CA18105

RIBMINS

Risk-based meat inspection and integrated meat safety assurance

WG 3 - Abattoir level controls and risk categorisation of abattoirs

Morgane Salines | 08. 04. 2022. | RIBMINS conference [Cordoba, Spain]

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WG3 P23: Pig abattoir interventions in a risk-based meat safety assurance system: A systematic review and meta-analysis of the efficacy of interventions to reduce microbiological contamination on pig carcasses

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WG3 Introduction

- Interventions at abattoir level to control microbiological hazards are an essential part of meat safety assurance systems
- Interventions:
  - GHP-based (pre-requisites at the pre-slaughter stage (e.g. lairage holding time and feed withdrawal) and during slaughter and carcass dressing (e.g. scalding, singeing, rectum sealing, head removal, knife trimming, carcass washing);
  - Hazard-based – known efficacy (hot water washing, steam pasteurisation, organic acid washes, other chemical washes)
- Priority hazards for control in pigs: *Salmonella* and *Yersinia*
- Indicator microorganisms for process hygiene assessment: aerobic colony count (ACC), *Enterobacteriaceae* count (EBC), generic *E. coli* count (ECC)
- No work has been performed to pool efficacy results of pig interventions on indicator organisms (ACC, EBC, ECC) and *Yersinia*.

WG3 specific objectives

- 3.1 Assessment of effectiveness of new tools | methods for detection of carcass contamination
- 3.2 Assessment of the significant intervention strategies and alternative methods for the slaughtering | the carcass dressing

Years 1 & 2

- 3.3 Assessment of the performance of food safety management systems
- 3.4 HEI in risk categorisation of abattoirs

Years 3 & 4

Task 3.2.3. Systematic review and Meta-analysis **pig** interventions

- **The task is finished**
- Literature searched 1990-2021 (>30 years)
- Systematic review and meta-analysis performed
- Work spanned 2019-2021

Contributors

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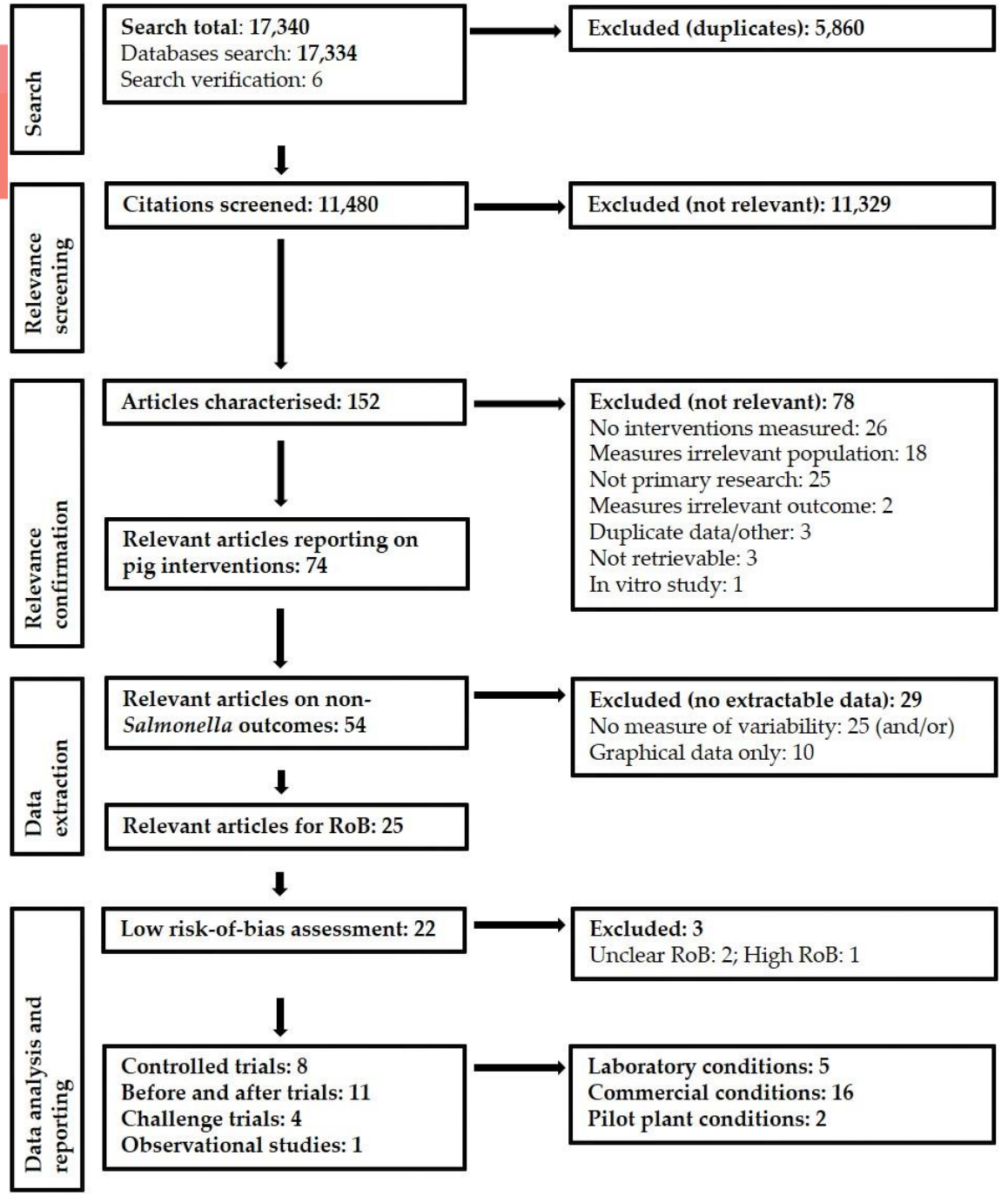
WG3 Methodology

- Systematic review:
  - PICO framework,
  - From lairage to chilled carcasses
  - Scopus & CAB Direct (1990-2021), SciELO (2002-2021)
  - All stages, two reviewers, third to resolve discrepancies
  - Risk of bias performed to see which studies are suitable for meta-analysis
- Meta-analysis:
  - Data stratified by study design/conditions, intervention (sub)category, outcomes and measures (prevalence, concentration: mean log CFU)
  - Meta-analysis performed when an intervention group had three or more trials with a low risk of bias
  - A mixed-effects model was used to create pooled summary statistics and then presented as Forest plots.
  - Tests for heterogeneity of study groups were performed.



