Campylobacter Data Gathering Survey

Background

Starting in February 2014, the FSA has carried out surveys of the levels of Campylobacter on chickens at retail, covering the whole market until Aug - Oct 2017, and only smaller retailers and butchers since then. The top 9 retailers have been publishing the results of their own testing for all calendar quarters since Oct - Dec 2017.

During the months of Oct - Dec 2018, the FSA carried out a data gathering survey to provide an independent snapshot of how Campylobacter levels have behaved since the top 9 retailers started to publish their own results. This report presents the findings of this survey.

The headline indicator of Campylobacter contamination that has been used (both in the FSA retail survey and the retailers' own testing) is the percentage of chickens giving a result of over 1000 colony-forming units per gram (cfu/g) of Campylobacter. The protocol used for the most recent FSA retail surveys and the retailers' own testing requires 5-10g of chicken neck skin (generally the most contaminated part of the chicken) to be tested. All samples above 2g are tested but only the results from those with 5-10g are generally used in analysis.

Comparisons between the results of the FSA data gathering survey and those of previous FSA retail surveys are based on an average across the top 9 retailers weighted by market share[1]. In the comparisons between the results of the data gathering survey and those of the retailers' own testing, an unweighted average of the top 9 retailers is used (giving equal weight to each retailer) to be consistent with the way in which we present the retailers' own results each quarter.

The prevalence values presented in this report are an estimate based on a sample survey and there is a degree of uncertainty associated with them. This report includes 95% credible intervals which reflect the uncertainty present in the estimate of the true prevalence. These credible intervals should be interpreted as providing a range of values within which there is 95% chance that the true value lies. For the purposes of this report, the difference between credible and confidence intervals should be considered a technicality and the reader should interpret them as they would confidence intervals.

Summary of results

Figures quoted here are the prevalence of high levels of Campylobacter contamination (over 1000cfu/g) among a sample of chickens sold by the top 9 retailers.

1. The unweighted average based on the FSA data gathering survey (Oct - Dec 2018) is 5.8% , whilst the retailers' own testing for the same time period found an average of 3.1%, though there are factors not included in this analysis that could have a significant effect on results e.g. different labs performing the data gathering testing and retailers' own testing.
2. The market weighted average of 5.6% from the FSA data gathering survey (Oct - Dec 2018) is not significantly different from the latest market weighted result of 5.9% from the FSA retail survey (Aug - Oct 2017) or the market weighted result of 5.2% from the same time the previous year (Oct - Dec 2016), suggesting contamination levels have not increased since the retailers began publishing results of their own testing.

[1] The weighting by market share is based on data provided by Kantar for the 52 week period ending 1st February 2015.

Data gathering survey

1.1 The FSA data gathering survey represents the period Oct - Dec 2018 (although sampling did run over into the start of January 2019). The data gathering survey consisted of 451 chicken neck skin samples (on average 50 per retailer) taken from randomly selected whole, chilled, UK produced chickens and tested for Campylobacter.

1.2 In this report, the results of the data gathering survey are compared with retailers' own testing from the same time period, as well as data from previous FSA retail surveys, specifically looking at the proportion of samples with over 1000cfu/g of Campylobacter.

1.3 The survey protocol specifies that the results used for analysis should contain 5-10g of neck skin. However, in practice, many of the samples collected did not conform to this range. Removing the samples which did not fall within the 5-10g range (to 1 decimal place) did not appear to have any discernible systematic effect on the results. Excluding these samples would have reduced an already small number of samples, so they were included for a more robust assessment.

