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# ***Keel bone lesions in laying hens: occurrence and risk factors***

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# The challenge



## SCIENTIFIC OPINION

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### Welfare of laying hens on farm

EFSA Panel on Animal Health and Animal Welfare (AHAW),  
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# The framework

Welfare consequences

## Bone lesions

Group stress

Unwanted sex

Inability for  
comfort

Inability for  
exploration  
and foraging

Isolation stress

Predation stress

Resting  
problems

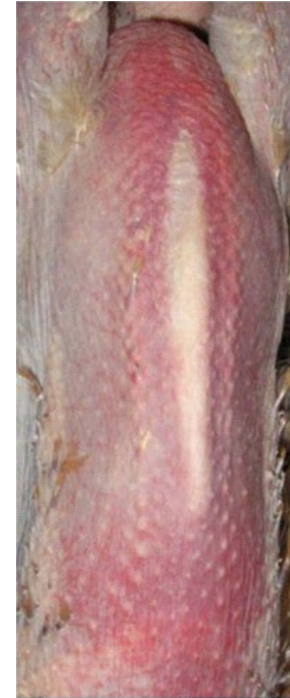
Restriction of  
movement

Skin disorders

Soft tissue  
lesions and  
integument  
damage

EFSA, 2023

## Keel deviations



Strait keelbone



Keelbone with  
deviation



Keelbone with  
deformation

## Keel fractures

Welfare Quality Protocol, 2019

# The framework

## Welfare consequences

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### Keel fractures



Wilkins et al., 2011

# Implications

## Keel deviations

Observed in native jungle fowl chickens and broiler chickens, too  
(*Bokkers and Koene, 2003; Kittelsen et al., 2021*)

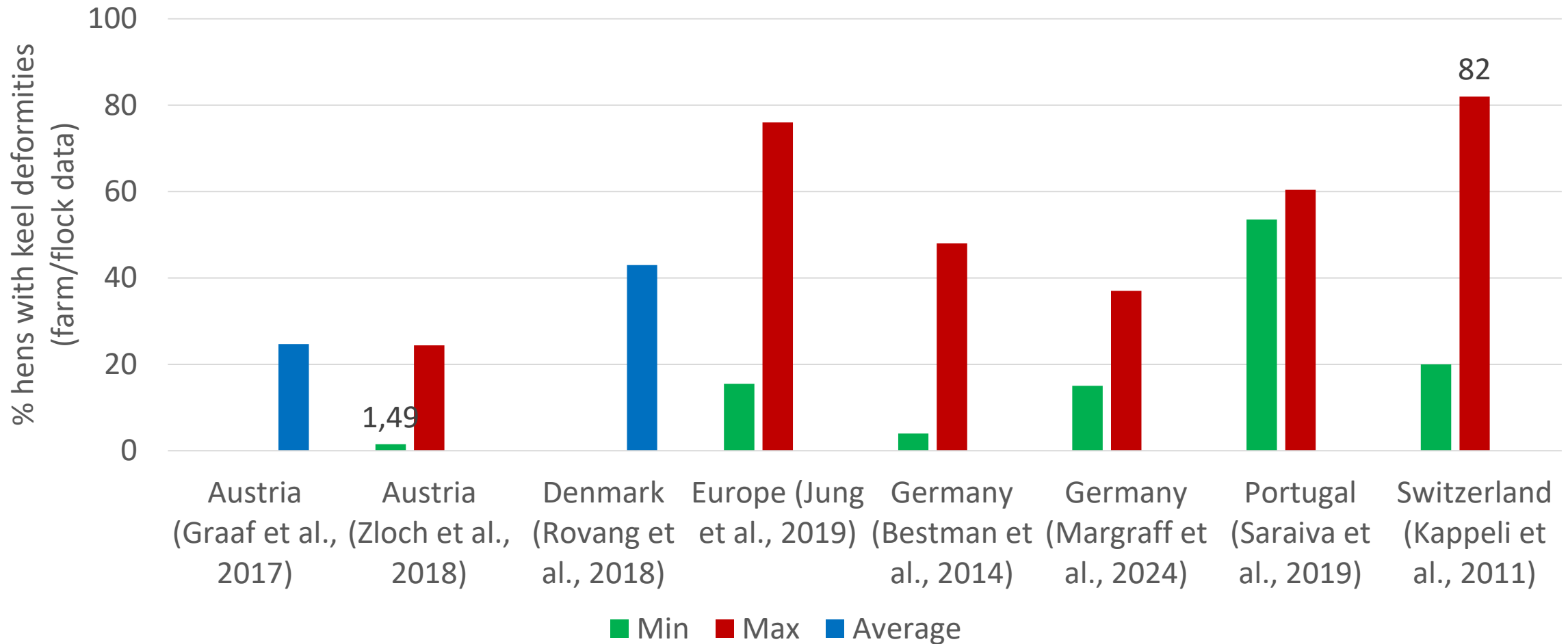
Muscle/skeletal development, long-term pressure on keel bone, birds' kinetics  
(*Bokkers and Koene, 2003; Pickel et al., 2011; Stratmann et al., 2015*)

## Keel fractures

Negative affective states (pain, distress, and/or discomfort)  
(*Nasr et al., 2012; Rokavec and Zupam Šemrov, 2020; Edgard et al., 2023; Montalcini et al., 2024*)