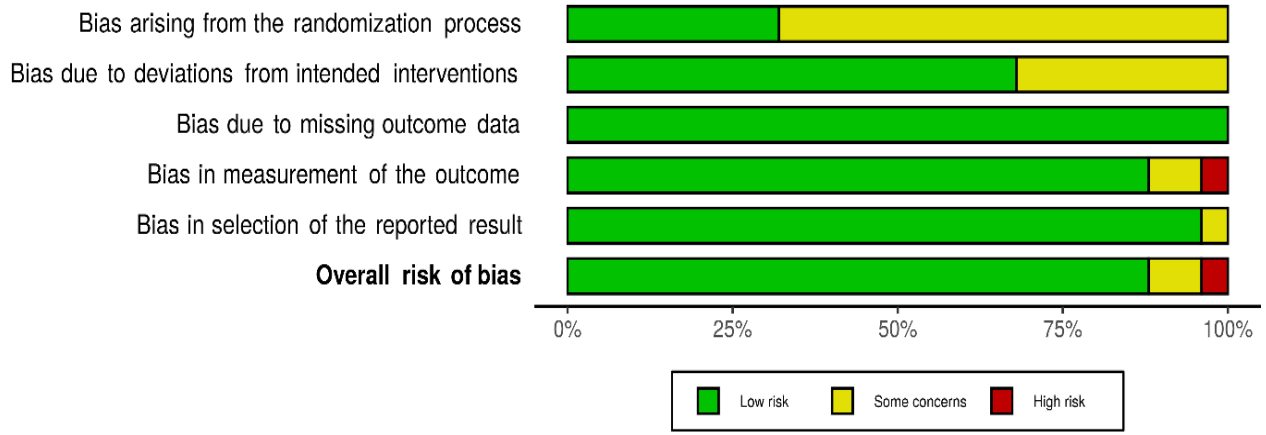
WG3 Results – systematic review

- 74 relevant studies were identified (including *Salmonella*); 54 on non-*Salmonella* outcomes
- *Salmonella* excluded further due to recently published meta-analysis (Young et al., 2016)
- Only 25 with extractable data; **22** (88%) were of low risk of bias and available for meta-analysis.

Article characteristic	No of articles (%)
Study design	
Challenge trial	7 (24%)
Before-and-after trial	12 (41%)
Controlled trial	9 (31%)
Cohort study	1 (3%)
Study conditions	
Laboratory conditions	6 (23%)
Commercial abattoir conditions	18 (69%)
Research/pilot plant	2 (8%)
Intervention category/subcategory	
Pig handling in lairage	2 (5%)
Scalding	4 (10%)
Singeing	4 (10%)
Other standard processing procedures/GHP	8 (20%)
Carcass pre-chill interventions	12 (31%)
Chilling, spray chilling, blast chilling	9 (23%)
Outcomes investigated	
Aerobic colony count	17 (38%)
Enterobacteriaceae	9 (20%)
Generic *E. coli*	12 (27%)
Yersinia enterocolitica	6 (13%)
Yersinia pseudotuberculosis	1 (2%)

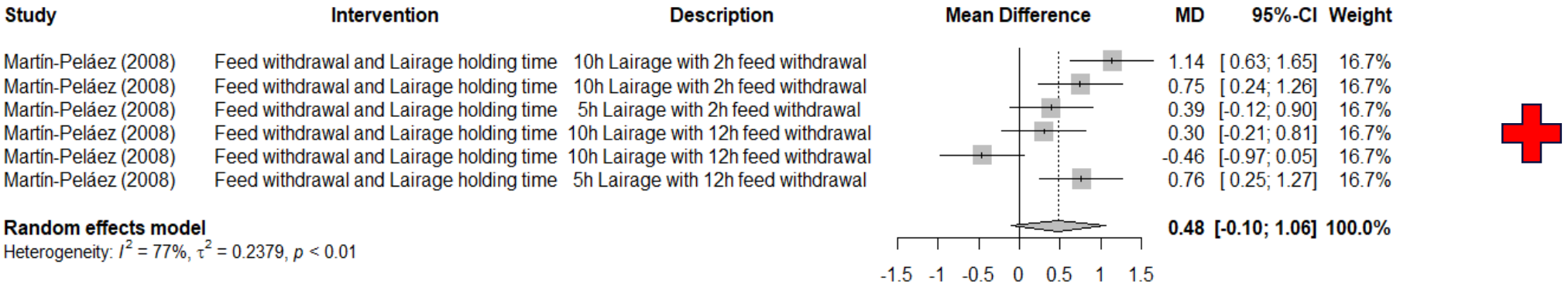
Results – Risk of Bias

- **22** papers low risk of bias
- Three or more trials – forest plots generated:
  - 48 forest plots, 40 with meta-analysis summary effects, 13 low/moderate heterogeneity
- Test for heterogeneity:
  - homogenous (p>0.05 on the test for heterogeneity),
  - moderately heterogeneous (p<0.05, I^2<=60%),
  - highly heterogeneous (p<0.05, I^2>60%).
- Meta-analysis grade:
  - Significant positive effect
  - No effect
  - Significantly homogenous studies



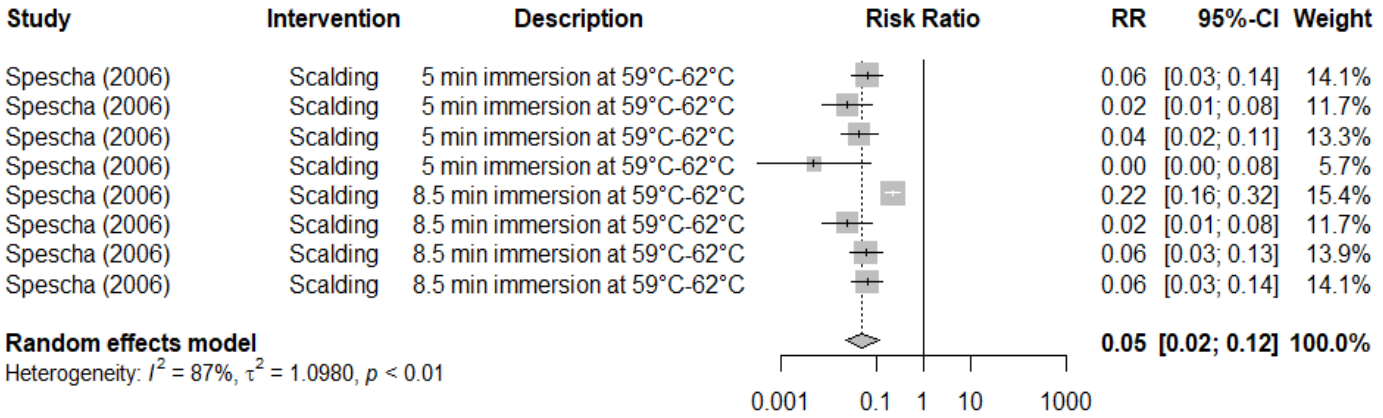
Results – pre-slaughter, **lairage interventions**

- **Only 2** papers available
- *Enterobacteriaceae* counts in pig caecal content increased with both feed withdrawal and lairage holding time (MD 0.48, 95% CI: -0.10 to 1.06, I^2 = 77%)

