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Update and review of control options for Campylobacter in broilers at primary production

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Background

- In April 2011, EFSA published an opinion on "Campylobacter in broiler meat production: control options and performance objectives and/or targets at different stages of the food chain".
- 2012 EFSA opinion on the public health hazards to be covered by inspection of poultry meat identified the need to address *Campylobacter* as a high priority. EFSA Journal 2012;10(6):2741.
- In line with the high priority set by the EFSA opinion on poultry meat inspection, competent authorities must sample themselves for *Campylobacter* or carefully verify the implementation of the process hygiene criterion by the operator.

Terms of reference

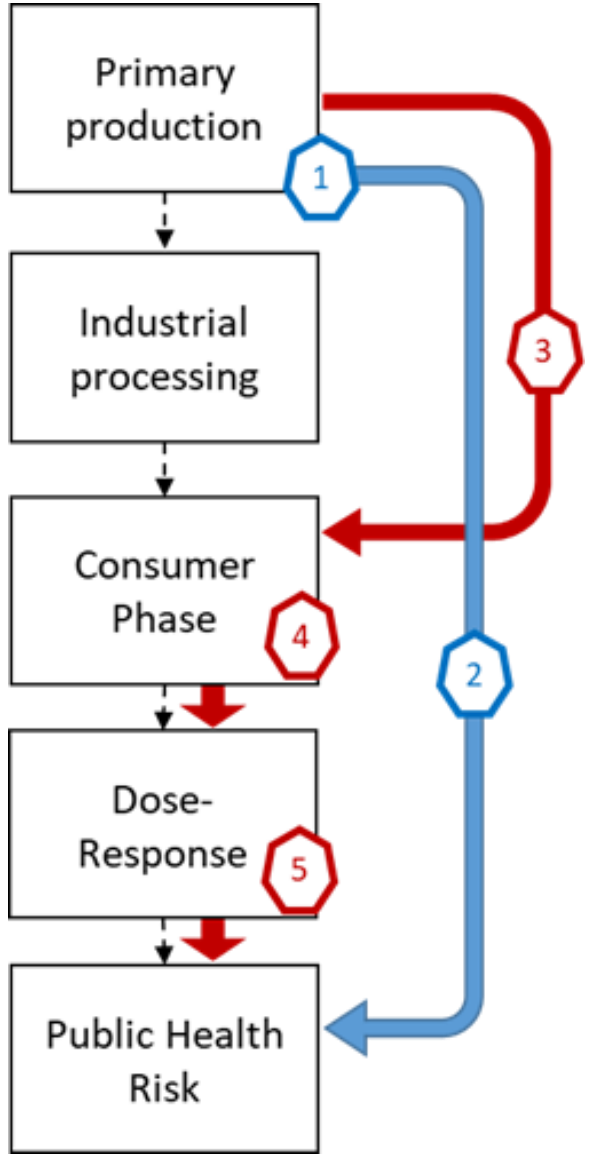
- Provide an update of the 2011 scientific opinion, more in particular to review, identify and rank the possible **control options at primary production level**, taking into account, and if possible quantifying, the **expected efficiency in reducing human campylobacteriosis cases**. Advantages and disadvantages of different options at primary production should be assessed, as well as the possible synergic effect of combined control options.

Assessment questions (AQ)

- AQ 1: What **new scientific evidence** about control options has become available since the previous opinion of 2011 and what is their relative risk reduction on campylobacteriosis?
- AQ 2: What is the **ranking** in terms of effectiveness of the selected control options in reducing human campylobacteriosis cases at the primary production level?
- AQ 3: What are the **advantages** and **disadvantages** of the selected control options?
- AQ 4: What would be the effect of **combining** control options?