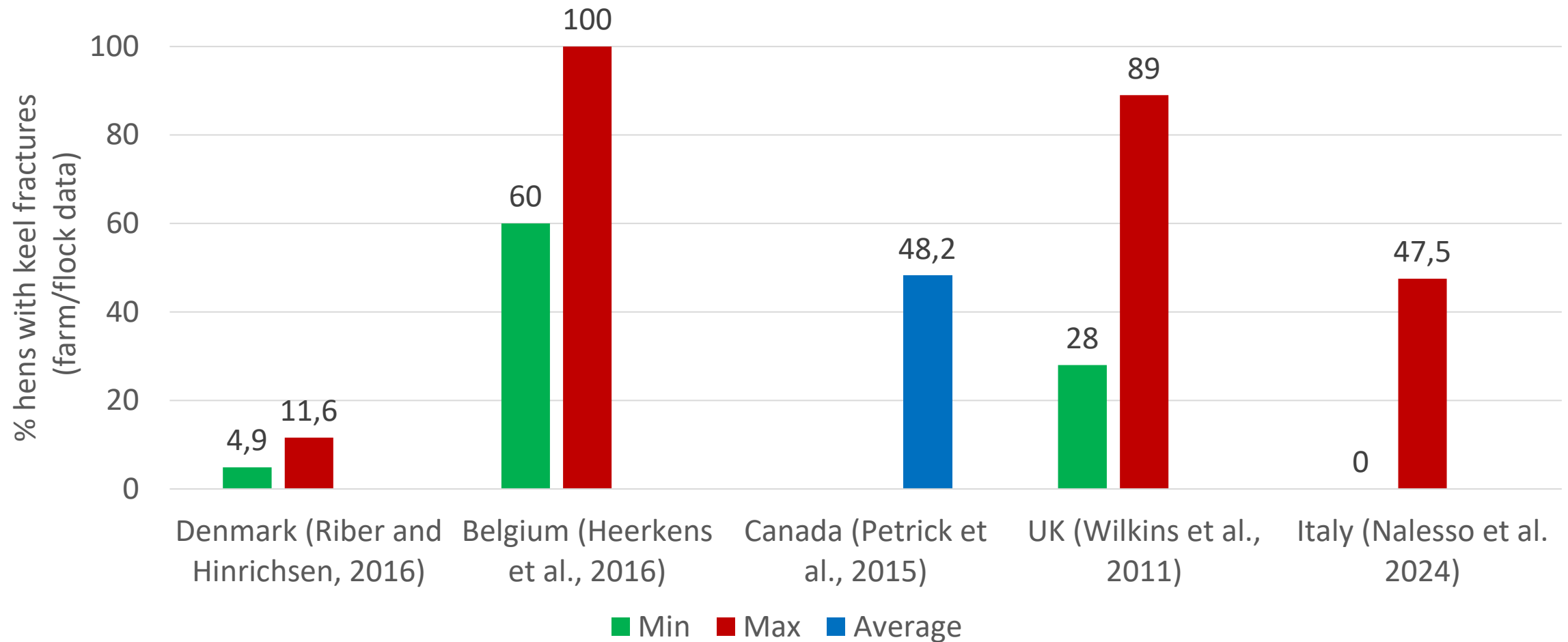
Negative effects on egg production and egg quality  
(*Nasr et al., 2013; Candelotto et al., 2017; Raufener et al., 2019; Wei et al., 2020*)

# Keel deformities: commercial flocks





# Keel fractures: commercial flocks





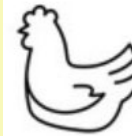
# Hazards for keel bone lesions

## Commercial flocks

### Hazards

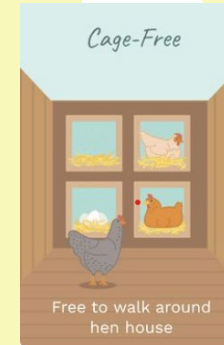
#### Animals

(genetics as for persistent egg production; age at first egg and during the production cycle)



#### Housing and equipment

(cage vs. cage-free housing systems; perches, ramps and other equipment; outdoor access)



#### Management

(training of pullets for navigation ability, feeding, on farm and pre-slaughter handling of hens, slaughtering season, flock size)

Toscano et al., 2020; Rufener and Makagon, 2020; EFSA, 2023

Animals (Heerksen et al., 2016; Käppeli et al., 2011; Margraff et al., 2024; Petrik et al., 2015; Riber and Hinrichsen, 2016)

Housing and equipment (Bestman and Wagenaar, 2014; Graaf et al., 2017; Jung et al., 2019; Heerksen et al., 2016; Käppeli et al., 2011; Margraff et al., 2024; Nalesso et al., 2024; Petrik et al., 2015; Riber and Hinrichsen, 2016; Røvang et al., 2018; Saraiva et al., 2019; Wilkins et al., 2011; Zloch et al., 2018)

Management (Graaf et al., 2017; Käppeli et al., 2011; Jung et al., 2019; Nalesso et al., 2024)

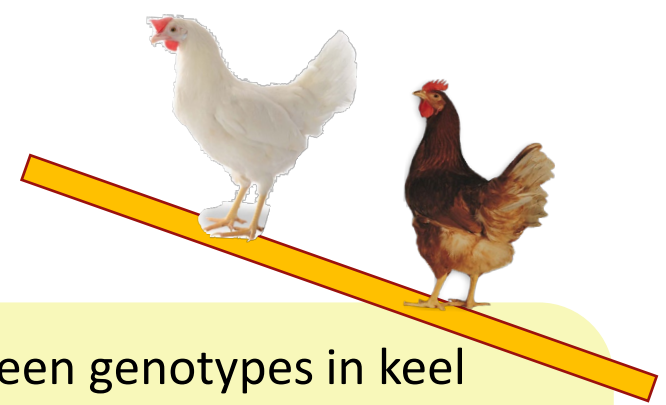


# Genotype: background

Main recommendations concerning more urgent welfare issues in egg production

- .....
- Implement protocols to define welfare trait information (e.g. **keel bone fractures** and plumage condition) for **all commercial hybrids** to encourage further progress in genetic selection and to enable producers to choose strains with a reduced risk of bone lesions and soft tissue lesions and integument damage