1.4 A new method for estimating the prevalence of chickens with over 1000cfu/g of Campylobacter among chickens sold by the top 9 retailers has been implemented to provide a more robust analysis. Specifically, the new method models the uncertainty in the prevalence directly. It provides more information about the estimated tails of the prevalence distribution and is more accurately able to model samples with zero positive results than the method used in previous FSA survey analysis involving weighted averages of Campylobacter levels.[2]

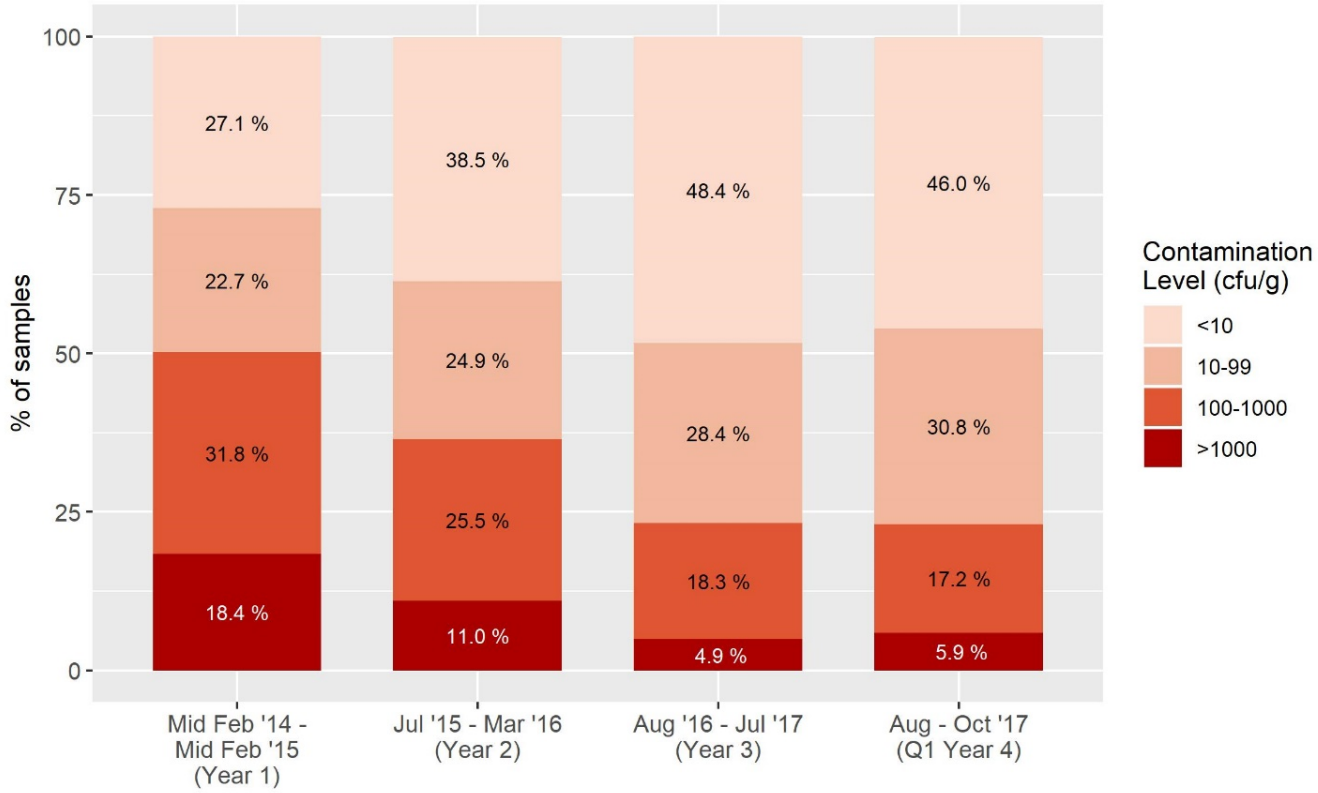
[2] Based on an uninformative 'neutral' prior of $Beta\left(\frac{1}{3},\frac{1}{3}\right)$ - as proposed by J. Kerman, Electronic Journal of Statistics, Vol. 5 (2011), 1450-1470.

Comparing the data gathering survey and past FSA retail surveys

1.5 The FSA retail survey shows a general downward trend in the levels of Campylobacter found on chickens sold by the top 9 retailers (Figure 2.1). Between Year 1 (mid Feb 2014 - mid Feb 2015) and Year 3 (Aug 2016 - Jul 2017) of the FSA retail survey, among the top 9 retailers:

- The percentage of samples testing positive for Campylobacter (over 10cfu/g) fell from 72.9% to 51.6%.
- The percentage of samples with high levels of Campylobacter (over 1000cfu/g) fell from 18.4% to 4.9%.