Approach to answer the term of reference

- The effectiveness of control options was estimated using two different modelling approaches for
  - control options reducing the *Campylobacter* prevalence in broiler flocks sent to slaughter (1-2)
  - control options reducing the *Campylobacter* concentration in their caecal content (3-5)

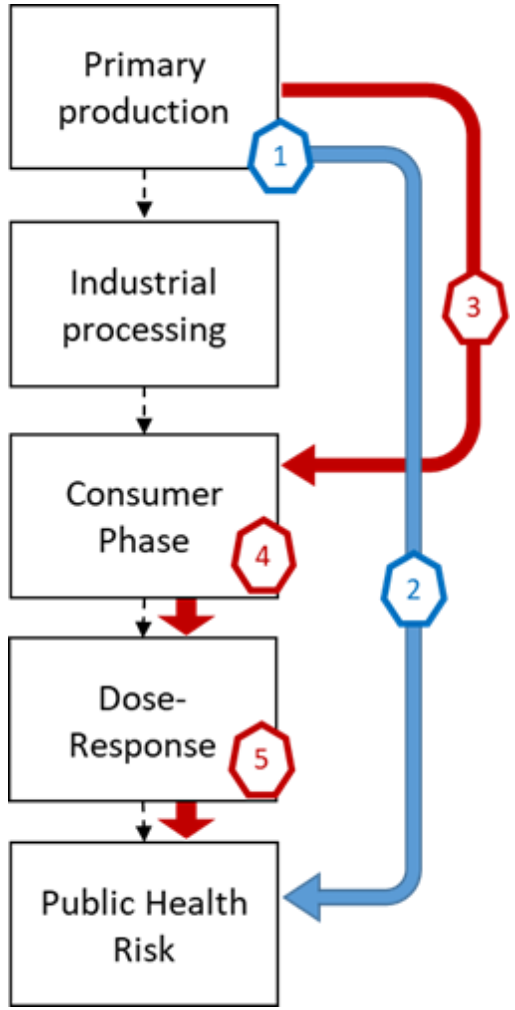


Approach to answer the term of reference

- The ranking of control options is based on the assessment of their potential effectiveness, using Expert Knowledge Elicitation (EKE) to combine the different streams of evidence and consider their associated uncertainties.
- Advantages and disadvantages of selected control options were assessed using literature search and expert judgement.
- The impact of combinations of two or more selected control options, including the potential for synergism, was assessed based on the literature search and expert judgement.

Control options to reduce the **prevalence** of *Campylobacter* spp. in broilers

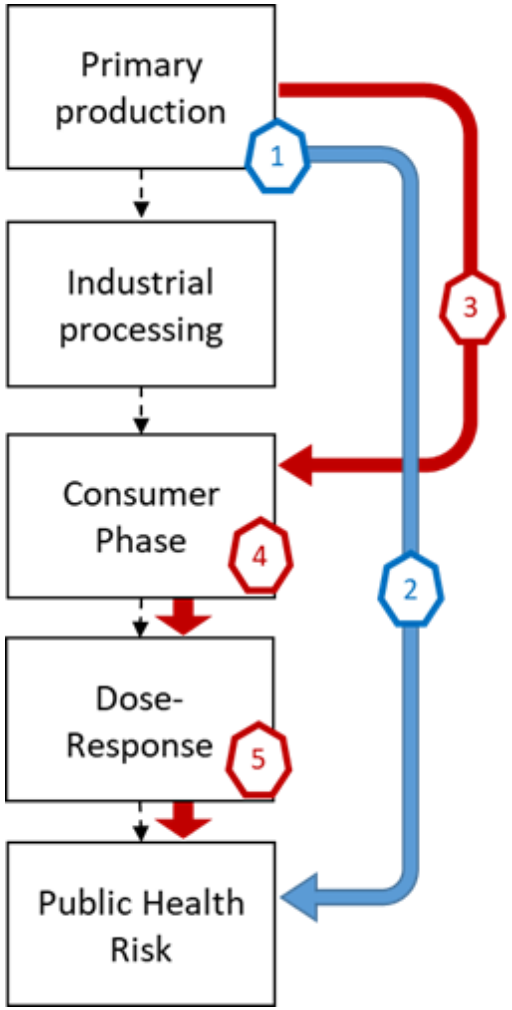
- Control options aimed at preventing the introduction of *Campylobacter* into the broiler house and the subsequent colonisation of the birds.
- Most studies on biosecurity practises and their association with *Campylobacter* status are designed as risk factor studies.
- Odds Ratios can be transformed into population attributable fractions (PAF) as a measure of the proportion of cases (positive flocks) estimated to be linked to a specific risk factor.



