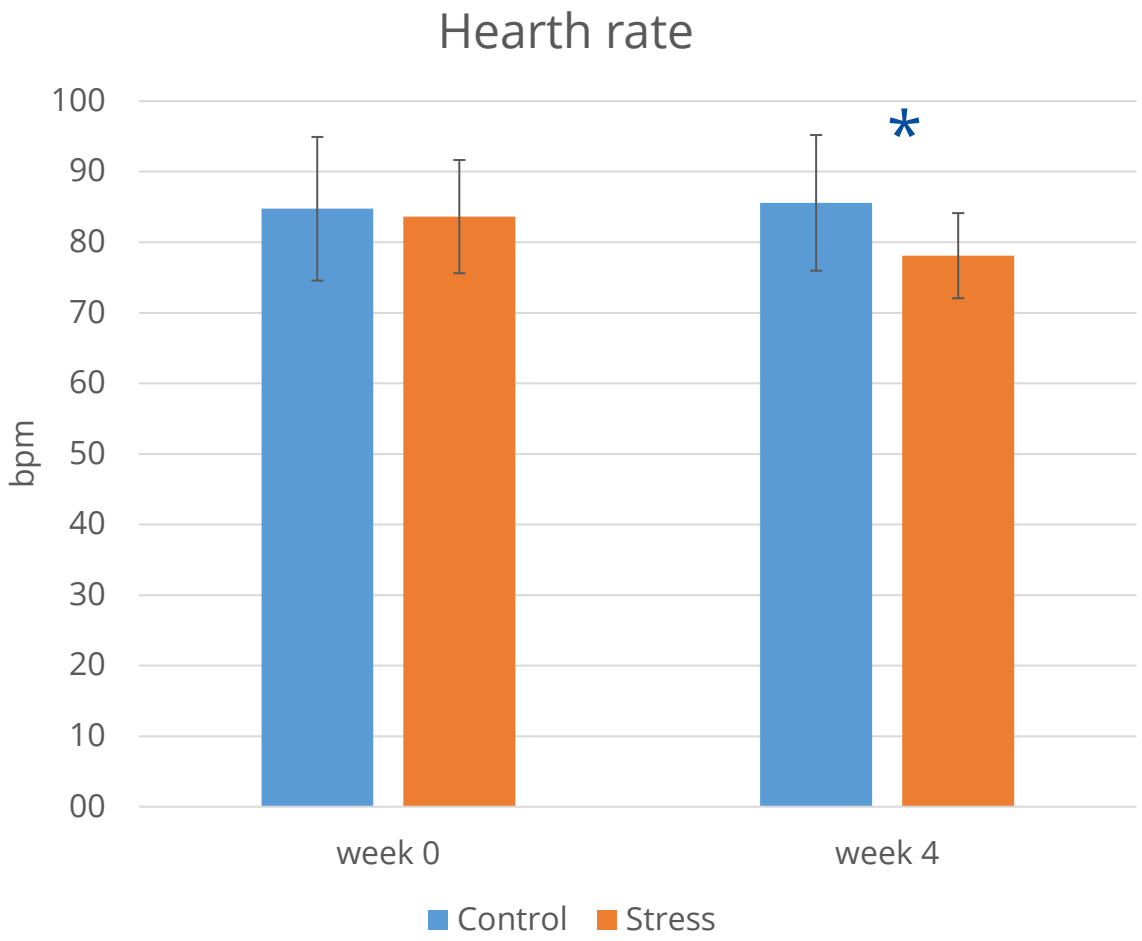
Grooming (obs/hour)