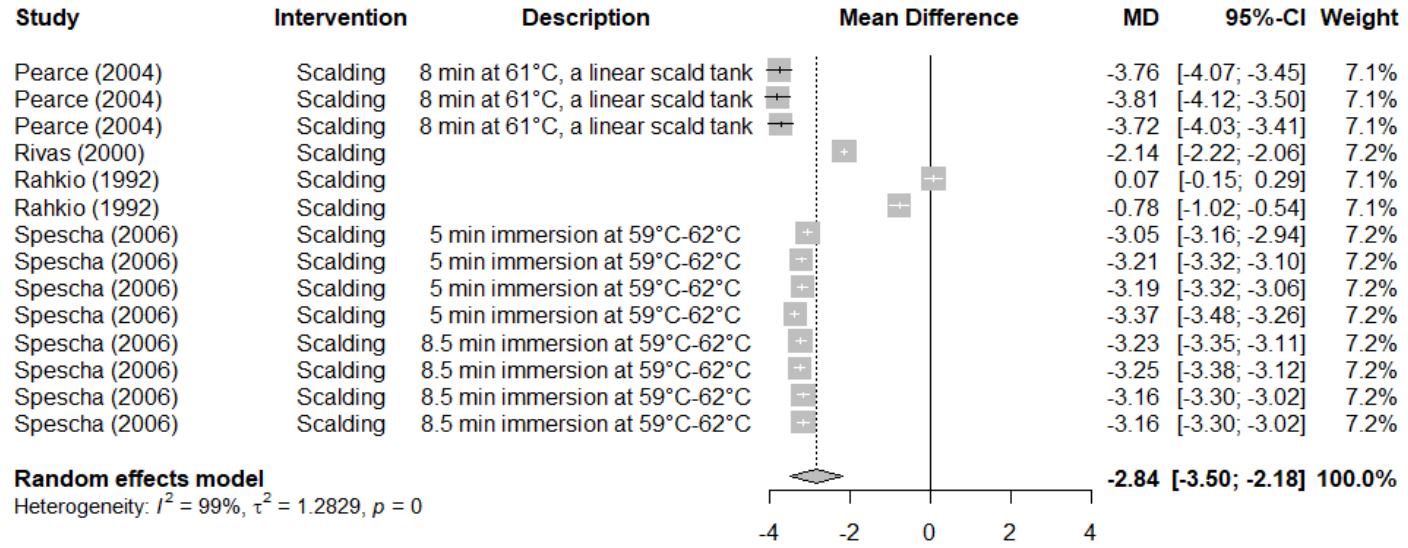


- Misting live pigs with disinfectant reduced *Enterobacteriaceae* counts on pig skin significantly when compared to water misting alone in only one trial (MD -1.36, 95% CI: -2.91 to - 0.19)

Results – standard processing procedures: **scalding**

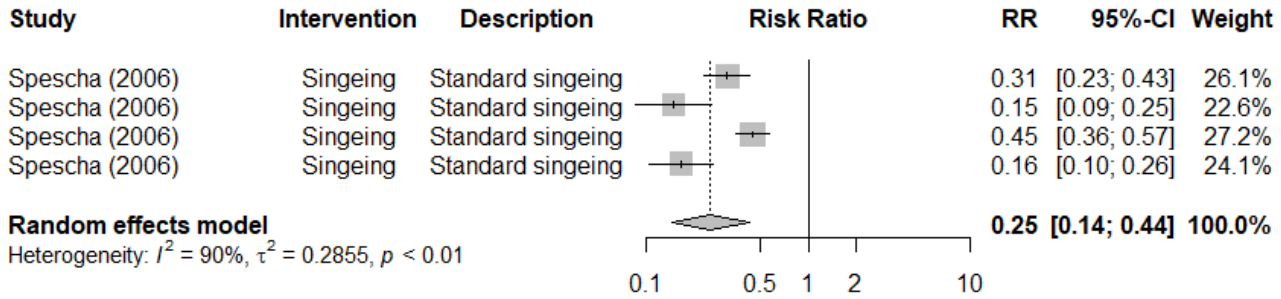


Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of scalding in reducing *Enterobacteriaceae* prevalence on pig carcasses

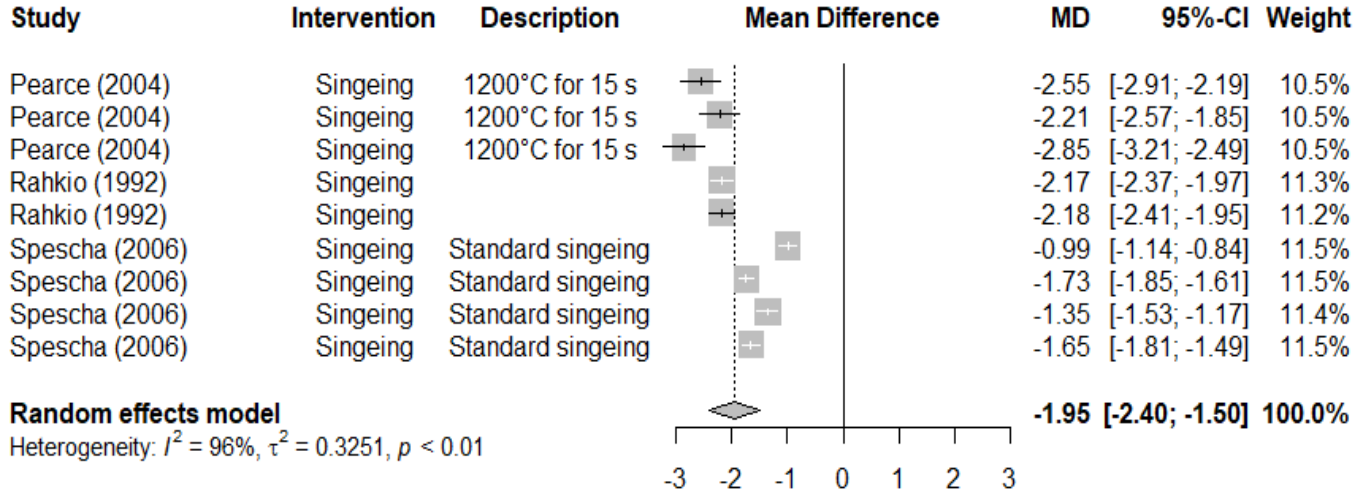


Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of scalding in reducing aerobic colony count (log_{10} CFU) on pig carcasses