EFSA, 2023

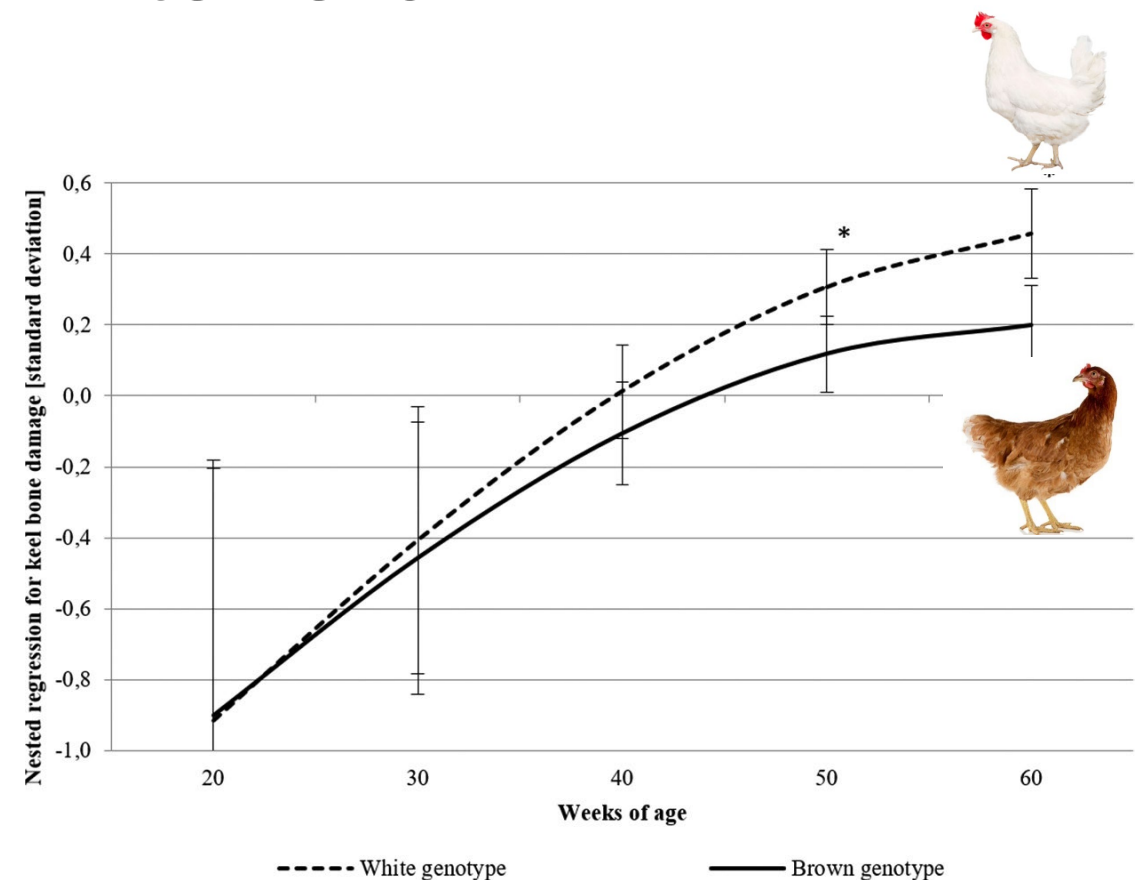
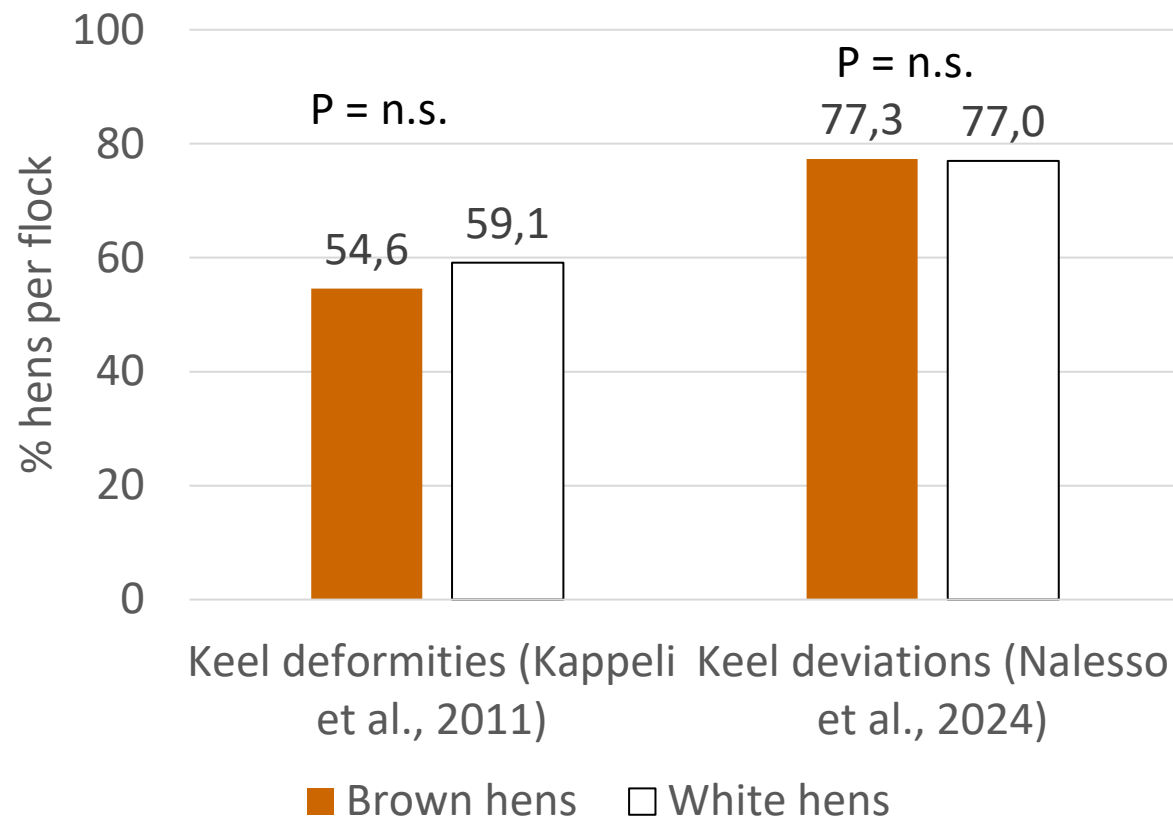


