Campylobacter & Broilers –Updates

Professor Paul Whyte
School of Veterinary Medicine
University College Dublin

Introduction: *Campylobacter*, Broilers & Food Safety

- Ingestion of *Campylobacter* contaminated foods or water causes food poisoning in humans (gastroenteritis….diarrhoea, nausea, vomiting, fever, abdominal pain etc)
- Infections usually self limiting (<7days)
- Severe complications following infection in small number of cases (~1/1000) such as Guillain-Barré Syndrome…. (affects peripheral nervous system, can cause long term partial paralysis!)…also reactive arthritis
- Broilers are the main source of campylobacters
- European Food Safety Authority
  - Estimate 20-30% human Campylobacter infections caused by handling, preparing & consuming raw broiler meat while up to 80% of human cases can be attributed to the chicken reserevoir as a whole

Introduction: *Campylobacter*, Broilers & Human Health

SCIENTIFIC REPORT

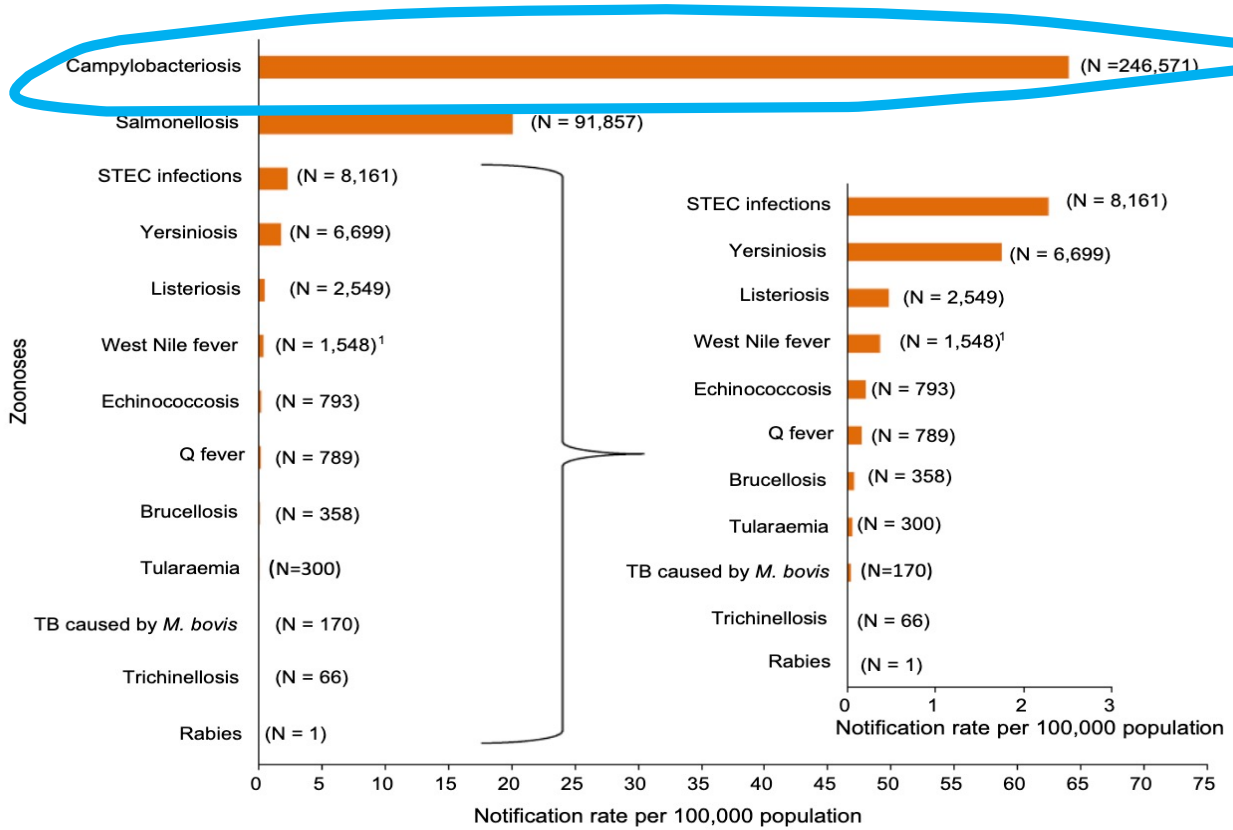
EFSA Journal

APPROVED: 19 November 2019

doi: 10.2903/j.efsa.2019.5926

The European Union One Health 2018 Zoonoses Report

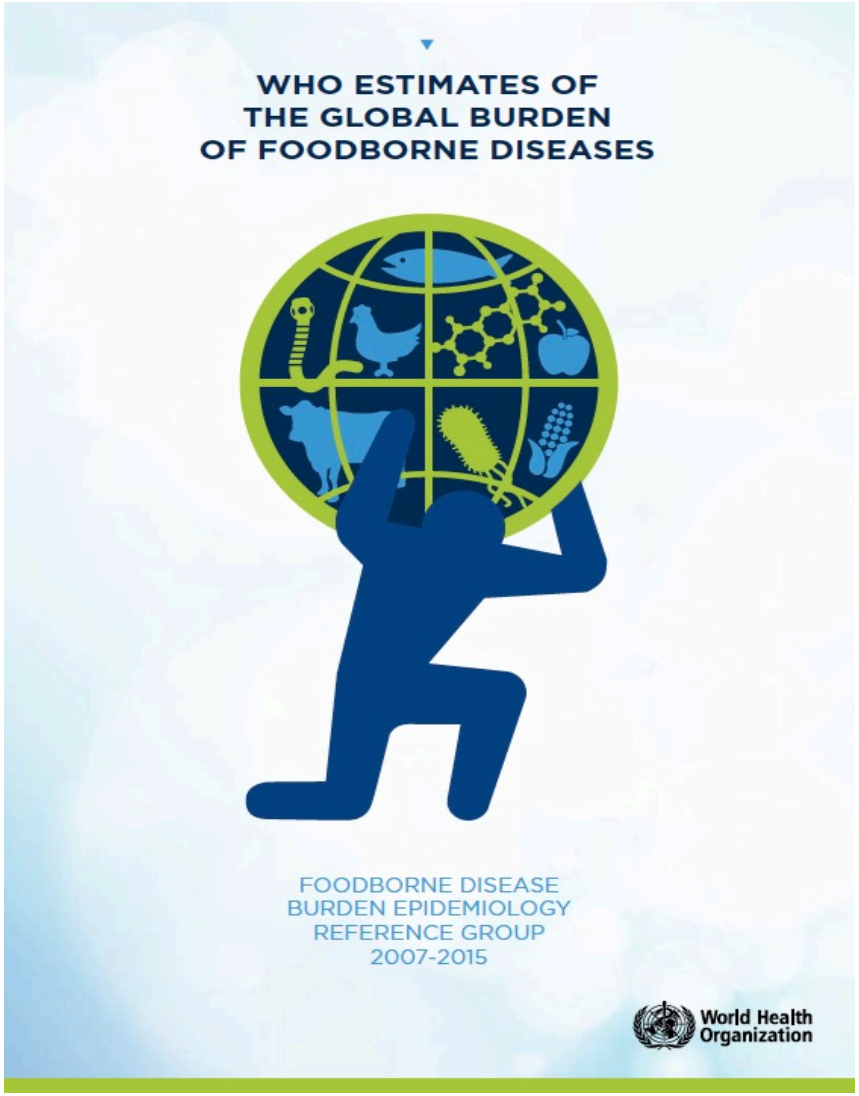
European Food Safety Authority and European Centre for Disease Prevention and Control
(EFSA and ECDC)



Note: The total number of confirmed cases is indicated between parentheses at the end of each bar.
[1]Exception: West Nile fever where the total number of cases was used.