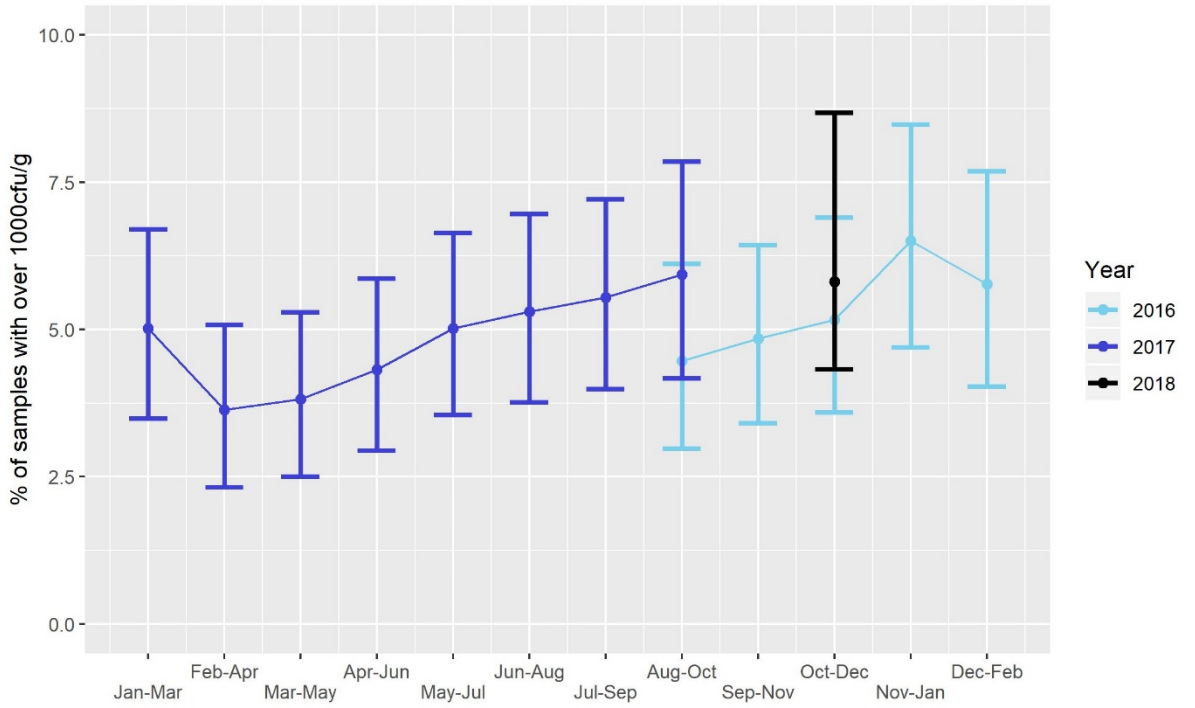
Figure 2.1 - Levels of Campylobacter contamination in chickens at retail among the top 9 retailers (weighted by market share) based on the FSA retail surveys.



1.6 The data gathering survey (Oct - Dec 2018) gives a market weighted figure of 5.6% of samples with high levels of Campylobacter contamination (over 1000cfu/g). This is statistically indistinguishable from:

- the latest quarter for which the FSA retail survey included the top 9 retailers (Aug - Oct 2017) – 5.9%
- the latest FSA retail survey data from the same time of year (Oct - Dec 2016) – 5.2%

Figure 2.2 - The percent of chickens with over 1000cfu/g Campylobacter among the top 9 retailers, based on FSA retail surveys and the FSA data gathering survey results (weighted by market share).



1.7 This comparison between the data gathering survey and past FSA results suggest that the prevalence of high level (over 1000cfu/g) Campylobacter in whole fresh chickens in the UK market at retail has not risen in the period between the data gathering survey and the previous FSA survey (the period for in which the top 9 retailers have been performing their own testing).