Differences between genotypes in keel bone deviations and fractures are expected based on:

- egg production level and persistence
- navigation ability
- animal size

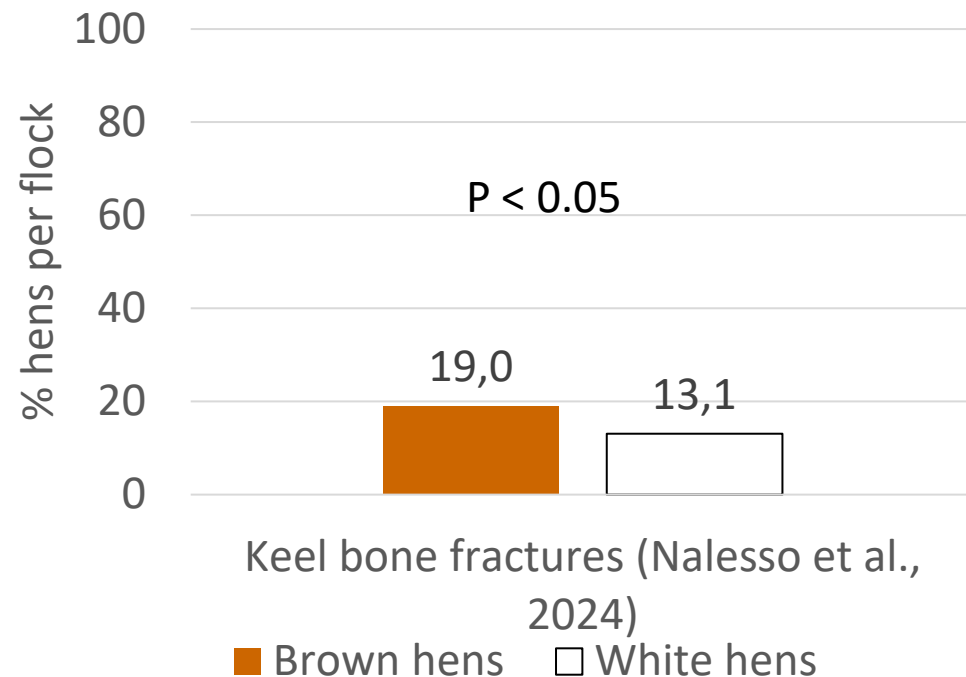
Candelotto et al. (2017)  
Rufener and Makagon (2020)  
Toscano et al. (2020)

# Genotype: brown vs. white hens

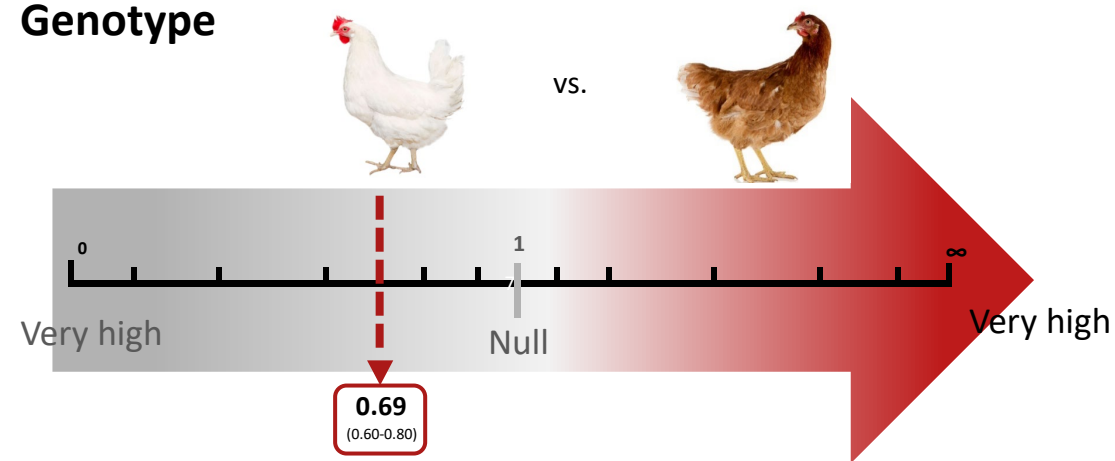


Keel bone damage  
Margaaf et al. (2024)