Figure 1: Reported numbers and notification rates of confirmed human zoonoses in the EU, 2018

37% Campy cases attributed directly to Fresh broiler meat 2018



- 31 Foodborne Hazards Considered
- (bacteria, viruses, protozoa, helminths, chemicals)

- ~ 600 million illnesses each year !!!

- 420,000 deaths

- Diarrhoeal disease agents most common

NB (Esp. ***Campylobacter* & norovirus)

Campylobacter and Broiler flocks – EFSA Baseline Study 2008

European Food Safety Authority

EFSA Journal 2010; 8(03):1503

SCIENTIFIC REPORT OF EFSA

Analysis of the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses in the EU, 2008[1]

Part A: *Campylobacter* and *Salmonella* prevalence estimates

European Food Safety Authority[2, 3]

European Food Safety Authority (EFSA), Parma, Italy

ABSTRACT

A European Union-wide baseline survey on *Campylobacter* in broiler batches and on *Campylobacter* and *Salmonella* on broiler carcasses was carried out in 2008. A total of 10,132 broiler batches were sampled from 561 slaughterhouses in 26 European Union Member States and two countries not belonging to the European Union. From each randomly selected batch the caecal contents of 10 slaughtered broilers were collected, pooled and examined for *Campylobacter*. From the same batch one carcass was collected after chilling and the neck skin together with the breast skin was examined for the presence of *Campylobacter* and *Salmonella*, in addition to the determination of the *Campylobacter* counts. *Campylobacter* was detected in pooled caecal contents of broilers and on broiler carcasses in all participating countries. At Community level the prevalence of *Campylobacter*-colonised broiler batches was 71.2% and that of *Campylobacter*-contaminated broiler carcasses was 75.8%. The Member State prevalence varied from 2.0% to 100.0% and from 4.9% to 100.0%, for caecal contents and carcasses, respectively. The results of the counts of *Campylobacter* on broiler carcasses showed substantial variation among the countries in contamination levels. About two-thirds of the *Campylobacter* isolates from the pooled caecal contents as well as from the broiler carcasses were identified as *Campylobacter jejuni*, while one-third was *Campylobacter coli*. Twenty-two Member States and one non-Member State isolated *Salmonella* on the broiler carcasses, with a Community prevalence of 15.7%. This prevalence varied widely among the Member States, from 0.0% to 26.6%. However, one Member State had an exceptionally high prevalence of 85.6% with the majority of isolates being *S.* Infantis. The Community prevalence of *Salmonella* Enteritidis or *Salmonella* Typhimurium-contaminated broiler carcasses was 3.6%. *Salmonella* Infantis and *Salmonella* Enteritidis were the two most frequently isolated serovars on broiler carcasses in the EU and accounted for about one-third and one-sixth of the *Salmonella* isolates, respectively.

EFSA Baseline Survey – Broiler Flocks (live birds)

% positive live flocks
- caecum +ive

efsa

Analysis of the baseline survey on the prevalence of *Campylobacter* in broiler batches and of *Campylobacter* and *Salmonella* on broiler carcasses in the EU, 2008

Table 3. Prevalence of *Campylobacter*-colonized broiler batches, by country and in the EU*, 2008

Country	N (No of broiler batches)	% prevalence[3]	95% CI[3]
Austria	408	47.8[4]	41.5[4] - 54.2[4]
Belgium	337	31.0	23.6 - 39.4
Bulgaria	275	29.6	21.9 - 38.6
Cyprus	375	30.6	25.7 - 36.0
Czech Republic	422	61.3	56.1 - 66.3
Denmark	396	19.0	15.9 - 22.6
Estonia	102	2.0[1]	0.5[1] - 7.5[1]
Finland	411	3.9	3.8 - 4.0
France	422	76.1	70.4 - 81.0
Germany	432	48.9	40.3 - 57.7
Hungary	321	50.1	44.5 - 55.7
Ireland	394	83.1	75.2 - 88.8
Italy	393	63.3	54.5 - 71.3
Latvia	122	41.0	17.0 - 70.2
Lithuania	374	41.5	40.7 - 42.2
Luxembourg	12	100	73.5[2] - 100[2]
Malta	367	96.8	95.0 - 98.0
Netherlands	429	24.4	20.3 - 29.0
Poland	419	78.9	74.1 - 83.0
Portugal	421	82.0	76.3 - 86.6
Romania	357	77.0	63.9 - 86.4
Slovakia	422	73.6	63.6 - 81.6
Slovenia	413	78.2	78.1 - 78.2
Spain	389	88.0	84.0 - 91.2
Sweden	410	13.2	8.0 - 21.0
United Kingdom	401	75.3	69.9 - 80.1
EU (26 MS)*	**9,224**	**71.2**	**68.5 - 73.7**
Norway	396	3.2	2.1 - 4.8
Switzerland	296	59.0	55.0 - 62.9

[1] As one slaughterhouse contributed to the entire survey, point estimate and 95% CI are based on logistic regression.
[2] Exact binomial CI, the clustering of data is not taken into account.
[3] Prevalence estimates and CIs at national as well as at EU level were obtained taking into account correlation among observations within the same slaughterhouse. In addition, at EU level, prevalence estimates and CIs were weighted for the national numbers of slaughtered broilers during 2008.
[4] Results assuming independent covariance structure.
* Greece did not participate in the baseline survey and two non-MSs, Norway and Switzerland, participated.

Ireland 83% Flocks Positive!!!! No 4 in Europe!!