Figure 2.3 - A comparison of the estimated prevalence of chickens with over 1000cfu/g of Campylobacter, between the FSA data gathering results (Oct - Dec 2018) and the most recent data from the FSA retail survey (Aug - Oct 2017) – weighted by market share. Median of estimated prevalence is approximately equal to mean of sample.

	% >1000cfu/g	
	Median	**95% Cr.I.**
FSA Data Gathering Survey (Oct - Dec 2018)	5.6	(4.0 - 8.9)
FSA Retail Survey (Aug - Oct 2017)	5.9	(4.5 - 8.2)
Difference	-0.3	(-3.1 - 3.1)

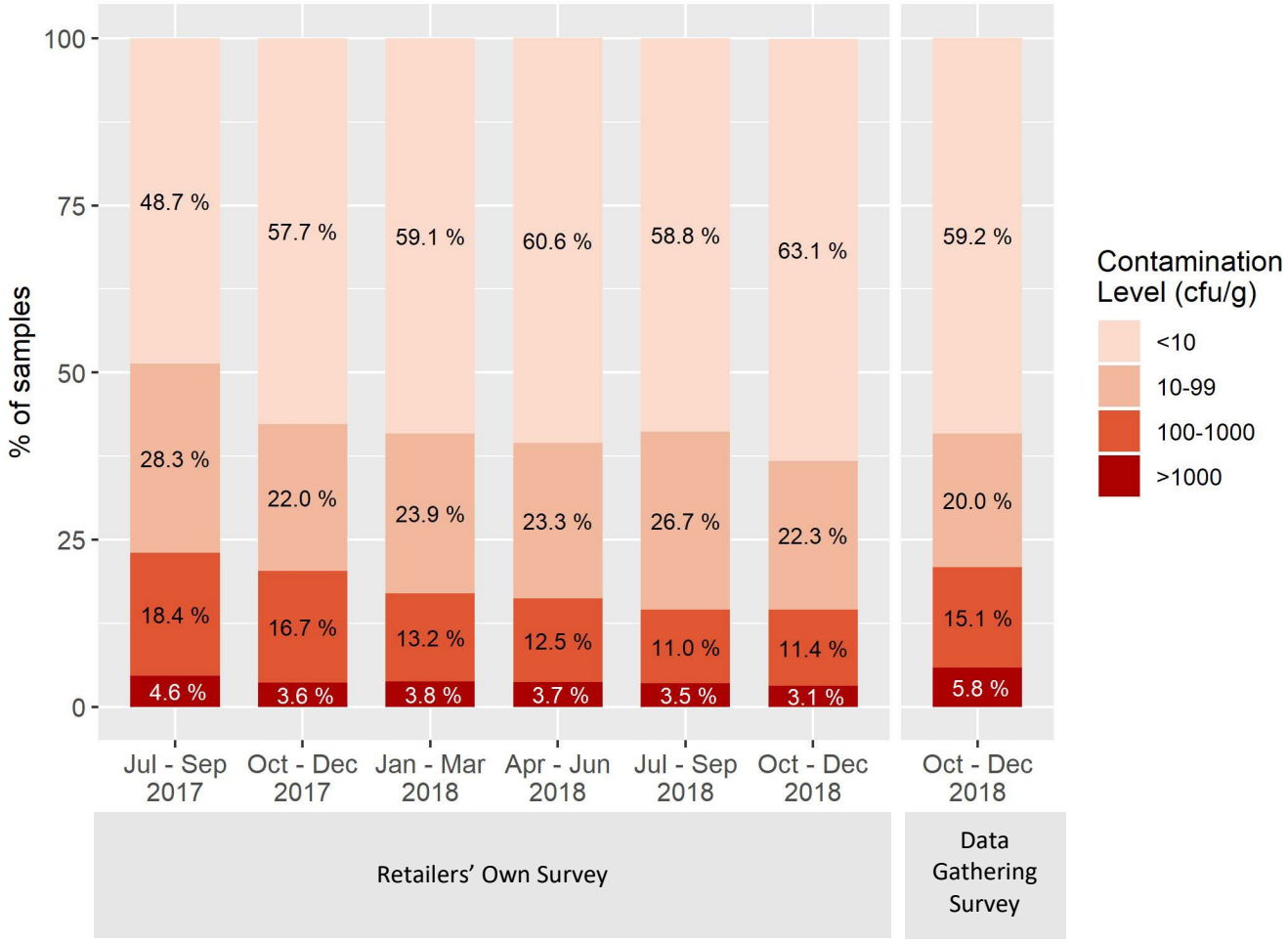
Figure 2.4 - A comparison of the estimated prevalence of chickens with over 1000cfu/g of Campylobacter, between the FSA data gathering results (Oct - Dec 2018) and the most recent FSA retail survey data from the same time of year (Oct - Dec 2016) – weighted by market share. Median of estimated prevalence is approximately equal to mean of sample.