# Genotype: brown vs. white hens



Genotype



Keel bone fracture  
Nalesso et al. (2024)

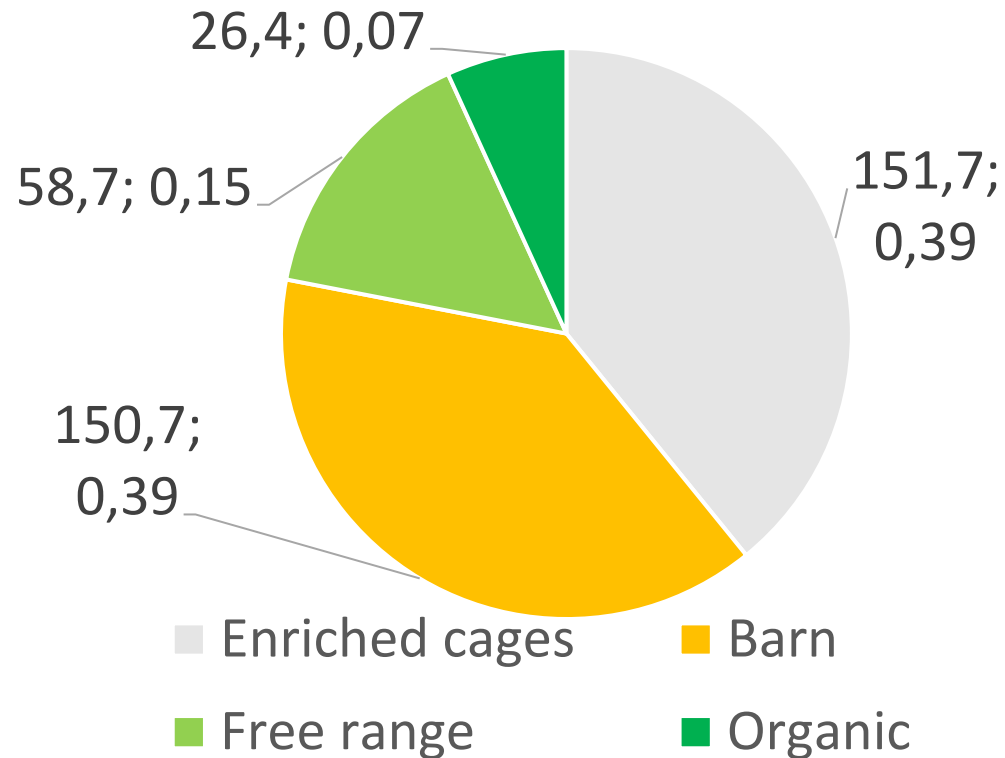
Differences among commercial genotypes

Heerkens et al., 2016 (brown hens)

Riber and Hinrichsen, 2016

# Housing system: background

Farmed laying hens (mil, %)



European Commission, 2024

Main recommendations concerning more urgent welfare issues in egg production:

- House all birds in non-cage systems
- .....