EFSA Baseline Survey – Broiler Flocks (live birds)

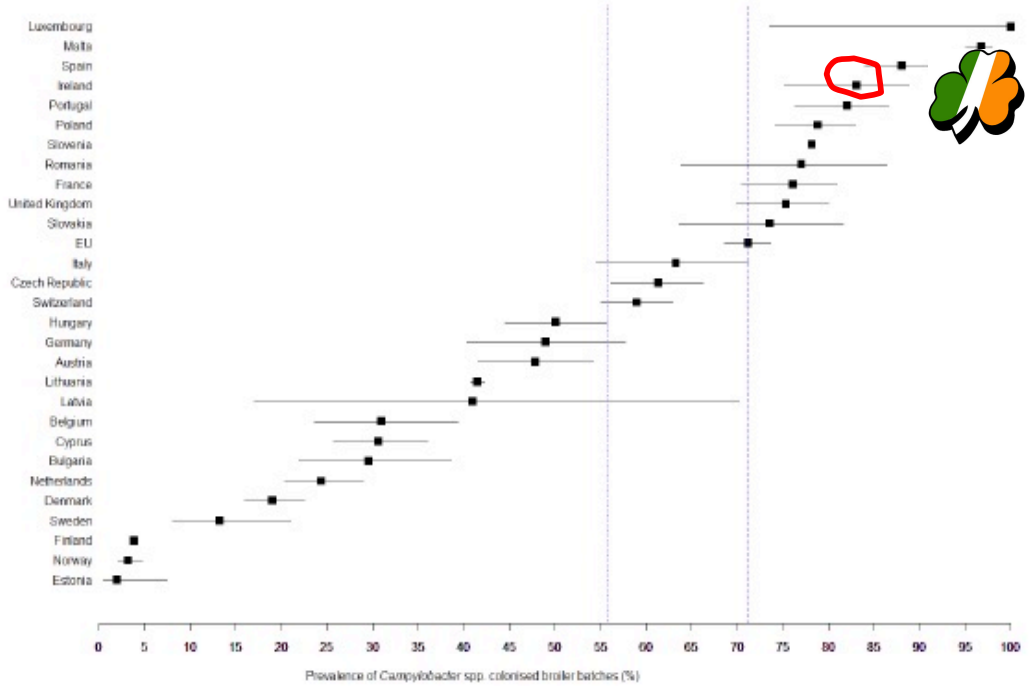


Figure 2. **Prevalence of *Campylobacter*-colonised broiler batches by country and at EU* level (dashed line), 2008. The dotted line indicates the median prevalence of 26 participating MSs. Horizontal lines indicate 95% CIs of prevalence**

* Greece did not participate in the baseline survey and two non-MSs, Norway and Switzerland, participated.

EFSA Baseline Survey – Broiler Carcases (after processing)

% positive carcases
- neck skin +ive

Table 4. Prevalence of *Campylobacter*-contaminated broiler carcasses, based on the combined results of the detection and enumeration method, by country and in the EU*, 2008

Country	N (No of broiler batches)	% prevalence[1]	95% CI[1]
Austria	408	80.6	76.7 - 83.9
Belgium	380	52.7	44.8 - 60.5
Bulgaria	280	45.2	38.9 - 51.7
Cyprus	357	14.1	14.0 - 14.2
Czech Republic	422	68.6	65.5 - 71.5
Denmark	396	31.4	26.1 - 37.2
Estonia	102	4.9[1]	2.1[1] - 11.2[1]
Finland	369	5.5	5.4 - 5.5
France	422	88.7	84.3 - 91.9
Germany	432	60.8	53.6 - 67.7
Hungary	321	55.3	48.9 - 61.6
Ireland	394	98.3	98.0 - 98.5
Italy	393	49.6	39.5 - 59.7
Latvia	122	33.6	11.3 - 66.7
Lithuania	374	45.8	42.0 - 49.6
Luxembourg[2]	13	100	75.3[3] - 100[3]
Malta	367	94.3	93.6 - 95.0
Netherlands	429	37.6	31.8 - 43.7
Poland	419	80.4	75.8 - 84.3
Portugal	421	70.2	58.7 - 79.7
Romania	357	64.2	51.9 - 75.0
Slovakia	422	79.1	68.8 - 86.7
Slovenia	413	77.8	70.7 - 83.6
Spain	389	92.6	89.8 - 94.7
Sweden	410	14.6	8.4 - 24.2
United Kingdom	401	86.3	79.6 - 91.0
EU (26 MS)*	**9,213**	**75.8**	**73.2 - 78.3**
Norway	396	5.1	3.1 - 8.3
Switzerland	408	71.7	63.8 - 78.5

[1] As one slaughterhouse contributed to the entire survey, point estimate and 95% CI are based on logistic regression.

[2] Exceptionally in Luxembourg no *Campylobacter* enumeration was executed in broiler carcass samples.

[3] Prevalence estimates and CIs at national as well as at EU level were obtained taking into account correlation among observations within the same slaughterhouse. In addition, at EU level, prevalence estimates and CIs were weighted for the national numbers of slaughtered broilers during 2008.

* Greece did not participate in the baseline survey and two non-MSs, Norway and Switzerland, participated.

Ireland 98% carcases
Positive!!!!
No 2 in Europe!!

EFSA Baseline Survey – Broiler Carcases (after processing)