Results – standard processing procedures: **singeing**

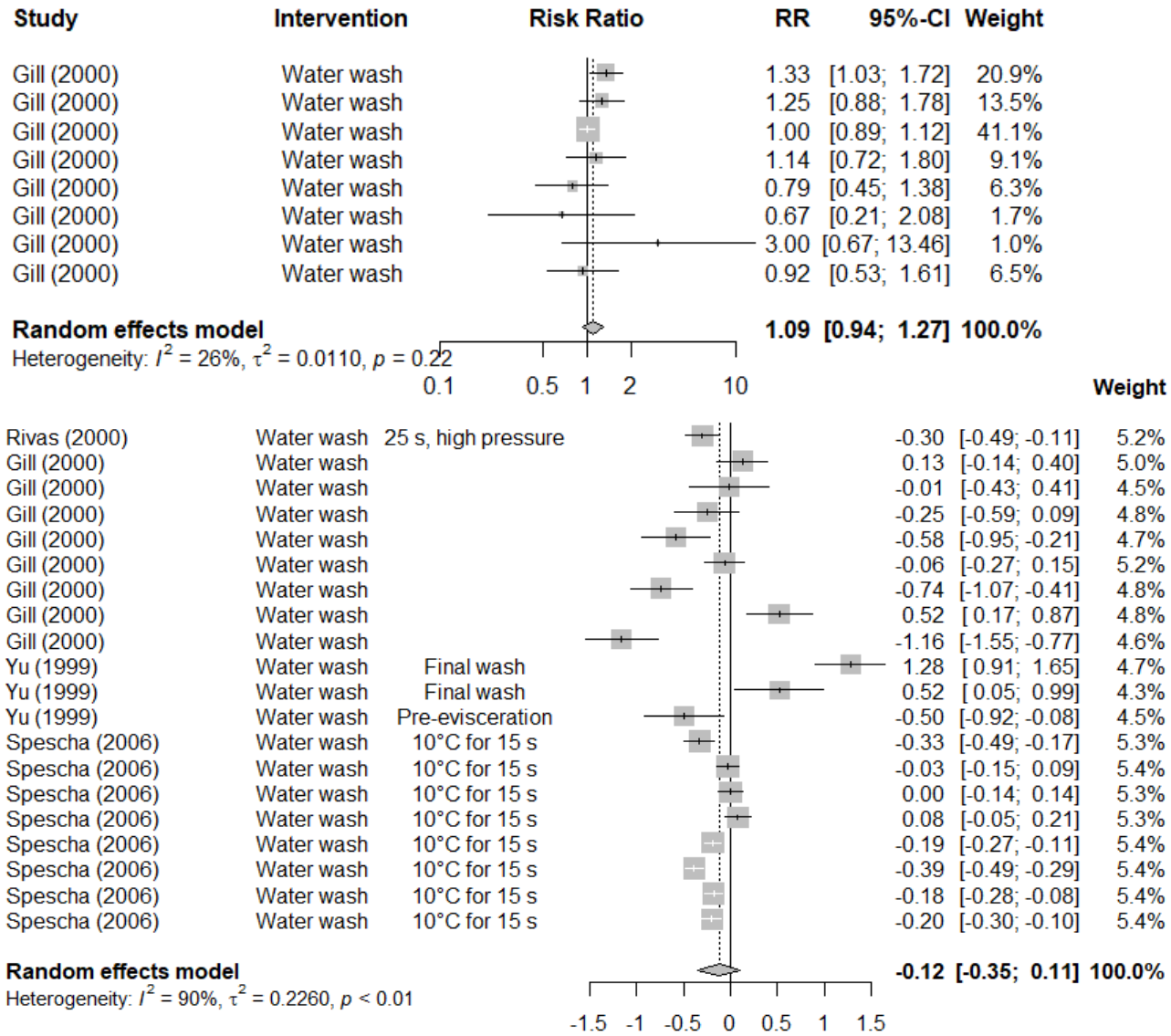


Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of singeing in reducing *Enterobacteriaceae* prevalence on pig carcasses



Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of singeing in reducing aerobic colony count (log_{10} CFU) on pig carcasses

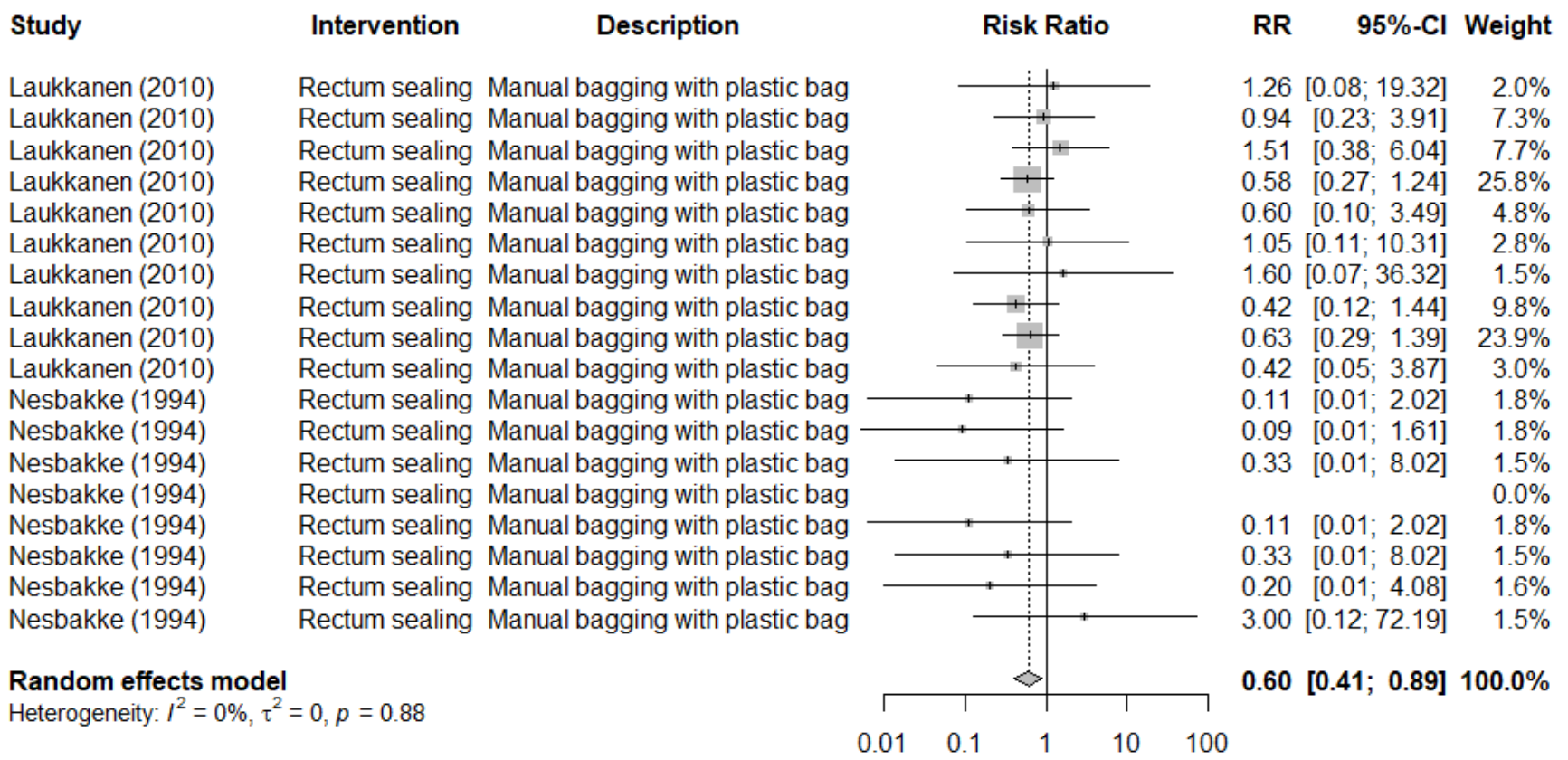
WG3 Results – standard processing procedures: **water wash**



Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of singeing in reducing generic *E. coli* prevalence on pig carcasses