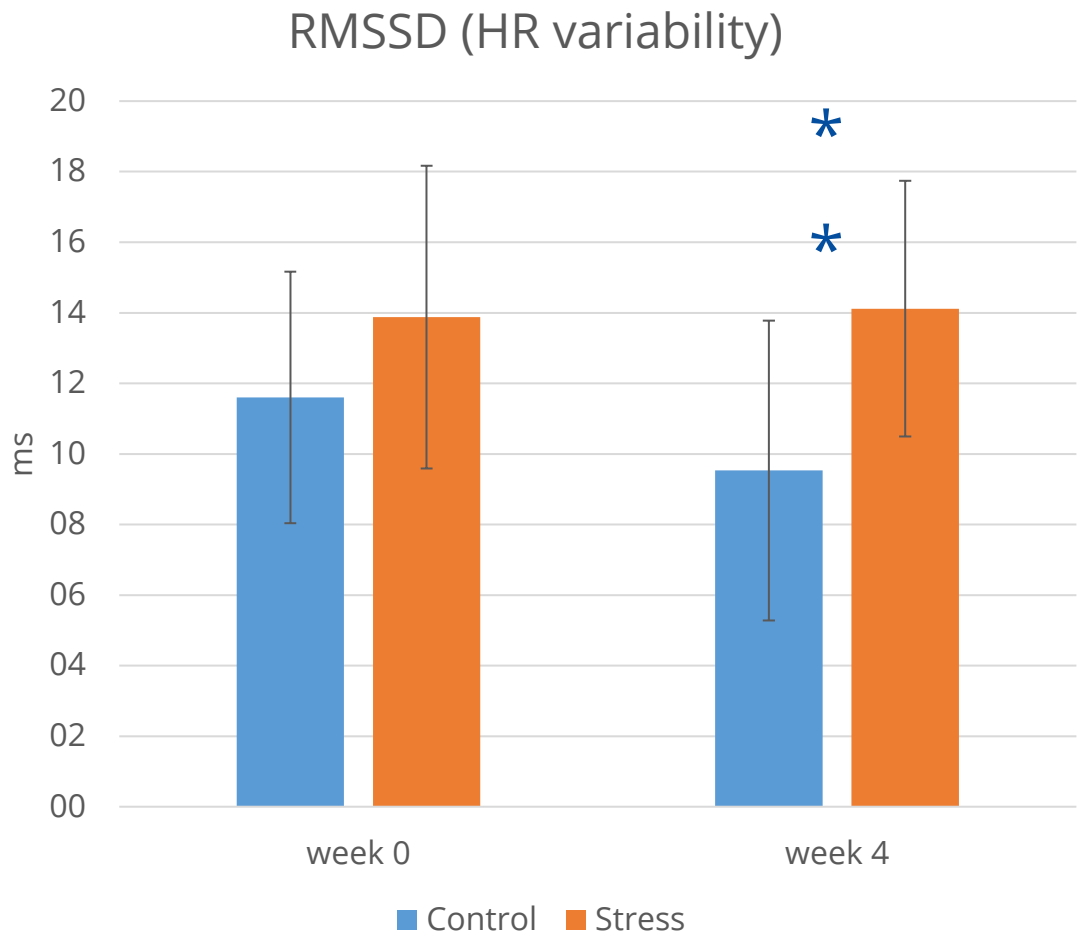
no difference between groups



Results – heart rate

(*) P ≤ 0.1
* P ≤ 0.05
** P ≤ 0.01
*** P ≤ 0.001





Results – biochemical and immune biomarkers

Blood Glucose (mg/dL)

Blood β-endorphin (pg/ml)

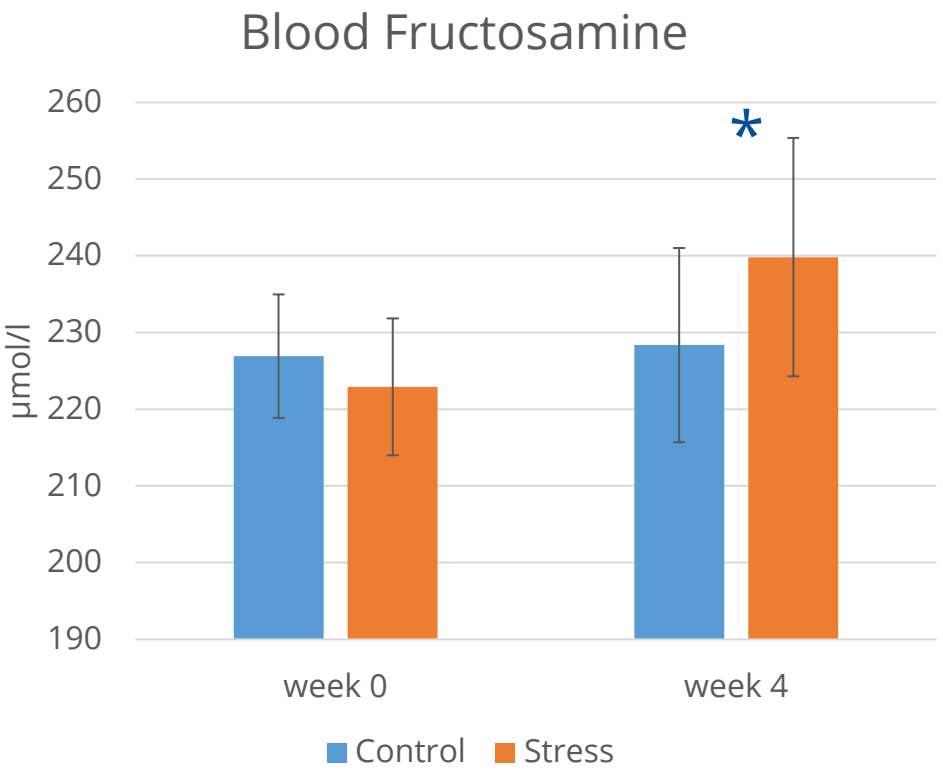
Blood T4 (µg/L)