Control options to reduce the **prevalence** of *Campylobacter* spp. in broilers

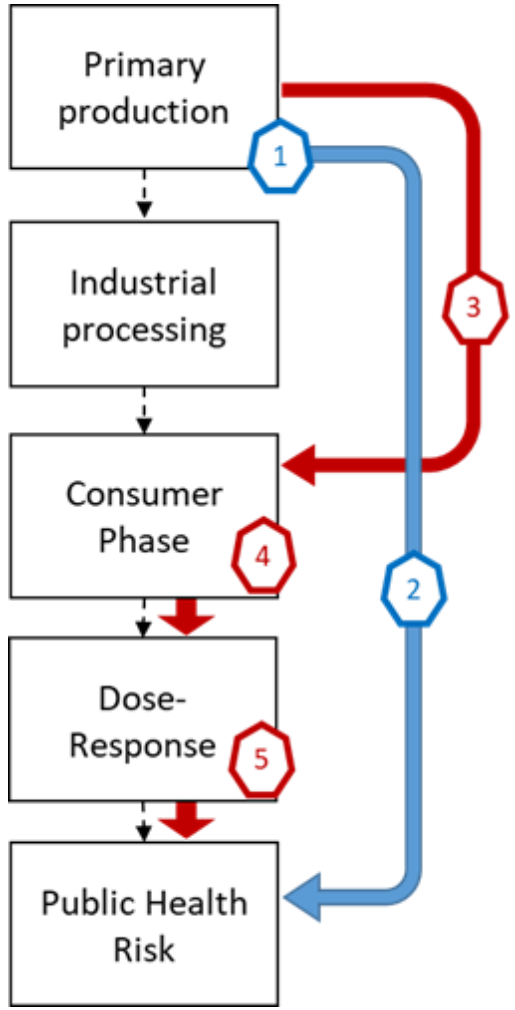
In this opinion, the PAF values were interpreted as:

the proportional reduction in flock prevalence that would occur if exposure to a risk factor was eliminated (i.e. the associated control option was applied throughout the EU).



Control options to reduce the **concentration** of *Campylobacter* spp. in broilers

- **Linear regression model** to translate a change in bacterial concentration in the chicken caeca into a change in concentration on broiler skin.
- **Consumer phase model** describes how the concentration on the skin or on the meat is linked to the dose ingested by the consumer.
- **Dose response model** dose response model describes how an ingested dose relates to the probability of infection and/or the probability of illness in humans.



Ranking and uncertainty assessment

- **Ranking** was informed by three different evidence streams:
  - effect of control options to reduce prevalence (supported by PAF and literature),
  - effect of control options to reduce the level of contamination in broilers (supported by probabilistic modelling)
  - and the effect of control options from the scientific literature (not supported by either PAF or probabilistic modelling).
- Expert judgement was essential for weighing and integrating the different streams of evidence and for considering their associated uncertainties.