EFSA, 2023



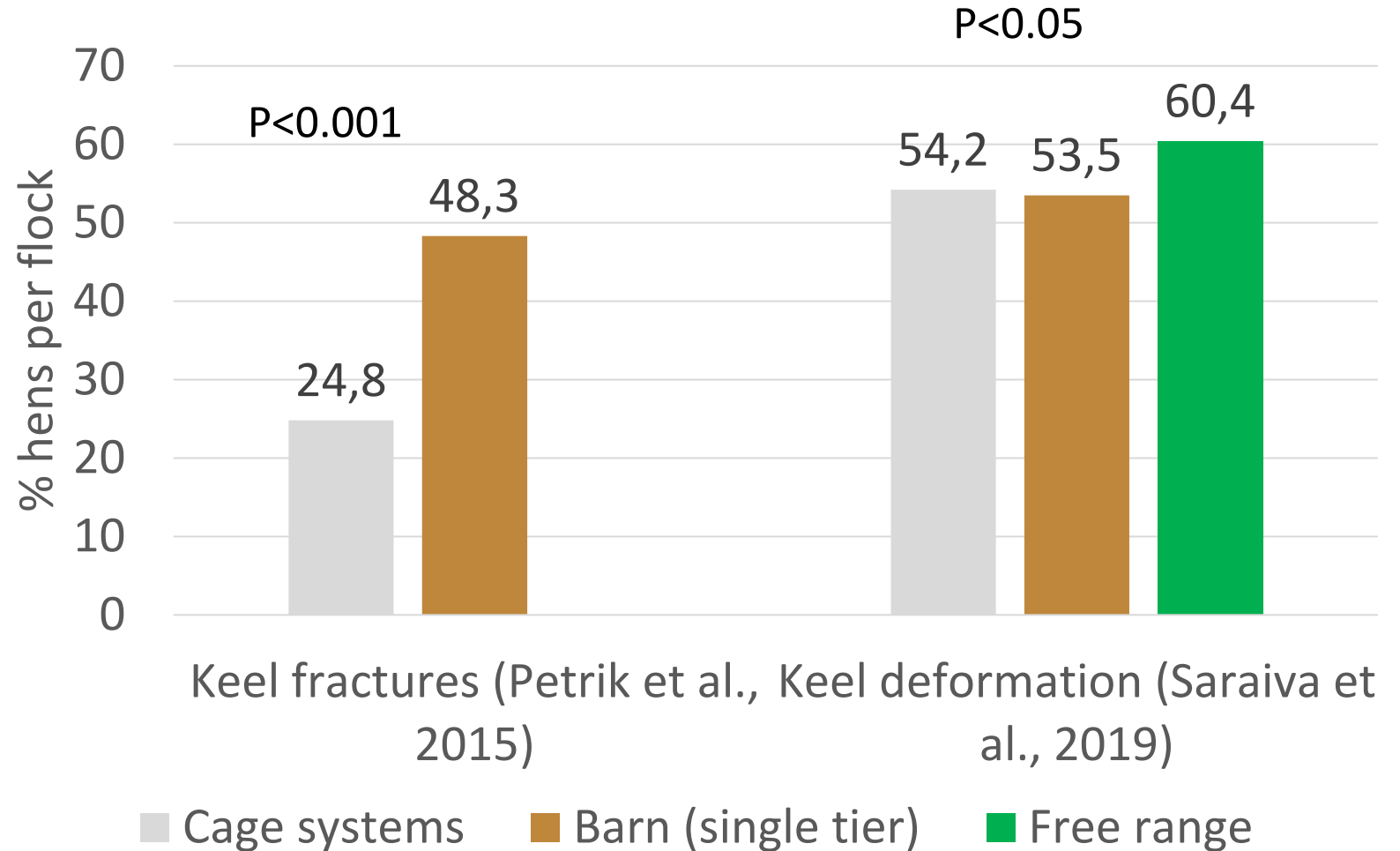


# Housing system: cage vs. cage-free systems

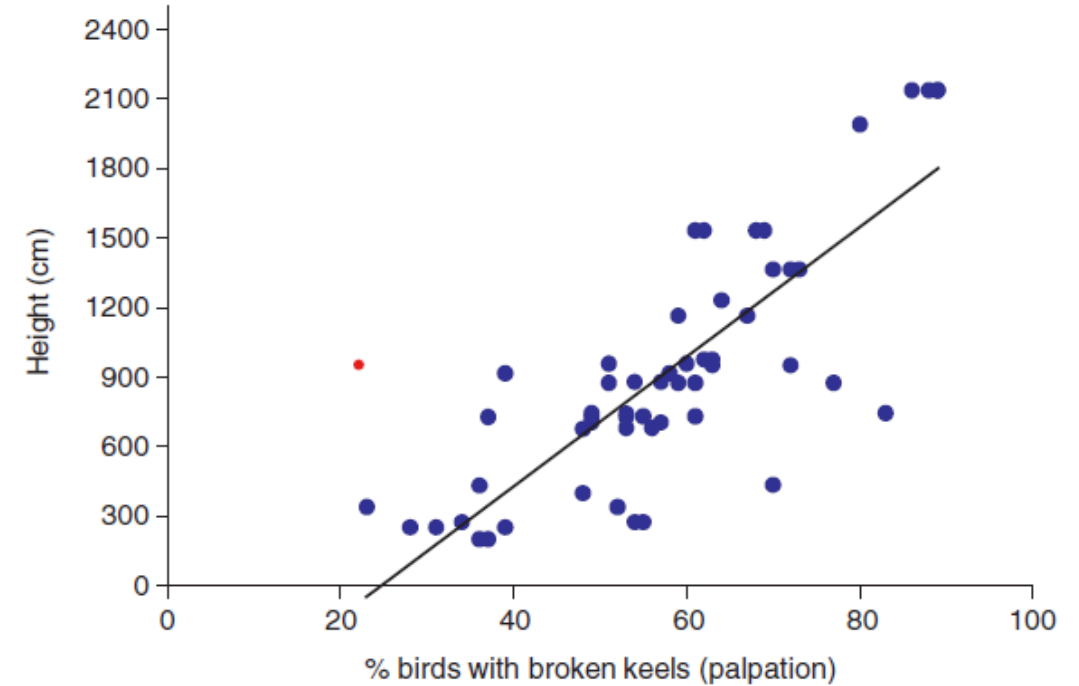
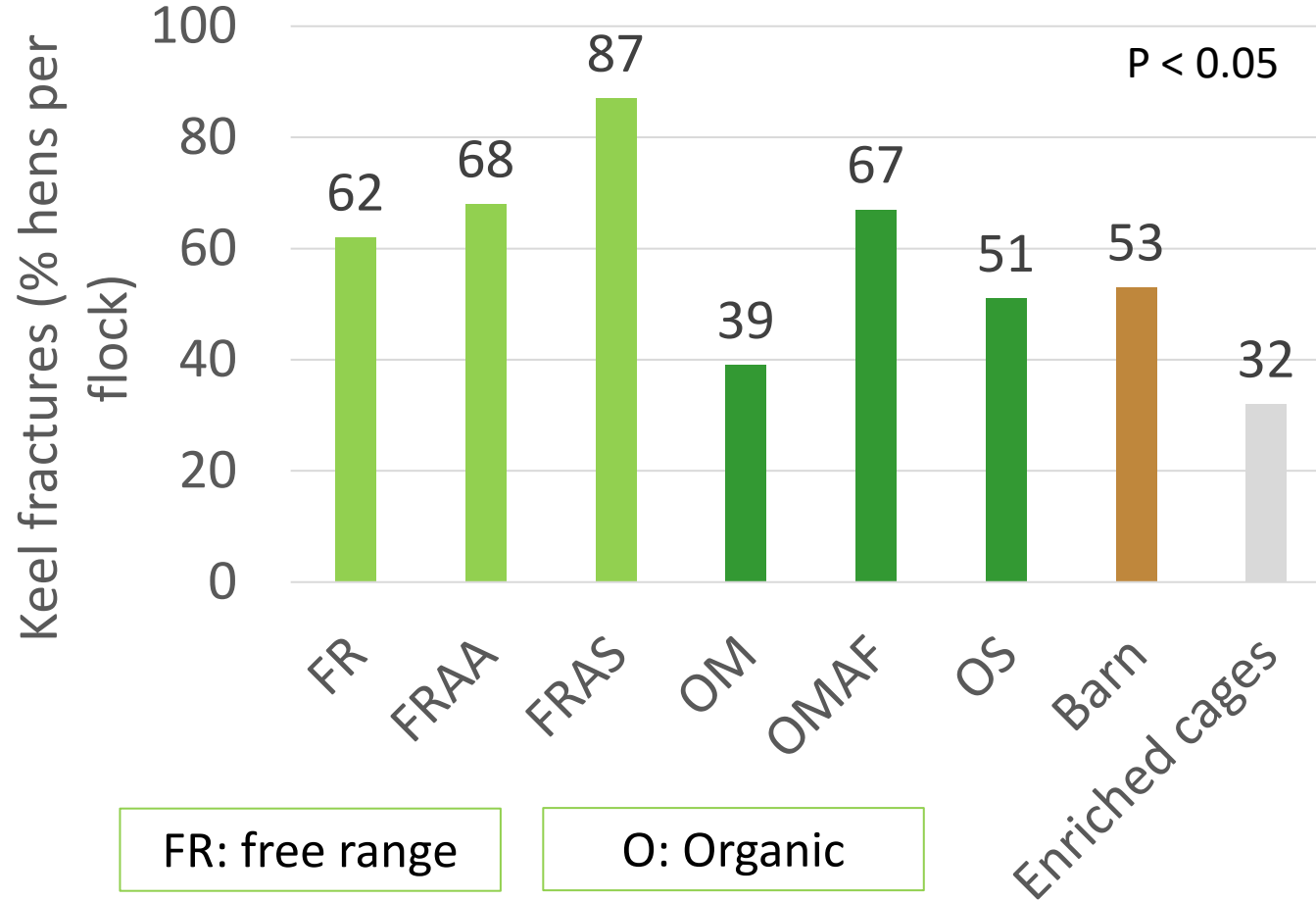
In single- and multi-tier systems, **high impact collisions and falls** and poor bone quality.