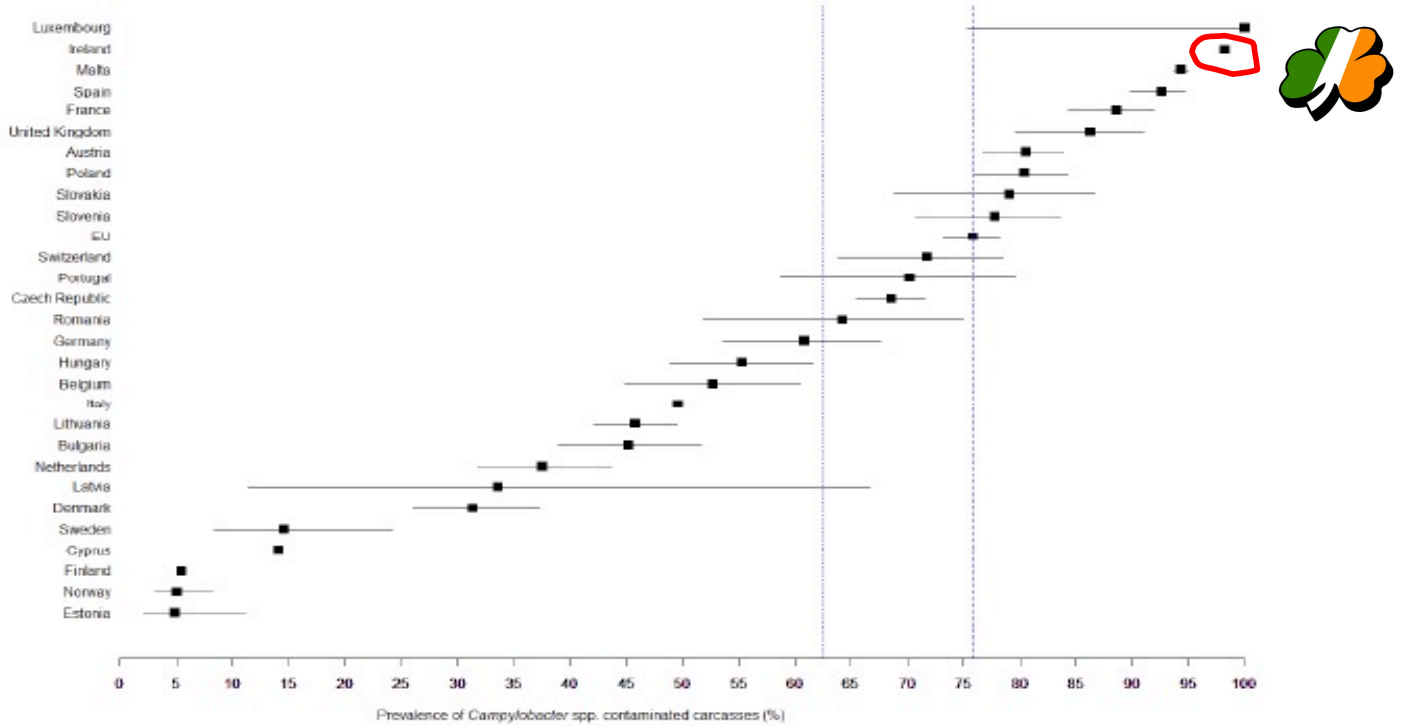


Figure 4. Prevalence of *Campylobacter*-contaminated broiler carcasses, based on the combined detection and enumeration method, by country and at the EU* level (dashed line), 2008. The dotted line indicates the median prevalence of 26 participating MSs. Horizontal lines indicate 95% CIs of prevalence. Exceptionally in Luxembourg no *Campylobacter* enumeration was executed in broiler carcass samples

* Greece did not participate in the baseline survey and two non-MSs, Norway and Switzerland, participated.

Clean-Broilers Project – Sub-task 2.1
Campylobacter Baseline Survey in Broilers - ROI

Objective

- To Repeat the 2008 EFSA Baseline Study in Broilers to evaluate progress within the Sector on controlling Campylobacter

- **Methods**

Total of 358 Broiler batches analysed over a 12 month period (Sept 2017 to Sept 2018 with monthly sampling in 3 main processing plants in ROI)

- Samples analysed were (i) Caceal contents

(ii) Neck skins (after chilling)

- Of 358 batches sampled, 178 first thin & 180 final thin birds

Campy Baseline Survey 2017-18 – Key Results Summary

- 358 Broiler batches sampled
  - 3 Main processing plants
  - First and Final thin
- Drastic reduction since 2008 Baseline Survey
  - 47% decrease in NS
  - 17% decrease in CC
- 13% of carcasses had levels greater than 1000cfu/g
  - **29%** reduction since 2008
- 1790 Neck flaps – **53%**
- 358 Caecal contents – **66%**

Risk Factors

- Depopulation – 3X more likely
- Seasonality
- Age of Broilers – 40-44 days
- Production type- higher risk in Free range

Clean Broilers –Sub-Task 2.2
Impact of Processing on *Campylobacter* levels on carcases

Objectives

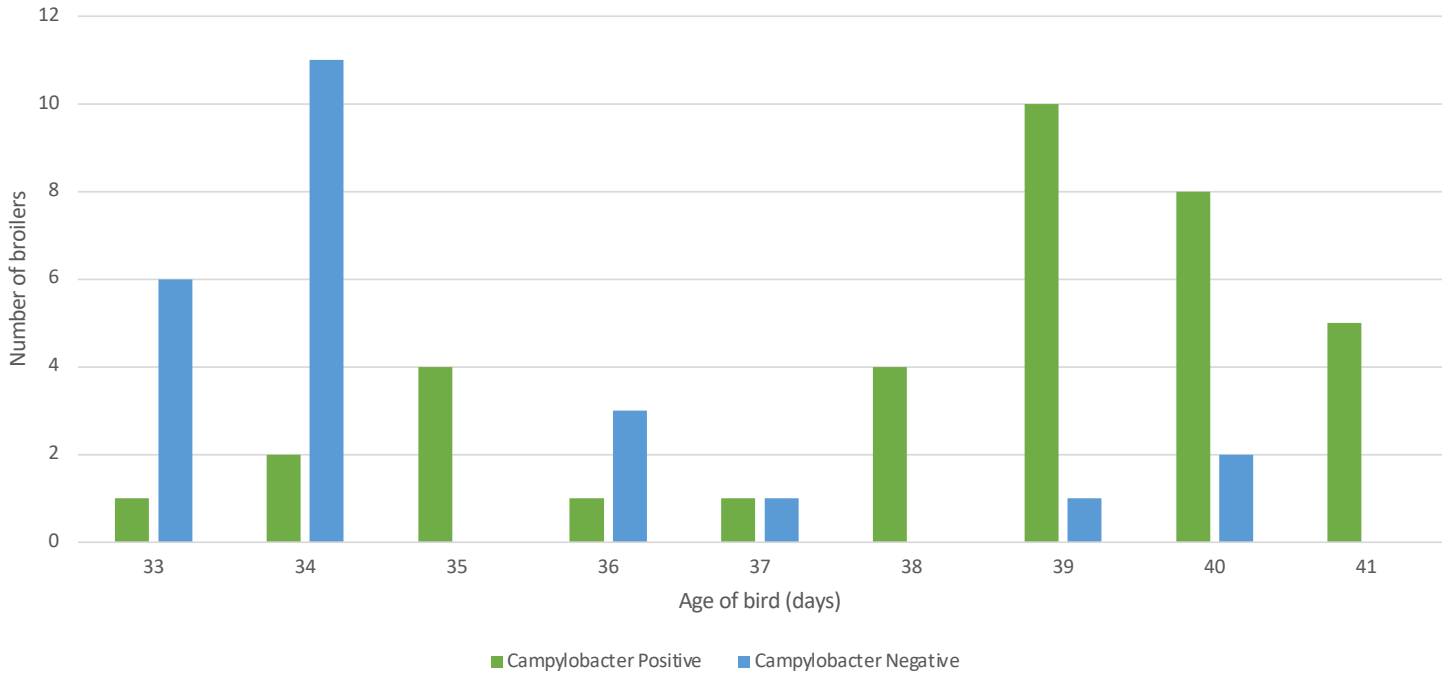
-To examine the impact of key processing stages on the levels of *Campylobacter* on broiler carcases

Methods

- Total of 60 Broiler batches collected over a 12 months (Oct2018 to Sept 2019) with monthly sampling -
  Samples obtained from one factory in ROI
  - 25 first thin batches & 35 final thin batches