Control options

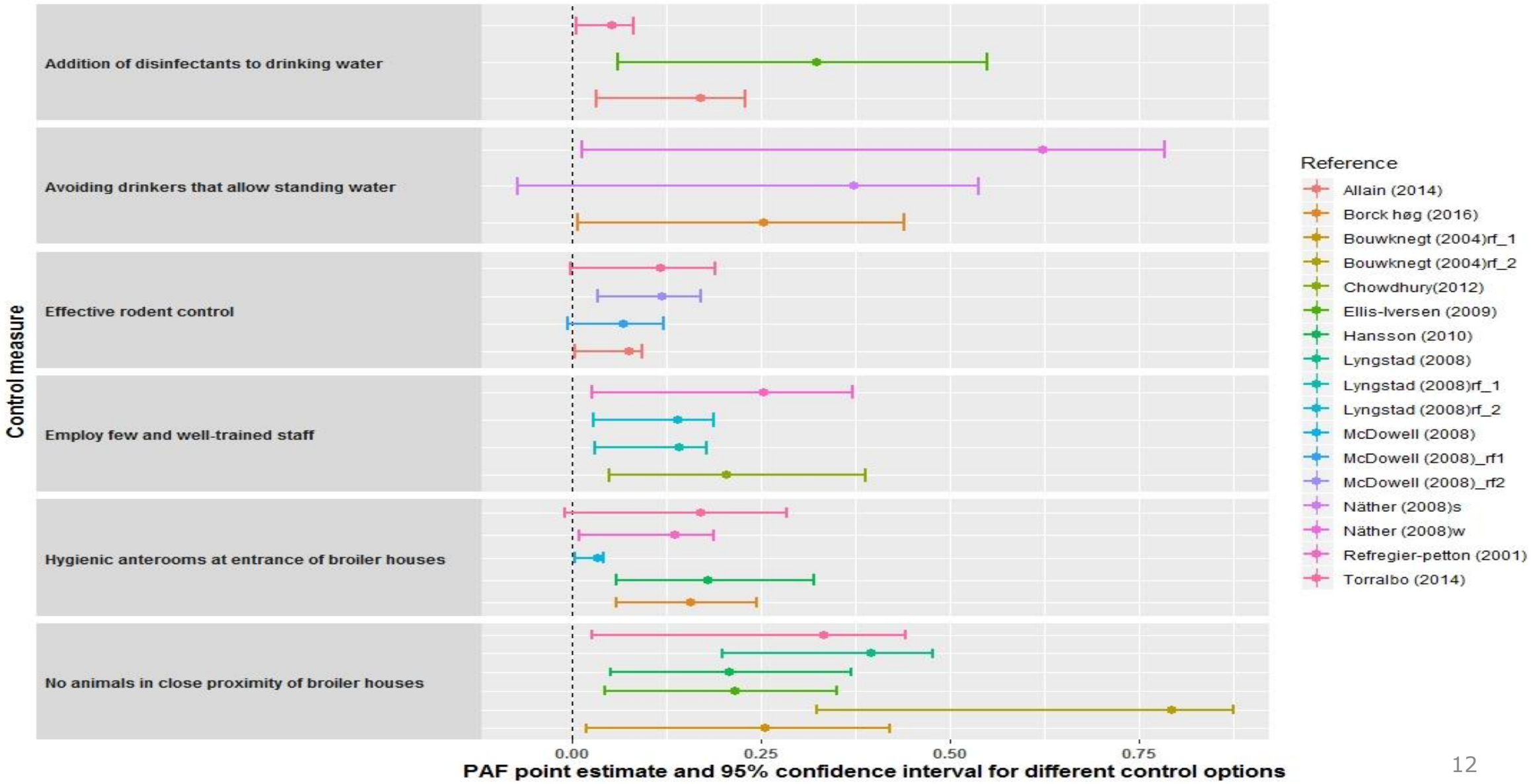
PAF

- Employing few and well-trained staff
- No animals in close proximity to the broiler houses
- Avoiding drinkers that allow standing water
- Addition of disinfectants to drinking water
- Designated tools per broiler house
- Hygienic anterooms at broiler house entrance
- Effective rodent control
- Reduced slaughter age
- Discontinued thinning

LR/CPM/DR

- Vaccination
- Feed and water additives
- Bacteriophage
- Effective cleaning and disinfection
- Selective breeding
- Fly screens and keeping insects out of the broiler house
- Stocking density and flock size
- Downtime between flocks
- Feed structure
- The number of houses on site
- Clean litter
- Litter amendments