In collective cages, poor bone quality due to the lack of vigorous activity like flight and high jumps; presence of **perches**

EFSA, 2023



# Housing system: cage vs. cage-free systems



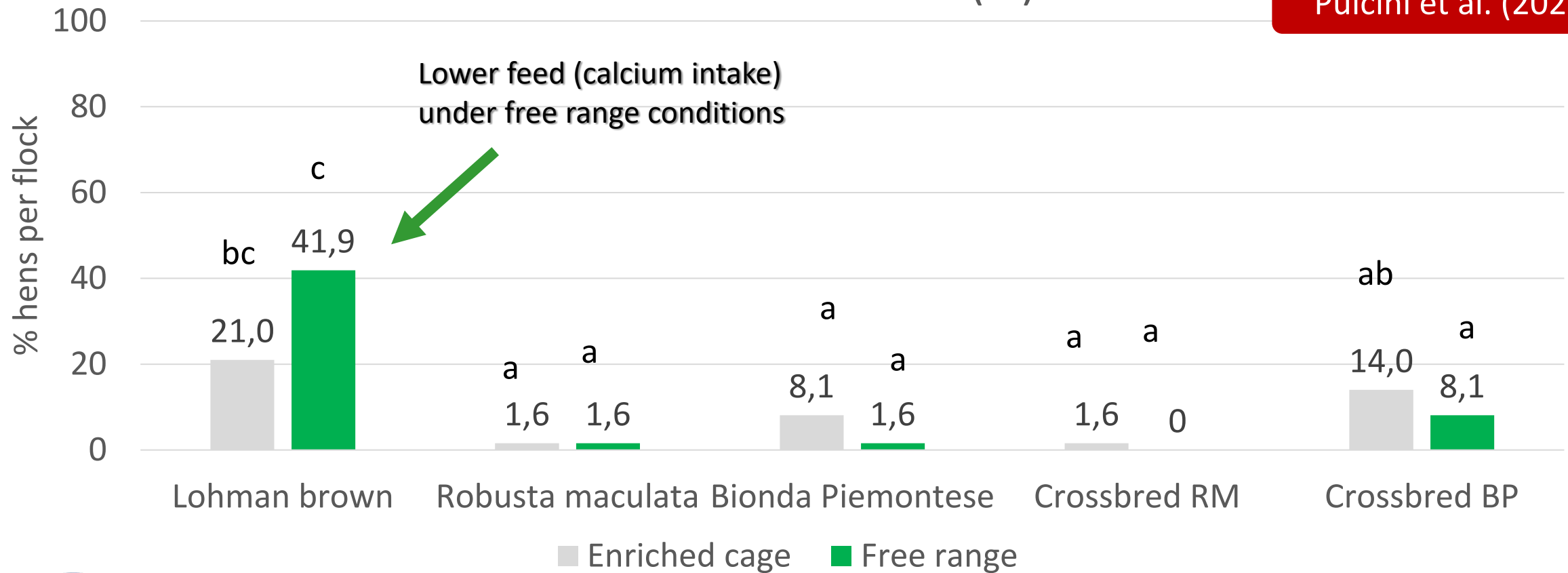
Relationships between height  
(perches/level) in the house and KBF  
( $r^2 = 0,67$ ,  $P < 0.001$ )