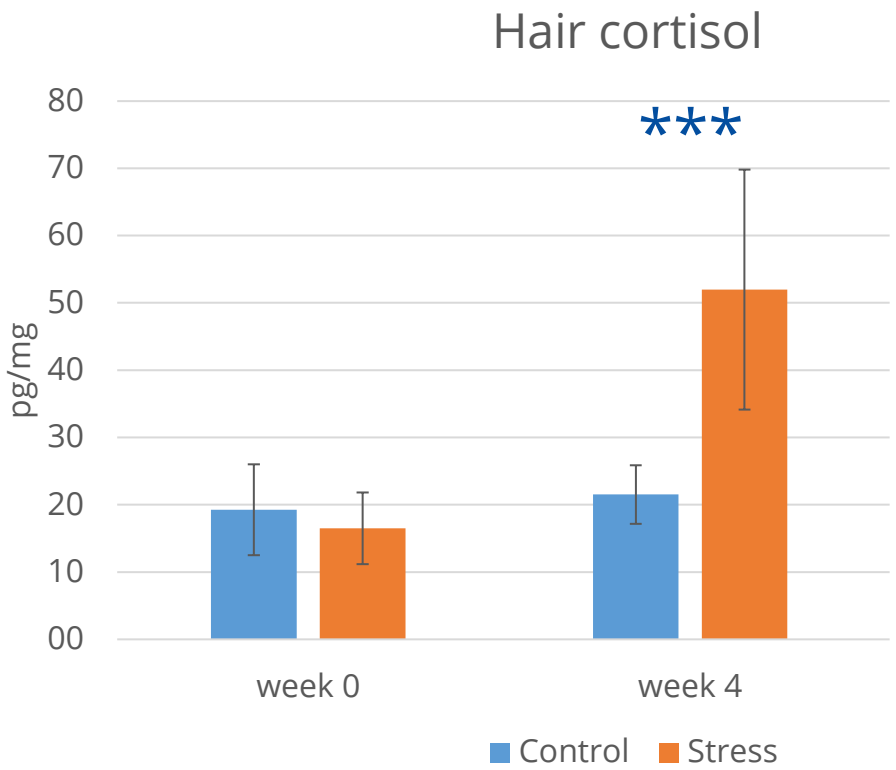
Salivary cortisol (µg/dL)

Leucocyte Profile

no difference between groups

(*) P ≤ 0.1
* P ≤ 0.05
** P ≤ 0.01
*** P ≤ 0.001





Conclusions

- Effects on activity, rumination and chasing/head-butt: effect of overstocking, competition and adaptation of animals
- Milk Loss: efficient alert system to detect troubles (but not specific)
- Heart rate: relevant biomarker (but tedious and complex)
- Blood fructosamine: interesting biomarker (but not specific, nutrition and energy balance)

✓ Hair cortisol

Next steps

- Analysis of milk composition data
- Duplication of the experiment (april 2021) in France
- Selection of 2 biomarkers
- Large scale sampling for assessment of stress

SAVE THE DATE
27 > 29/04/2022
in Namur, Belgium
Thanks for your interest!
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