	% >1000cfu/g	
	Median	**95% Cr.I.**
FSA Data Gathering Survey (Oct - Dec 2018)	5.6	(4.0 - 8.9)
FSA Retail Survey (Oct - Dec 2016)	5.2	(3.9 - 7.3)
Difference	0.4	(-2.2 - 3.8)

Comparing the FSA data gathering survey and the retailers' own testing

1.8 The results of the retailers' own tests for Campylobacter indicate that the average proportion of sampled chickens with over 1000cfu/g has remained between 3.8% and 3.1% for the last 5 quarters. (Figure 3.1). There was an average of 3.1% of samples having over 1000cfu/g in the survey conducted in Oct – Dec 2018.

Figure 3.1 - The levels of Campylobacter contamination among the top 9 retailers, based on the retailers' own testing and the FSA data gathering survey (unweighted).



1.9 Based on the data gathering survey (Oct - Dec 2018), the unweighted average among the top 9 retailers of the proportion of samples contaminated with high levels of Campylobacter (1000cfu/g) was 5.8%, a higher proportion than the most recent figure of 3.1% from the retailers' own testing from the same time period that may be statistically significant (Figure 2.4).

Figure 3.2 - A comparison of the estimated prevalence of chickens with over 1000cfu/g of Campylobacter, between the FSA data gathering results (Oct - Dec 2018) and the most recent FSA retail survey data from the same time of year (Oct - Dec 2016) – weighted by market share. Median of estimated prevalence is approximately equal to mean of sample.

	% >1000cfu/g	
	Median	**95% Cr.I.**
FSA Data Gathering Survey (Oct - Dec 2018)	5.8	(4.3 - 8.7)
Retailers' Own Testing (Oct - Dec 2018)	3.1	(2.5 - 4.2)
Difference	2.7	(0.8 - 5.5)

1.10 When interpreting these results, it should be kept in mind some of the differences may be due to the effect of the FSA data gathering survey and the retailers' own testing using different labs to perform tests.