Wilkins et al. (2011)

# Interactions housing system x genotype: cages vs. free range x commercial vs. local breeds

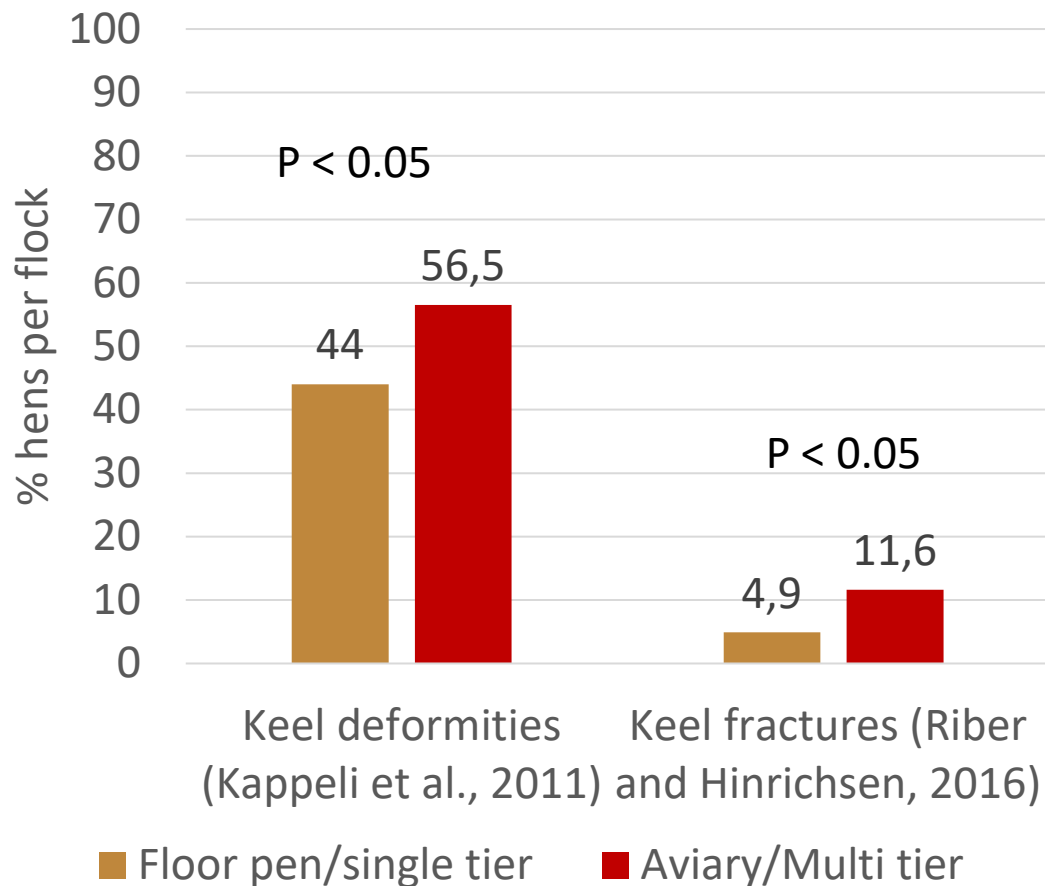
Keel bone fractures (%)

Pulcini et al. (2023)





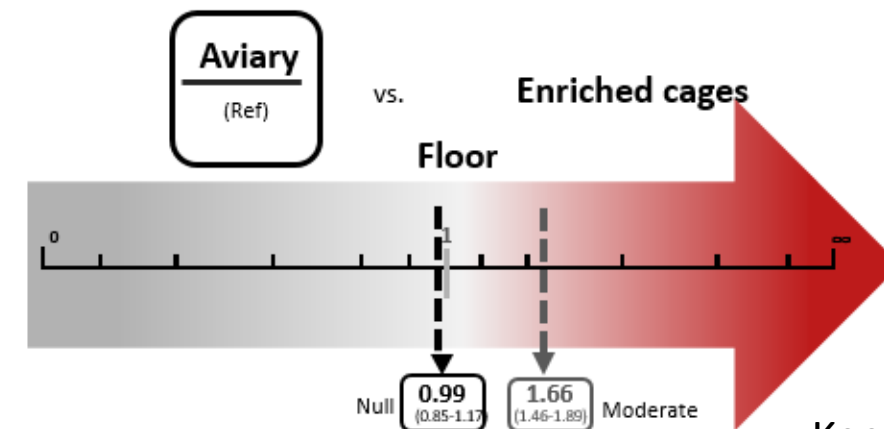
# Housing system: aviary vs. other systems



Higher risk for more keel deformities and more severe lesions in aviary vs. single tier systems -

- Zloch et al. (2018) in alternative systems
- Jung et al. (2019) in organic systems

Housing system



Keel fracture  
(Nalesso et al., 2024)



# Conclusions

## Main issues

Results from commercial flocks are not always consistent between Countries

Interactions exist between animals, housing systems and management

No direct relationships between hens' navigation possibilities/mobility and KB fractures

Keel bone fractures have been identified among most promising ABMs to be collected at the slaughterhouse for on-farm animal welfare

EFSA, 2023

## Perspectives

Looking for the best genotype in the different optimized housing system to reduce KBL

Harmonization of protocols and measurements for KBL

Automation of collection (image analysis) for large-scale collections of data about on-farm welfare



# Thanks



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