Estimating antimicrobial usage based on sales from a veterinary practice to beef & dairy farms, & challenges with denominator data

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Introduction

Target-setting to help reduce antimicrobial usage (AMU) in agriculture depends on well-defined and appropriate "metrics".

We assess a method for estimating one such metric (sales of antimicrobial per kg of bovine animal).

Methods

Data: Pharmaceutical sales from a veterinary practice and herd demographic data (from agricultural census).

75 cattle herds & years 2011-2015 ➔ 378 complete herd-years of data.

Ratios of antimicrobial sales per total kg of bovine calculated for each herd-year. The denominator was increased by ½ of the minimum value to prevent division by zero (true for 2 observations).

Results: ratio of numerator/denominator

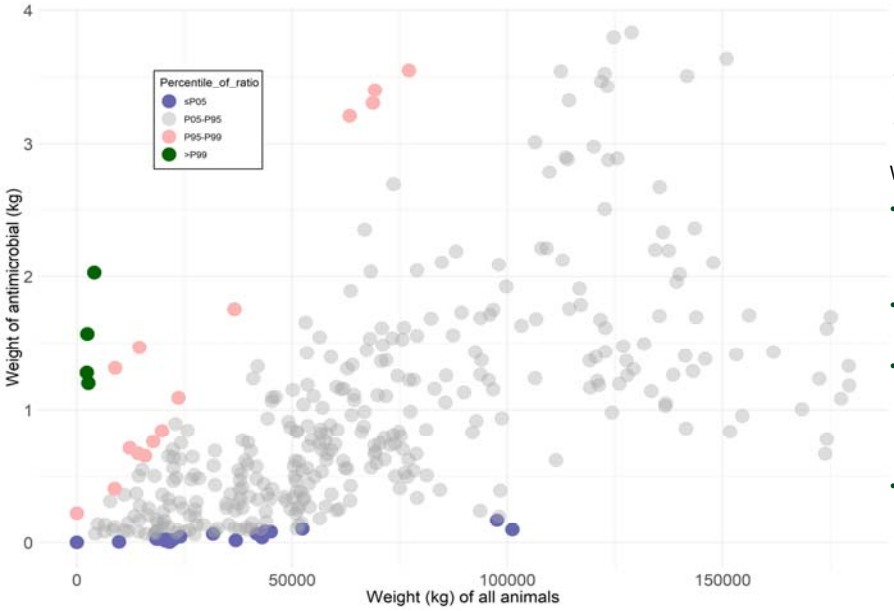

Fig 1. Total weight (kg) of active ingredient (a.i.) of antimicrobial sold and total weight (kg) of animal for each herd-year. Colours indicate the percentile range in which the ratio for each point belongs.

We see:

- As expected. a clear positive relationship between herd size and usage (Fig 1)
- Low ratios (bottom 5% of sales per kg) appear to be driven by **low total sales** (Fig 1 – **blue dots**)
- However, high ratios (top 5% of sales per kg) appear to be driven by fairly **small herds** (Fig 1 – **pink dots**)
- In particular the highest ratios (top 1%) all came from VERY small herds (Fig 1 – **green dots**)

Table 1. High, medium & low ratios cross-tabulated with high and low numerator or denominator values.

	Low Ratio ≤1 mg/kg	Med + High Ratio >1 mg/kg	Medium 1<ratio<= 50 mg/kg	Low + Med Ratio ≤50 mg/kg	High Ratio > 50 mg/kg
Numerator: Weight of a.i. in bottom 90%	9	322	315	324	7
Weight of a.i. in top 10%	0	37 (P=0.61	37	37	0 (P=1)
All 7 with ratio > 50 mg/kg had a small denominator					
Denominator: Weight of bovine in top 90%	7	324	324	331	0
Weight of bovine in bottom 10%	2	35 (P=0.23)	28	30	7 ($P<10^{-7}$)

Conclusions

- Despite using an **inclusive** denominator (i.e. all bovines), we still encountered two herd-years with 0kg recorded via the agricultural census
- The importance of particularly low estimates for the denominator is mathematically clear but **empirically** demonstrated here. Outlying high estimates for usage per kg of animal all came from those herd-years with very low total weights of animal.
- Our method seems to work for large herds but appears flawed for small herds
- Standardising usage in relation to herd size is clearly necessary **BUT…**
- Ratios designed for national-level targets may not be applicable to herd-level targets
- Perhaps these denominator data (agricultural census) are applicable to national estimates but unfit for this particular purpose – i.e. the comparison of herd years?

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