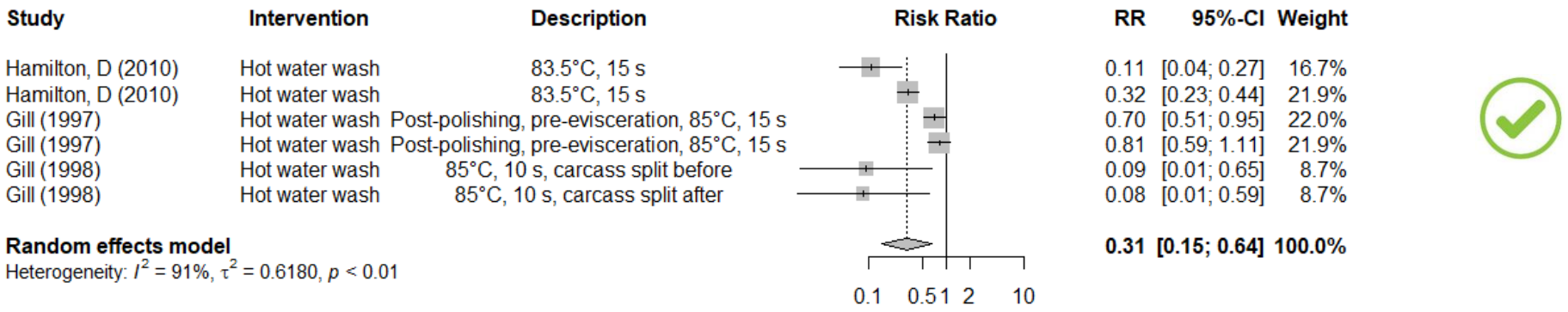
Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of water wash in reducing aerobic colony count (log_{10} CFU) on pig carcasses

Results – SPP: **rectum sealing**

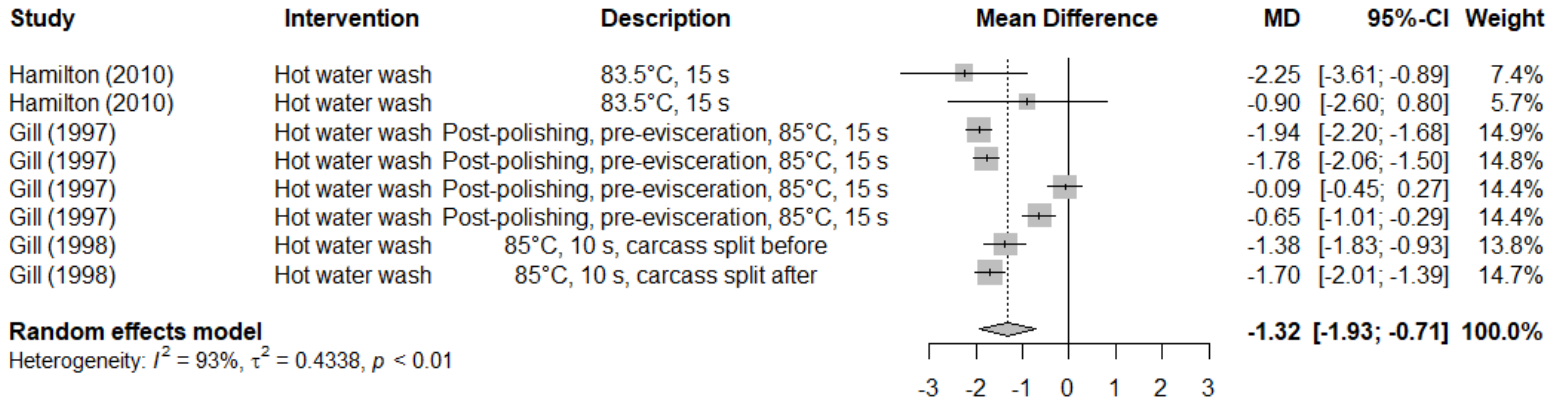


Forest plot of the results of controlled trials performed under commercial abattoir conditions to investigate the efficacy of rectum sealing in reducing ***Yersinia enterocolitica*** **prevalence** on pig carcasses

WG3 Results – hazard-based, pre-chill carcass interventions: **hot water wash**

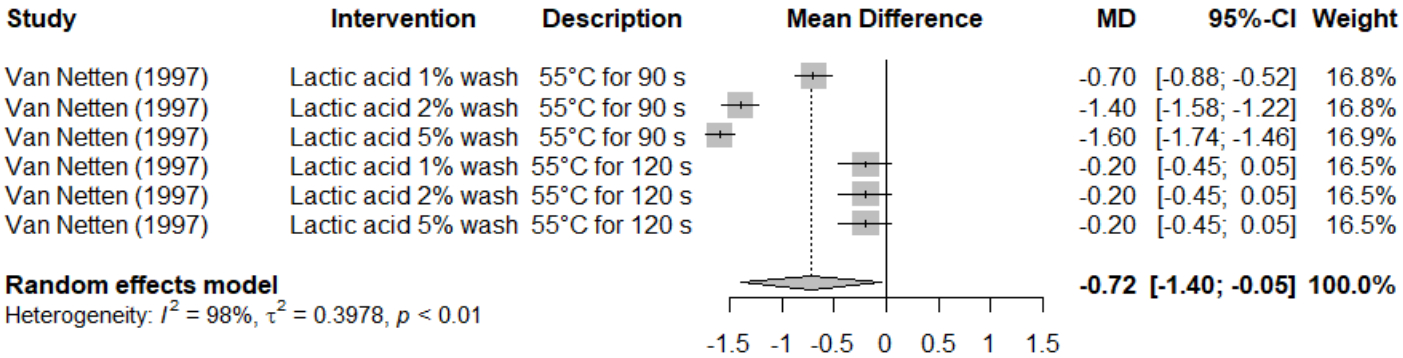


Forest plot of the results of combined controlled trials and before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of hot water wash in reducing generic ***E. coli* prevalence** on pig carcasses