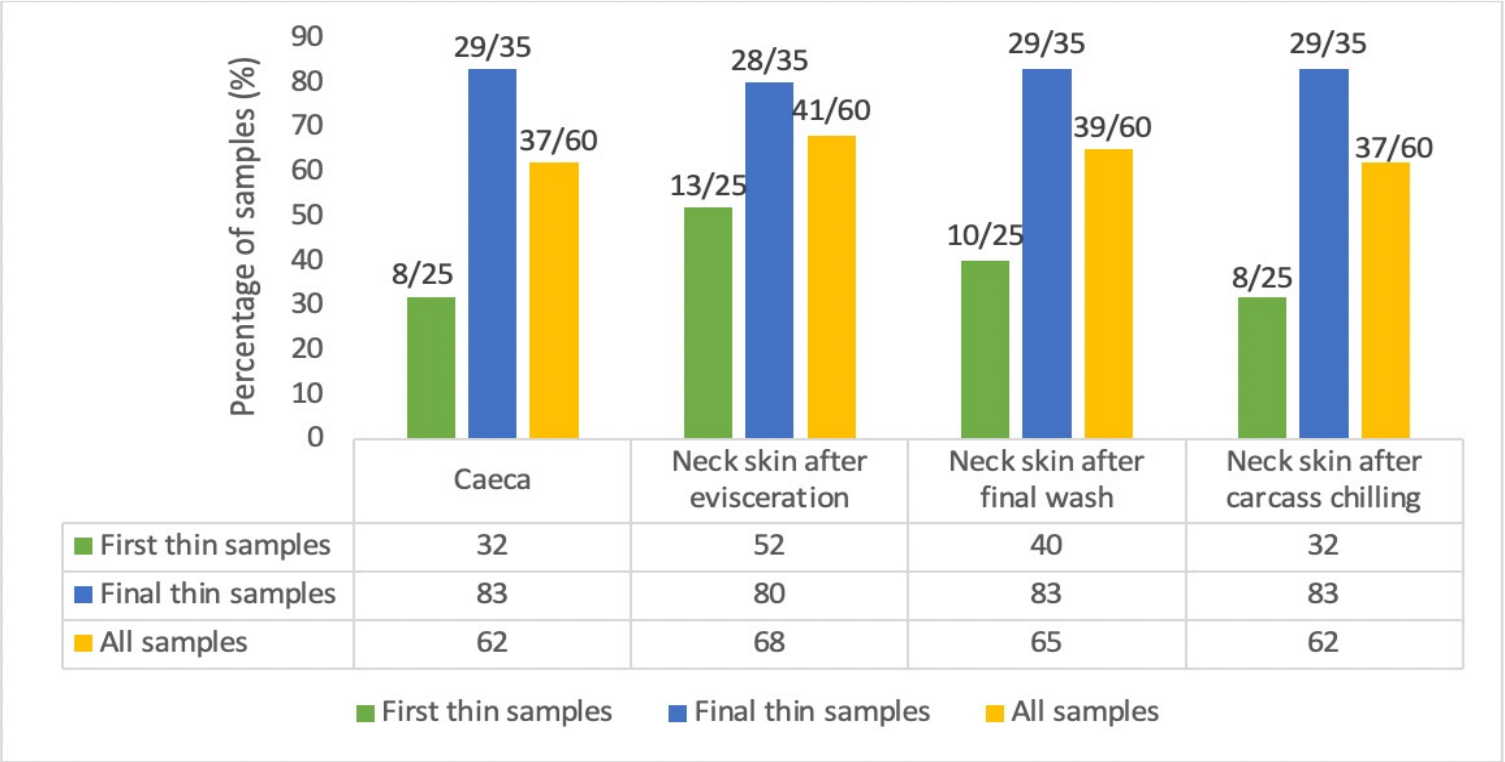
- Samples examined:
  (i) Caecal contents
  (ii) Neck skins after evisceration
  (iii) Neck skins after final carcase wash
  (iv) Neck skins after carcase chilling
-

Clean Broilers – Influence of bird age on Campylobacter status of Broiler Batches



- As age increases, no of positive broiler flocks also increased significantly

Clean Broilers – Influence of thinning stage on *Campylobacter* prevalence in Broiler Batches

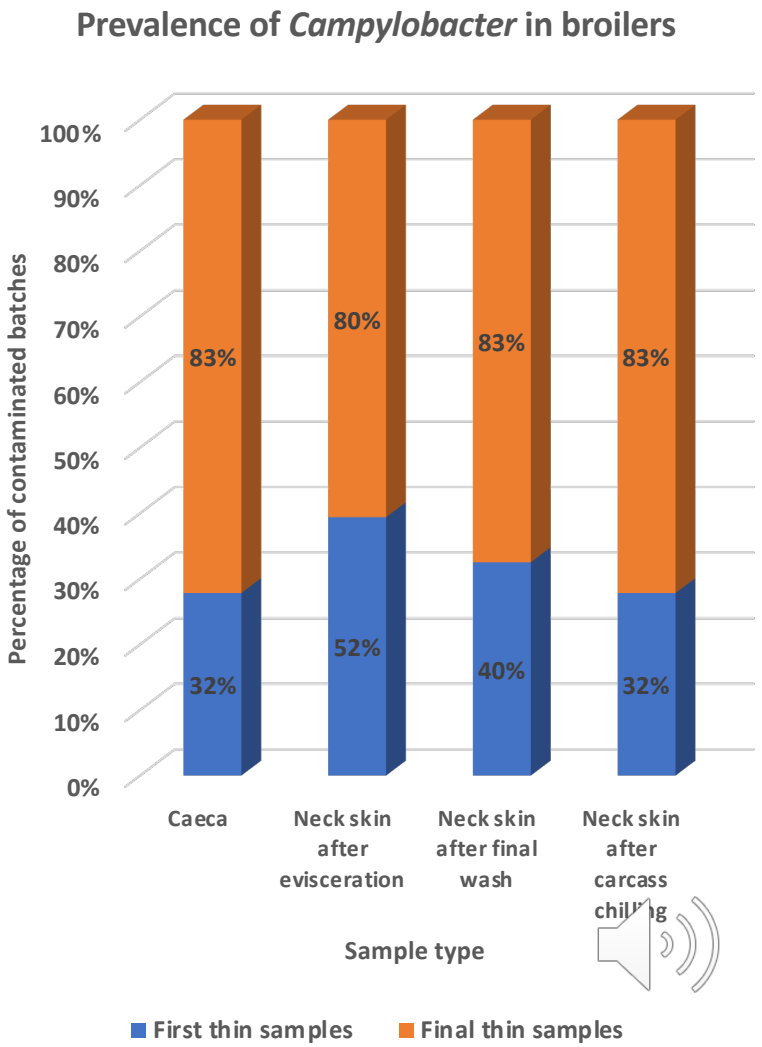


- First thin batches…..significantly fewer batches positive compared to final thin batches (Caecal contents)
- Carcases during processing……much lower numbers of Campy positive carcases from first thin batches compared t[illegible]ose from final thin batches
-