Campylobacter Data Gathering Report – Appendix

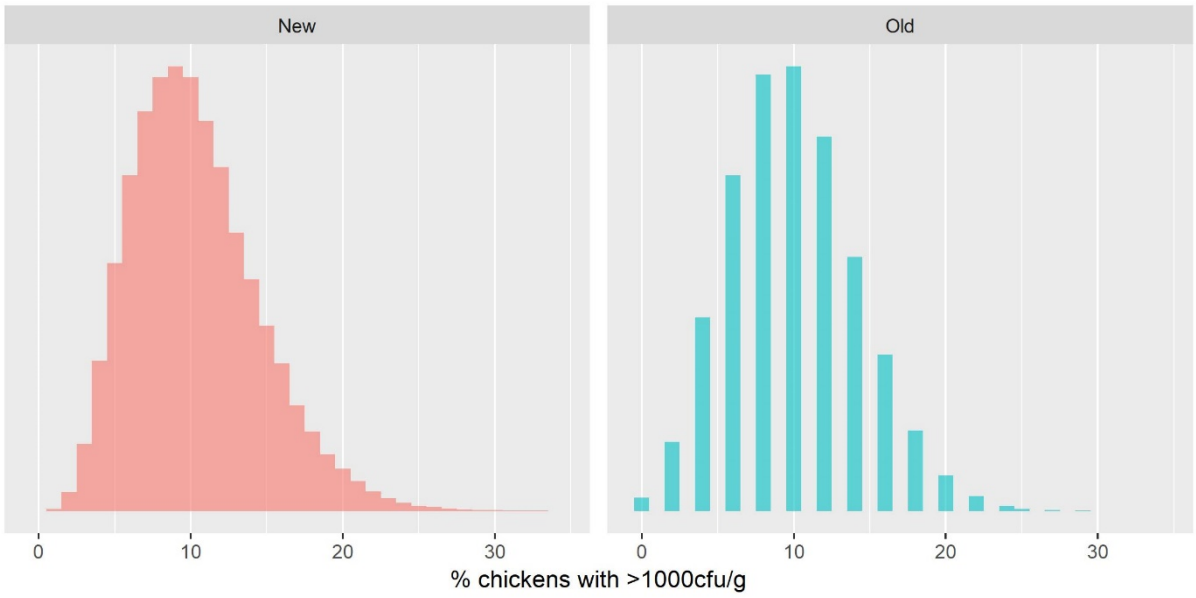
Calculation of prevalence

Prevalence has been modelled directly via a beta distribution, this requires a prior 'expected' distribution to be introduced and combined with the sample data to produce a posterior distribution. An uninformative prior is necessary whether an informative prior is used or not.

The undesirable effect of this uninformative prior is to cause the mean of the posterior distribution to be moved slightly closer to the mean of the uninformative prior (0.5 by definition), the size of this effect is dictated by the specific uninformative prior chosen. The reasoning behind the choice of Kerman's 'neutral' prior is that it is able to handle the case of finding zero positive results in a sample while keeping the shift in the mean to a sensible level – the median of the posterior becomes a good approximation of the mean of the sample when using this prior, hence the median has been included in tabulated results.

This method provides a continuous estimate of the prevalence as opposed to the discrete estimate derived from a scaled simulation of a binomial distribution, providing a better estimate of the tails of the distribution (Appx. Figure).

Appx. Figure – Comparison of prevalence obtained using current and previous methodology. The distributions have been normalised to allow easy comparison of the shapes.



The other common choices are the Haldane prior $Beta(0,0)$, the Uniform prior $Beta(1,1)$ and the Jeffreys prior $Beta\left(\frac{1}{2},\frac{1}{2}\right)$. The Uniform and Jeffreys priors have a larger effect on the mean of the posterior than the neutral prior. The Haldane prior (implicitly chosen by avoiding the use of a prior), though not affecting the mean, is unable to provide an estimate of the prevalence in the case of zero positive events in a sample.

The credible intervals obtained through the 'neutral' prior are slightly less conservative than those obtained via a Pearson-Clopper binomial confidence interval.

In this case, no informative prior distribution has been used, though this is something we might consider.

Samples with zero positive results

Normally, we take the mean of a sample to be the expected value for the population (assuming we have no other information), however our fundamental assumption is that the true prevalence of Campylobacter in chickens for any given retailer is neither zero nor one. A sample (particularly a small sample) with zero positive results does not lead us to believe that the most likely population prevalence is zero, we might instead say that the expected value $\bar{p}$ is somewhere in the interval:

$$0 < \bar{p} < \frac{1}{n}, \qquad \text{where } n \in \mathbb{N}^*$$

The values offered in this report in the cases where no positive results have been found fall within this interval and are based on the methodology outlined above.

Credible/Confidence Intervals

A 95% credible interval for a statistic e.g. the mean, is a range of possible values for which there is a 95% probability that the true value lies.

A 95% confidence interval is such that if we were to re-sample many times from a population and calculate a 95% confidence interval for each sample, 95% of those confidence intervals would be expected to contain the true value.