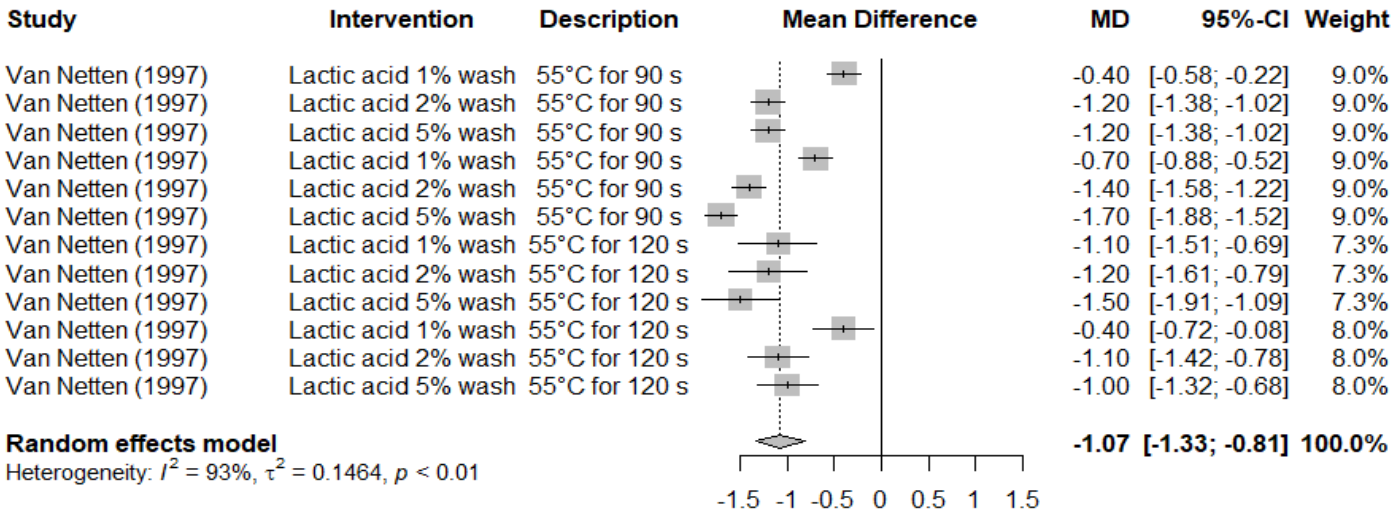


Forest plot of the results of combined controlled trials and before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of hot water wash in reducing **aerobic colony count (log_{10} CFU)** on pig carcasses

WG3 Results – hazard-based, pre-chill carcass interventions: **lactic acid wash**

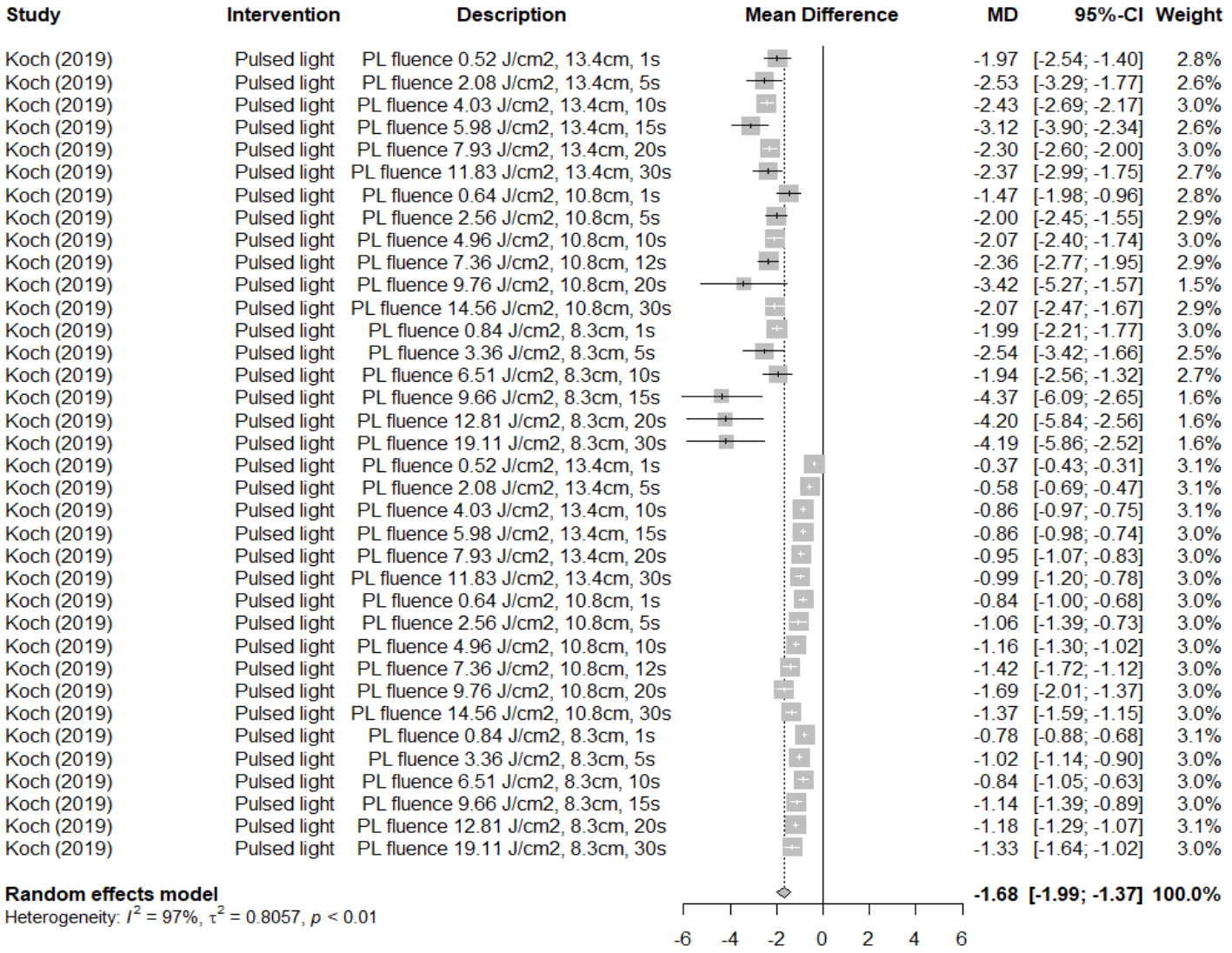


Forest plot of the results of **challenge trials** performed under **laboratory** conditions to investigate the efficacy of lactic acid wash in reducing ***Enterobacteriaceae* count** (log_{10} CFU) on pig carcass meat



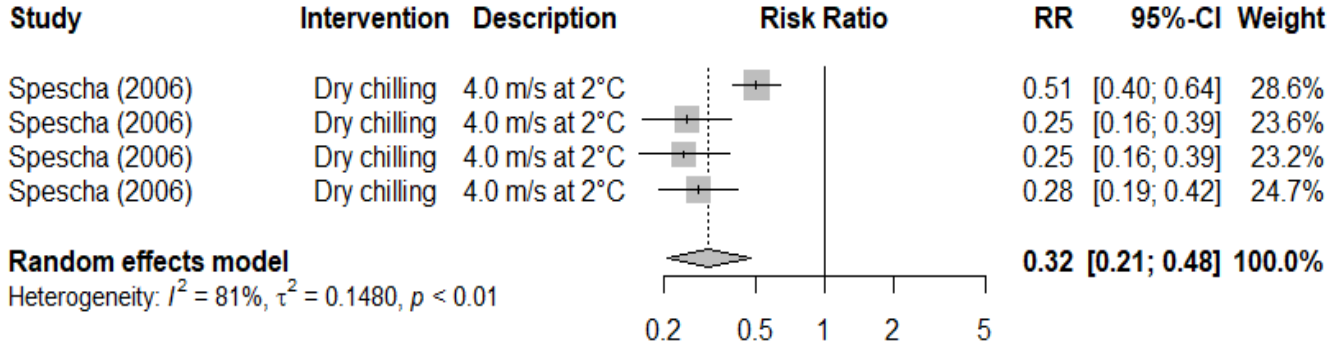
Forest plot of the results of **challenge trials** and performed under **laboratory** conditions to investigate the efficacy of hot water wash in reducing **aerobic colony count (log_{10} CFU)** on pig carcasses