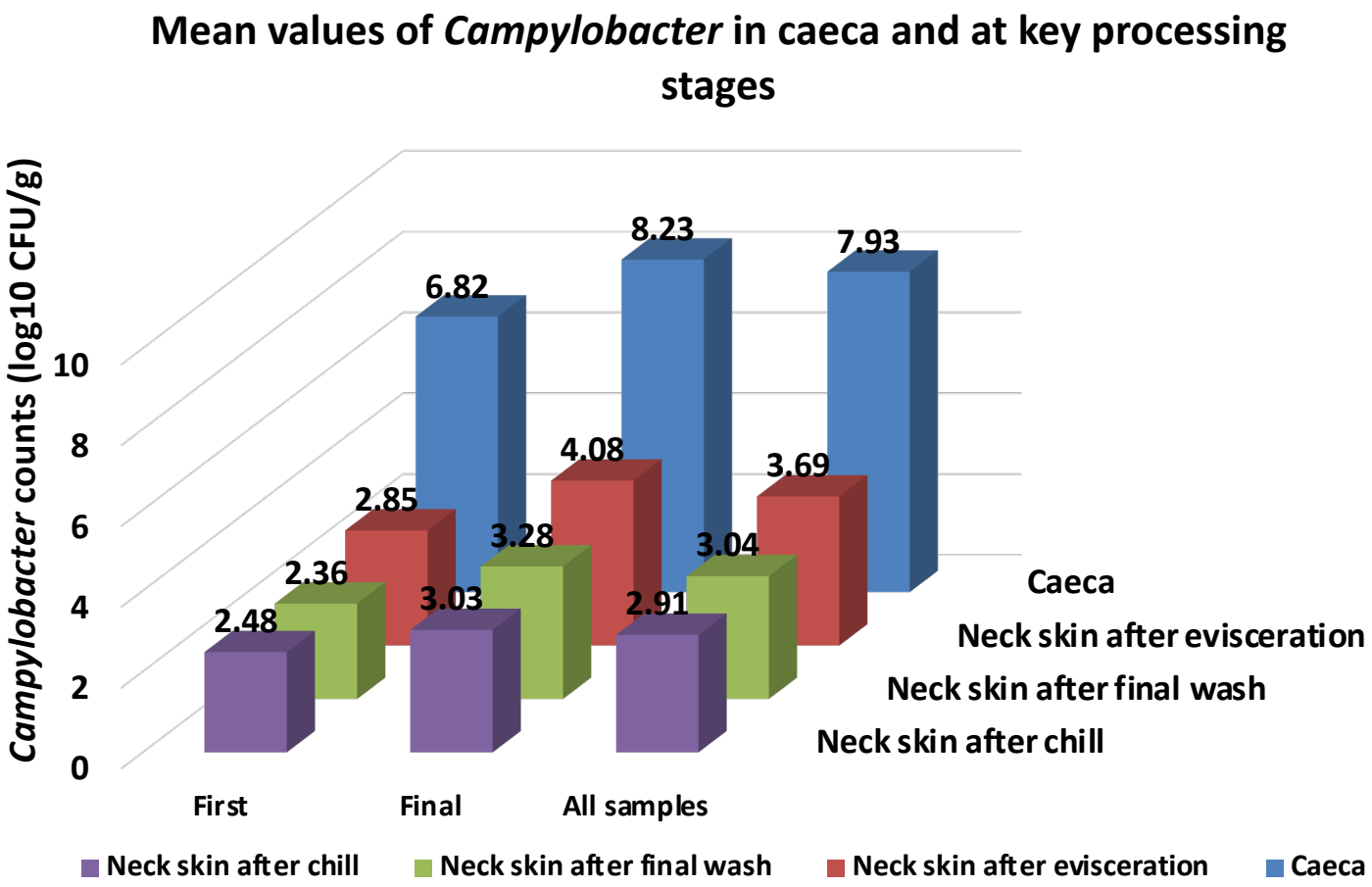
Clean Broilers – Influence of processing on *Campylobacter* contamination levels on broiler carcases

Mean *Campylobacter* levels in *Campylobacter* positive batches

Sample type	First/final thin status	Mean *Campylobacter* level (log10 cfu/g ± SD)
Caeca	First	6.82 ± 1.62
	Final	8.23 ± 1.08
	All samples	7.93 ± 1.33
Neck skin after evisceration	First	2.85 ± 0.63
	Final	4.08 ± 0.54
	All samples	3.69 ± 0.83
Neck skin after final wash	First	2.36 ± 0.65
	Final	3.28 ± 0.50
	All samples	3.04 ± 0.66
Neck skin after chill	First	2.48 ± 0.45
	Final	3.03 ± 0.44
	All samples	2.91 ± 0.50



Clean Broilers – Influence of processing on *Campylobacter* contamination levels on broiler carcases



Summary of Data from Processing Plant

- Bacterial counts decreased through the stages of processing
- Highest *Campylobacter* counts were observed at the evisceration stage of processing in both first and final thin batches
- Depopulation status had a significant effect on *Campylobacter* counts with significantly higher counts observed in final thin samples compared to first thin samples
- All first thin batches had counts below 1000 CFU/g after chilling and 52% of final thin batches had counts above this PHC limit
- Variables that may influence *Campylobacter* counts: flock age, flock weight and first/final thin status

Influence of Biosecurity on Flock *Campylobacter* Status up to FirstThinning

DAFM funded Project completed in 2016 (11/SF/328)

- 2 Groups of broiler farms were selected for the study

- 12 'High performance' farms with FULL compliance with Bord Bia & Processor Hygiene/Biosecurity audits over 3 previous broiler crops
  - All 12 farms in top 10% of economic performers within Processor Group

- 12 'Lower performance' farms with at least ONE non-compliance with Bord Bia & Processor Hygiene/Biosecurity audits over 3 previous broiler crops
  - All 12 farms in bottom 10% of economic performers within Processor Group

Influence of Biosecurity on Flock *Campylobacter* Status at First & Final Thinning