Results PAF


Addition of disinfectants to drinking water
Avoiding drinkers that allow standing water
Effective rodent control
Employ few and well-trained staff
Hygienic anterooms at entrance of broiler houses
No animals in close proximity of broiler houses
Control measure
0.00
0.25
0.50
0.75
PAF point estimate and 95% confidence interval for different control options
Reference
Allain (2014)
Borck høg (2016)
Bouwknegt (2004)rf_1
Bouwknegt (2004)rf_2
Chowdhury(2012)
Ellis-Iversen (2009)
Hansson (2010)
Lyngstad (2008)
Lyngstad (2008)rf_1
Lyngstad (2008)rf_2
McDowell (2008)
McDowell (2008)_rf1
McDowell (2008)_rf2
Näther (2008)s
Näther (2008)w
Refregier-petton (2001)
Torralbo (2014)

Conclusions on PAF

- Mean relative risk reductions that could be achieved by adoption of each of these six control options individually are estimated to be substantial.
- But the width of the confidence intervals of all control options indicates a high degree of uncertainty.
- For example, the mean estimate of the relative risk reduction for the control option "Addition of disinfectants to drinking water" was between 5% (95% CI 0.6-8.2) and 32% (95% CI 6.0-54.9) based on three available studies.

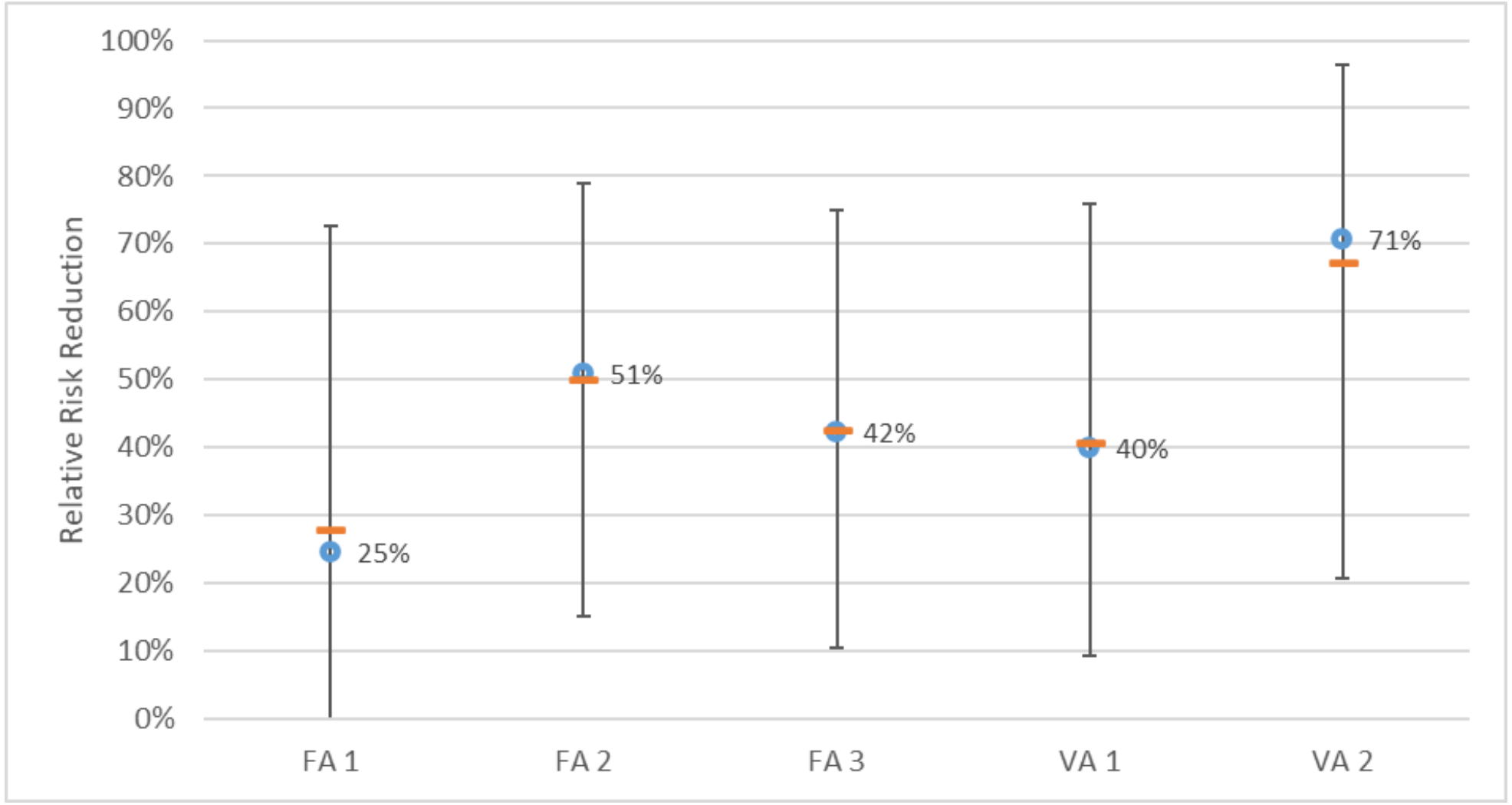
Control options to reduce the **concentration** of *Campylobacter* spp.