WG3 Results – hazard-based, pre-chill carcass interventions: **novel interventions (pulsed light)**

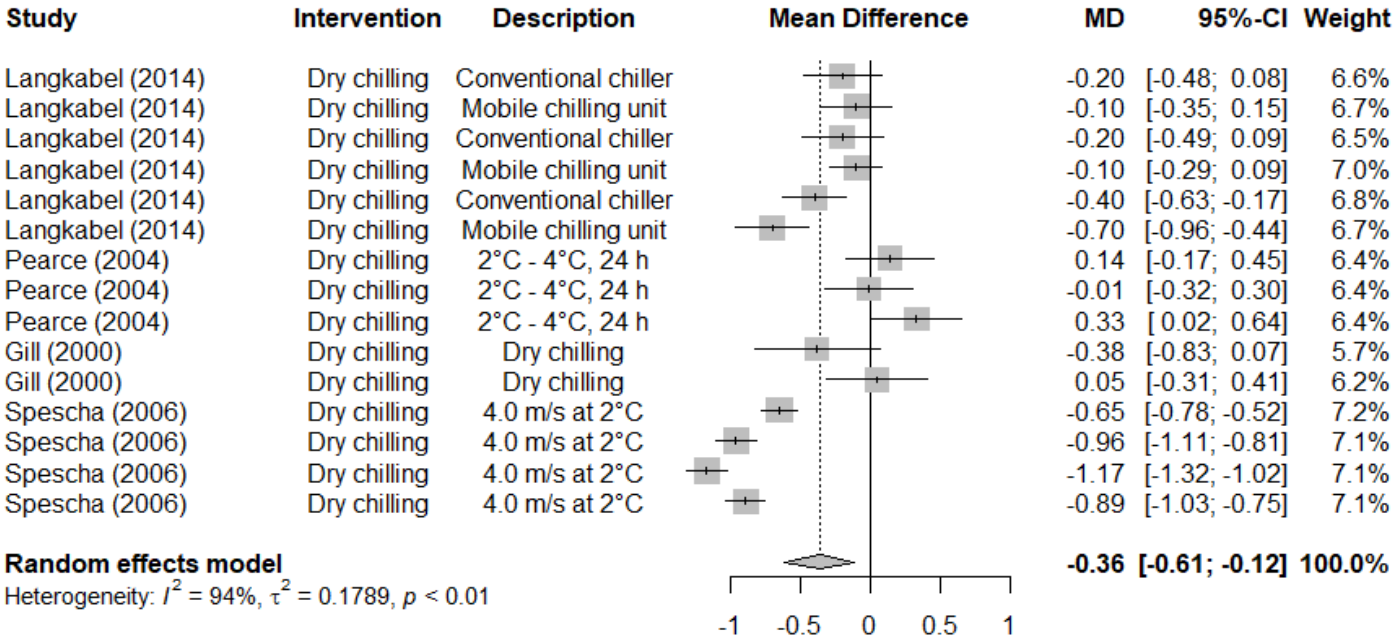


Forest plot of the results of challenge trials performed under laboratory conditions to investigate the efficacy of pulsed light treatment in reducing ***Yersinia enterocolitica*** **counts (log_{10} CFU)** on pig carcass meat.

WG3 Results – chilling: **conventional dry chilling**

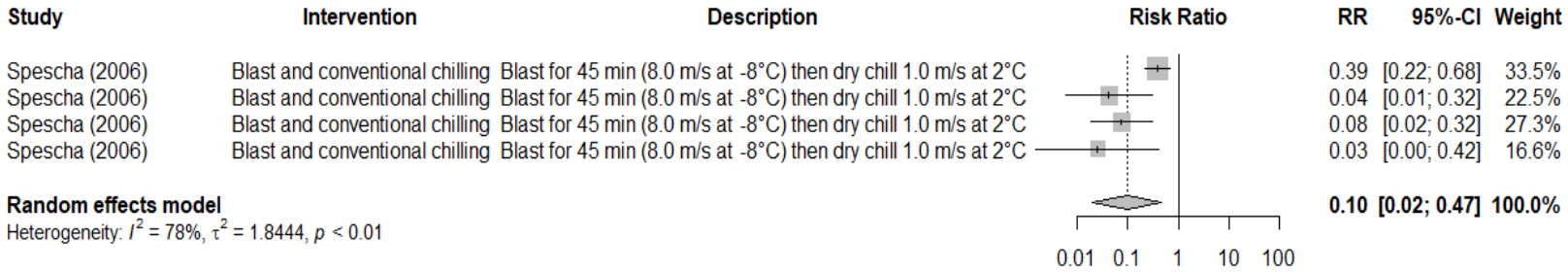


Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of dry chilling in reducing *Enterobacteriaceae* prevalence on pig carcasses

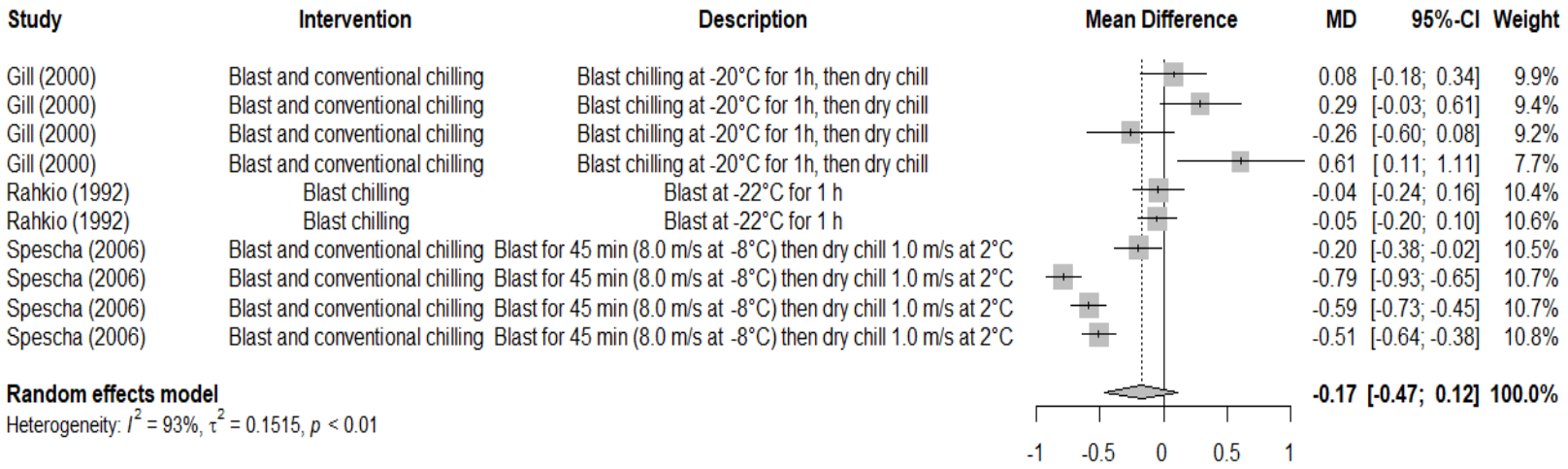


Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of dry chilling in reducing aerobic colony count (log_{10} CFU) on pig carcasses