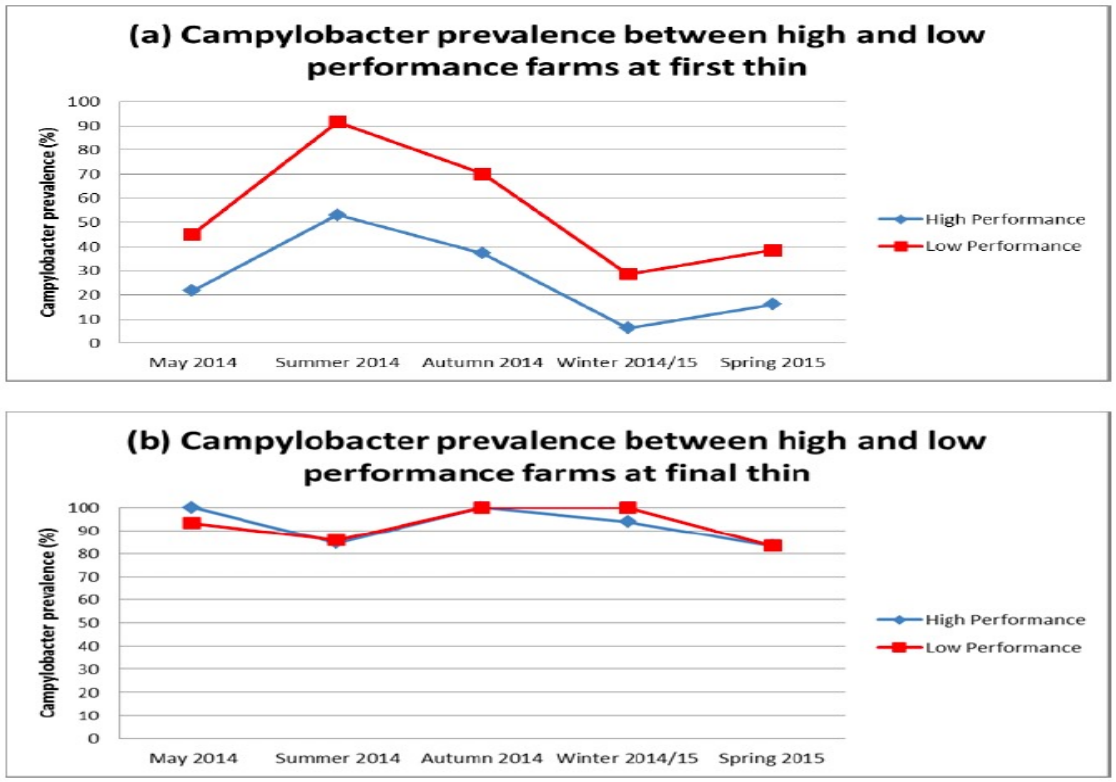
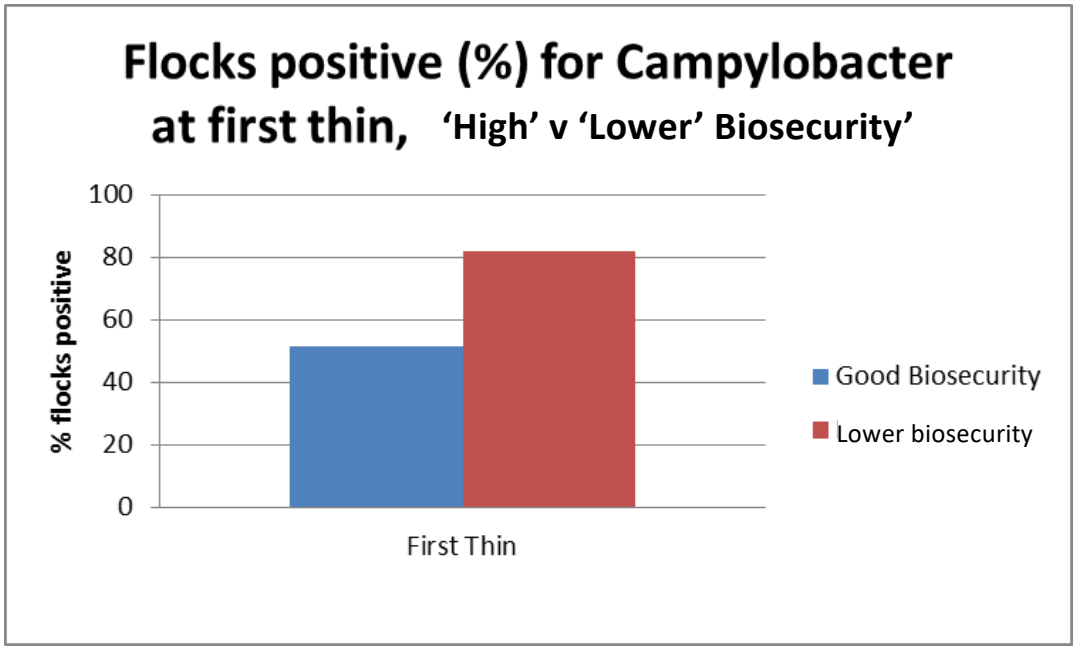


Figure 5.1(a, b): Comparisons of *Campylobacter* prevalence between high and low performance farms at a) first and b) final thin

Smith et al. (2016)

Influence of Biosecurity on Flock *Campylobacter* Status up to FirstThinning

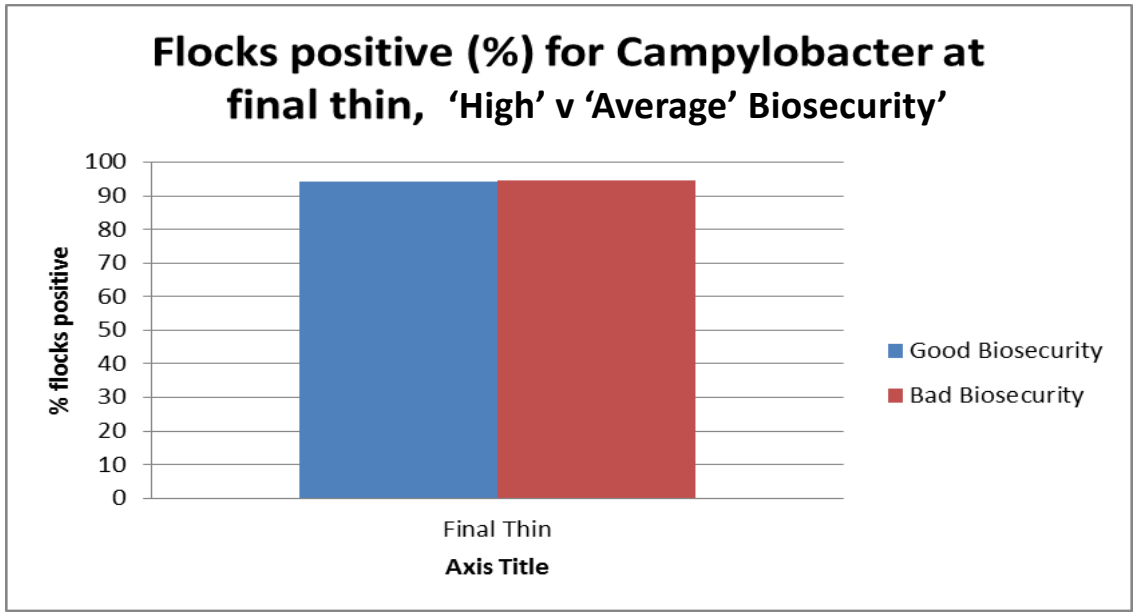


- 51.72% (out of 58) of flocks from 'high biosecurity' farms positive for Campy at first thin.
- 82.05% (out of 39) of flocks from 'average biosecurity' farms were positive for *Campy* at first thin.