- Feed and water additives and vaccination

Feed additive	d	s_d	S.E.M.	Number of birds tested	Reference
FA1	1.23	0	0.66	15	Guyard-Nicodème et al., 2016
FA2	3.25	2.2	0.64	15	Guyard-Nicodème et al., 2016
FA3	2	NA	NA	36 (3 replicates of 12)	Skoufos et al., 2019

Vaccination	d	s_d	S.E.M.	Number of birds tested	Reference
VA1	2.03	1.83	0.49	15 birds for each vaccine test	Meunier et al., 2017
VA2	4.15	1.63	0.51	15 birds for each vaccine test	Meunier et al., 2017

Results of model analysis

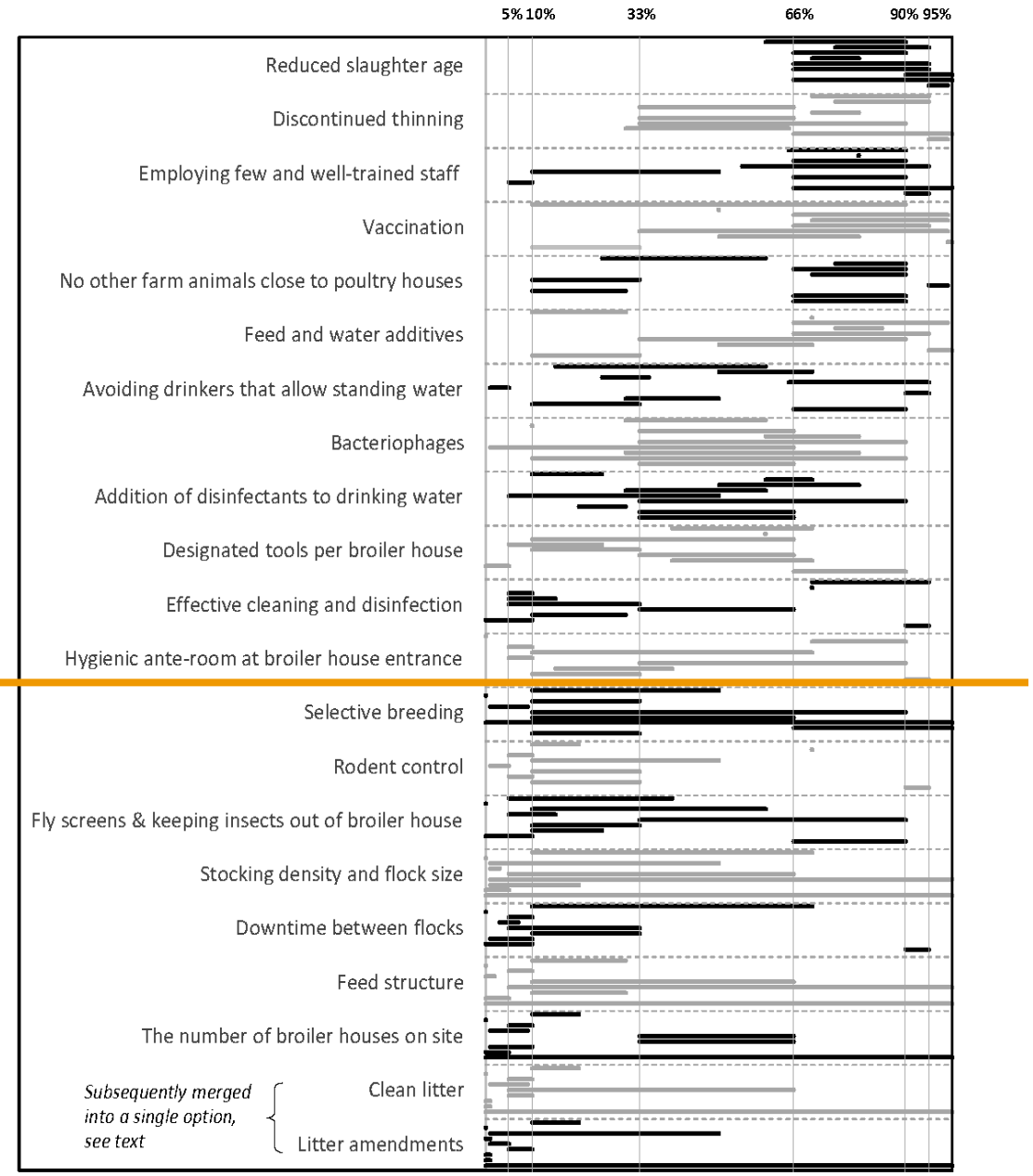


Conclusions on model results

- Updated model resulted in lower estimates of the slope of the linear regression line describing the relation between concentrations in caecal contents and on skin samples compared to 2011 opinion.
- Lower estimates of the relative risk reduction were obtained for the effectiveness of control options directed at a reduction in the caecal concentrations.
- E.g., for a 2-$\log_{10}$ reduction in caecal concentrations, the median estimate of the relative risk reduction is 42% (95% CI 11-75%). In 2011 opinion it was 76 – 98%.

Ranking (Step 1)

- After the first screening, twelve control options are identified as having a "higher probability to have more than 10% effect".
- The other eight control options in the lower part were considered having a "lower probability to have more than 10% effect".