WG3 Results – chilling: **blast chilling**

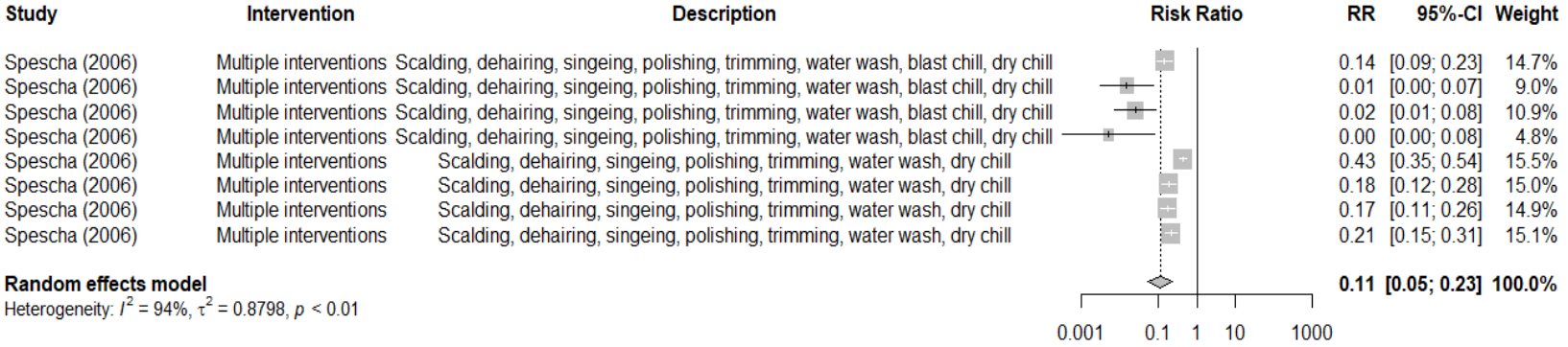


Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of blast and conventional chilling in reducing *Enterobacteriaceae* prevalence on pig carcasses

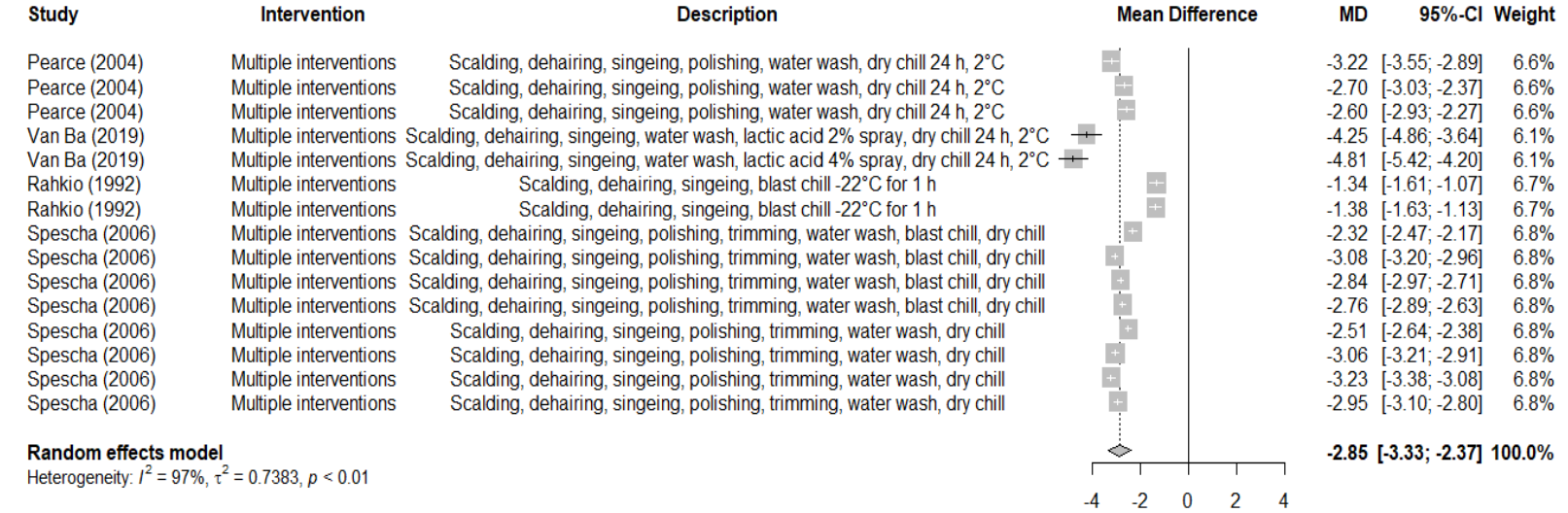


Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of blast and conventional chilling in reducing aerobic colony count (log_{10} CFU) on pig carcasses.

WG3 Results – **multiple interventions**



Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of multiple interventions in reducing *Enterobacteriaceae* prevalence on pig carcasses



Forest plot of the results of before-and-after trials performed under commercial abattoir conditions to investigate the efficacy of multiple interventions in reducing aerobic colony count (log_{10} CFU) on pig carcasses.

WG3 Discussion & Conclusions

- >30 years of literature reviewed, 4 microorganisms, all possible interventions from lairage to carcass chilling

however

- Only 22 eligible papers and 40 meta-analysis summary effects generated: significant gaps in the literature about pig interventions
- Not all studies had extractable data (<50% !)
- High heterogeneity of studies (>2/3)
- Sufficient data for scalding, singeing, but
- Lack of data for carcass steam pasteurisation, organic acid washes (acetic acid, and lack of data on lactic acid from commercial trials)
- Lack of sufficient data on most interventions, to reduce heterogeneity

WG3 Discussion & Conclusions

- Scalding, singeing – 2-3 logs ACC, RR 0.05 – 0.25 *Enterobacteriaceae* prevalence
- Rectum sealing – RR 0.60 for *Yersinia enterocolitica*
- Hot water wash – up to 1.3 logs ACC and *E. coli*
- Multiple interventions – up to 3 logs ACC, RR 0.11 *Enterobacteriaceae* prevalence
- Recommendations:
  - Standard processing procedures and hot water wash recommended
  - More research is needed
  - Methodologies and data recording needs to be harmonised

WG3 Systematic review and Meta-analysis of pig interventions

- Big thanks to all contributors in this task (2019-2022) and co-authors of this work and future manuscript

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WG3 specific objectives: what next ?

- 3.1 Assessment of effectiveness of new tools | methods for detection of carcass contamination
- 3.2 Assessment of the significant intervention strategies and alternative methods for the slaughtering | the carcass dressing

Years 1 & 2

- 3.3 Assessment of the performance of food safety management systems
- 3.4 Harmonised Epidemiological Indicators (HEI) in risk categorisation of abattoirs

Years 3 & 4

Thank you for the attention.

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