***NB- ~30% difference in number of farms positive due to biosecurity practices on farm**

Smith et al. (2016)

Influence of flock age and/or thinning on Flock *Campylobacter* Status



- 94.11% (out of 34) of 'high biosecurity' flocks were *Campy* positive at final thin
- 94.44% (out of 36) of 'average biosecurity' flocks were *Campy* positive at final thin.

***NB- No difference in number of farms positive irrespective of biosecurity practices at final thinning**

- age &/or thinning is a risk factor for introducing campy to flocks

- highlights importance of biosecurity & hygiene practices around thinning

Smith et al. (2016)

Influence of Biosecurity on Economic Performance, Feed Conversion Ratio (FCR) & Mortality

- **Economics**

  -Significant difference in gross income/1000 birds (€107) between ‘High’ and ‘Lower’ biosecurity farms

- **FCR**

  - Significant difference in FCR between ‘High’ and ‘Lower’ biosecurity farms (1.67 versus 1.61 kg/kg)

- **Mortality**

  - No difference between ‘High’ & ‘Lower’ biosecurity farms

Smith et al. (2016)

Comparison of potential Risk Factors between High & Lower Biosecurity Farms

Risk Factor	High Biosecurity Farms	Lower Biosecurity Farms
Step over Barrier	10/2	2/9
Concrete apron	12/0	6/5
House specific tools	3/9	7/4
House specific footware	12/0	5/6
House specific oversuit	11/1	6/5
Other livestock & separate farm entrance	10/2	4/7

x/y = no. farms with factor/no. farms without factor

Smith et al. (2016)

Potential Risk Factors…other studies (Denmark)

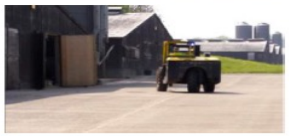
Risk Factors associated with increased prevalence of Campylobacter positive flocks:

- No. houses on farm
- Presence of infected neighbouring farms (<2km)
- Disposal of dead birds
- No. persons/times entering house
- Water supply (public *versus* private well)
- Shared ante-room
- Presence of fly nets
- House dedicated clothing
- High mortality rates
- Flock age
- Infection status on farm from previous season

(Chowdhury et al 2012 & Sommer et al. 2016)

Catchers & Biosecurity… importance of training- -UK

Table 1
Biosecurity hazards and their identification by catchers (n = 53), including comparison of responses for those with and without (self-reported) biosecurity training. The number in each cell is the percent of respondents that correctly identified each hazard.

Hazards			Hazard identification (%)			
Description	Short name	Still from film	Overall n = 53	With Training n = 42	No training n = 11	PR Test[a] p value
The catching crew wear clothes from another farm	clothes		70	76	45	0.048*
The catching forklift is not sanitised before going onto farm	Forklift		75	83	45	0.009**
Dirty clothing and boots are put on from the back of the catching van	Dirty clothes		72	71	73	0.932
Boots are not dipped on entry to the shed[b]	Dip		96	100	82	0.005**
The modules/transport crates are dirty	Crates		87	93	64	0.011*
The forklift is not sanitised before entering another shed	Between sheds		77	83	54	0.042*
The catching crew sit in their van for their break	Break		93	95	82	0.134

(Millman et al. 2017)

Campylobacter Risk Factors…..Denmark & Norway

Table 1
Significant explanatory variables for the main model of *Campylobacter* prevalence in Danish and Norwegian broiler farms. The p-value is given for each significant variable together with the effect-estimate, standard error, odds ratio (OR) and OR confidence intervals.

		Main model–DK and NO (summer)					
		Type 3 p-value	Estimate	Standard Error	Odds Ratio	95% Confidence intervals [lower; upper]	Effect on Campylobacter prevalence
Intercept	–	–	−1.83	0.80	–	–	
Age of house	0–5 year	0.002	−0.46	0.22	0.63	[0.41; 0.98]	The newest broiler houses had the lowest prevalence
	6–15 years	–	0.25	0.13	1.28	[0.99; 1.67]	
	>15 years	–	0	0	–	–	
Anteroom/barrier	Yes	0.003	−0.37	0.13	0.69	[0.54; 0.88]	High biosecurity resulted in the lowest prevalence
	No	–	0	0	–	–	
Country	DK	<0.0001	3.20	0.40	14.23*	[8.22; 24.65]	Norway had the lowest prevalence
	NO	–	0	0	–	–	
Drinkers	Nipples without cups	0.006	−1.66	0.67	0.19	[0.05; 0.71]	Lowest prevalence on farms using nipples without cups
	Nipples with cups	–	−1.19	0.66	0.3	[0.08; 1.11]	
	Bells	–	0	0	–	–	
Downtime	0 days	0.001	−0.84	0.55	0.43	[0.15; 1.28]	Lowest prevalence on farms with short downtime-days between flocks
	1–9 days	–	−1.72	0.43	0.18	[0.08; 0.42]	
	10–19 days	–	−1.30	0.41	0.27	[0.12; 0.61]	
	20–29 days	–	−0.20	0.40	0.82	[0.37; 1.81]	
	30–50 days		0	0	–	–	
Number of broiler houses		0.022	0.35	0.13	–	–	NO: Farms with low number of broiler houses had lower prevalence. DK: the number of houses was not significant (p = 0.88 result not shown)
Houses·country	DK	0.016	−0.36	0.14	0.99	[0.90; 1.09]	
	NO	–	0	0	1.43	[1.10; 1.86]	
No. of farms (total)		276					
No. of farms (final model)		256					
No. of flocks		3083					

(Borck Hog et al., 2016)

Conclusions

- Good progress made on reducing Campylobacter in broiler flocks since 2008
  - -was 83% live broiler batches campy positive , now 66%
  - -was 98% processed carcase batches campy positive, now 53%

- But…more progress needed. 13% of processed carcase batches still above the permitted contamination level (>1000cfu/g) as per Process Hygiene Criteria legal limit

- On-farm Biosecurity is most effective means of reducing Campy in broiler flocks….needs to be implemented <u>effectively & consistently</u>

Acknowledgements

- Research collaborators in UCD, Teagasc, CIT, FSAI & DAFM

-Research funding from DAFM

Thank you for your attention!

UCD DUBLIN

Teagasc
Agriculture and Food Development Authority

MTU
Ollscoil Teicneolaíochta na Mumhan
Munster Technological University

An Roinn Talmhaíochta, Bia agus Mara
Department of Agriculture, Food and the Marine

Food Safety
AUTHORITY OF IRELAND