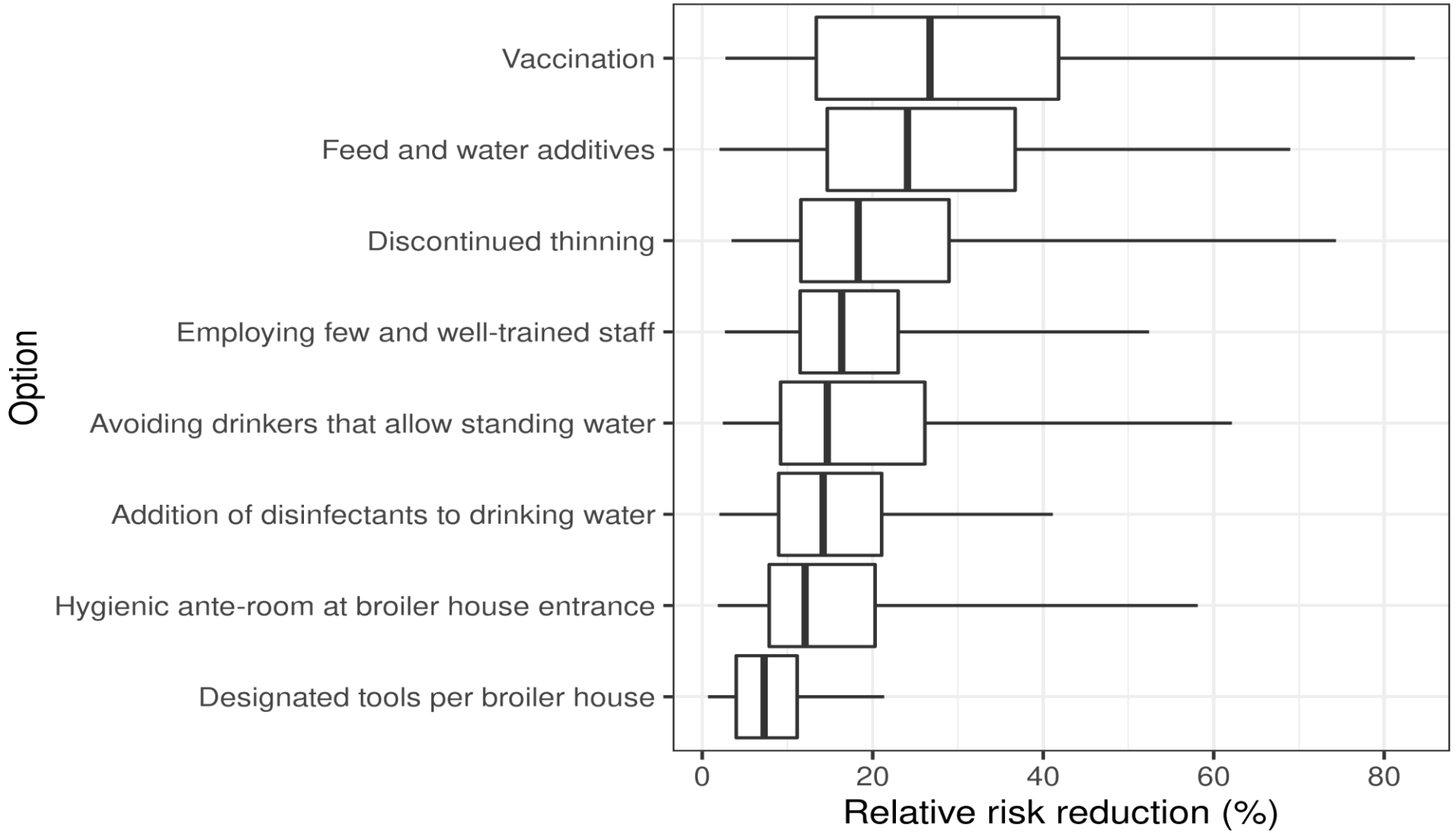


Ranking (Step 2)

4/12 were excluded:

- No other farm animals in close proximity to the broiler houses: lack of feasibility of implementation and doubts about the evidence of transfer of *Campylobacter* spp.
- Effective cleaning and disinfection: The definition not precise enough to enable judgements
- Reduced slaughter age: current practices vary largely between EU countries and welfare issues relating to fast-growing birds might prevent application;
- Bacteriophages: lack of convincing evidence of effectiveness in the field due to shortage of field studies.

Results for ranking of 8 control options



Effect of combining control options

- Multiple control activities are expected to have a higher effect preventing *Campylobacter* spp. from entering the broiler house and infecting the birds. To minimise the risk of *Campylobacter* colonisation, all control activities relating to biosecurity would have to be implemented in full.
- It is not possible to quantify the effects of combined control activities.
- Combining two control options targeting prevalence and concentration, respectively, may result in a cumulative effect, if their targets are unrelated.

Published outputs

- Scientific opinion Update and review of control options for Campylobacter in broilers at primary production
  https://efsa.onlinelibrary.wiley.com/doi/10.2903/j.efsa.2020.6090

- Modelling approach for control options affecting the Campylobacter concentration in the caecal content of broilers
  https://zenodo.org/record/4024362#.X23D72gzbD4

- APHA/FSA monitoring programme for Campylobacter in broiler flocks and broiler carcases in the UK (2012-2017) (FS241051, FS101126)
  https://zenodo.org/record/3742190#.X23EX2gzbD4

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