Identifying serotype-specific risk factors for *Salmonella* in Danish breeding pig holdings using multi-level analyses

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Objectives

To present risk factors for *Salmonella* Derby or *S*. Typhimurium in faeces in Danish breeding pig herds, using data from EU baseline survey on prevalence of *Salmonella* in breeding pigs, 2008.

Introduction

Pork and pork products are considered the second most important source of *Salmonella* after table eggs and the most prevalent in those products are *S*. Typhimurium and S. Derby. Analysis of Portuguese data of European 2008 *Salmonella* survey raised the possibility that *S*. Typhimurium infection is likely to be associated with animal-related factors while other *Salmonella* serotypes may be associated with environment-connected factors (Correia-Gomes et al., 2012). In this work we looked for potential risk factors for 1) *Salmonella* in general, 2) *S*. Derby and 3) *S*. Typhimurium, respectively, in faeces collected in Danish breeding pig herds and compared the results of the general EU baseline studies as well as to a similar multi-level study from Portugal. Data originated from the 2008 EU baseline survey on *Salmonella* in breeding pigs

Figure 1

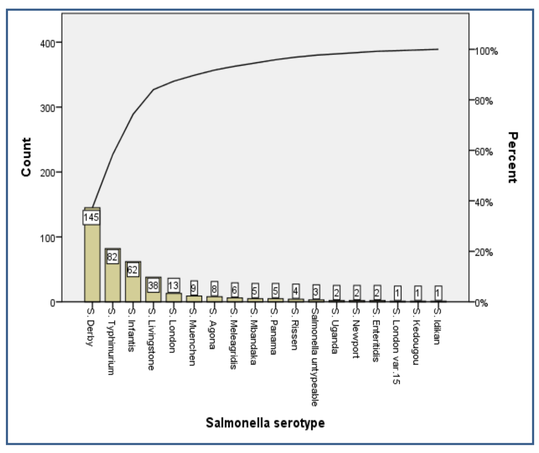


Figure 2

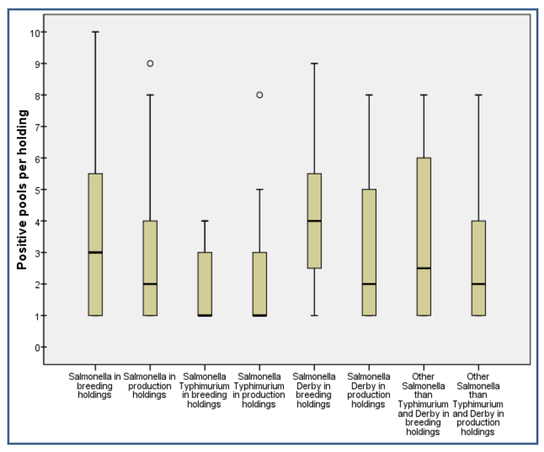


Figure 3a

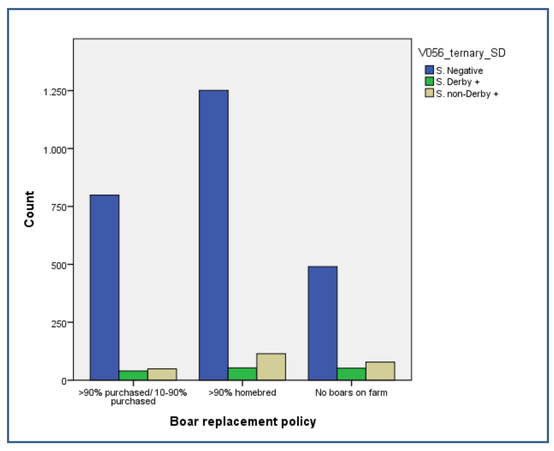
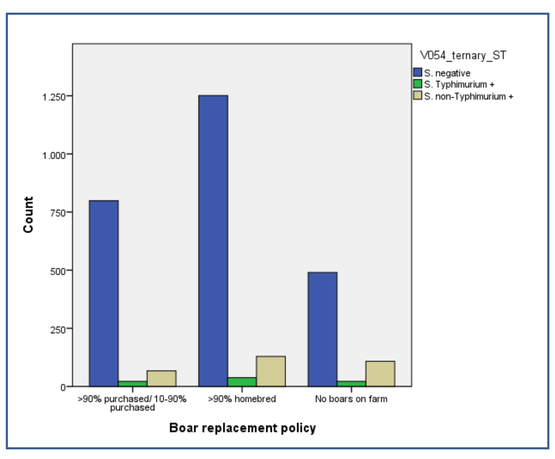


Figure 3b



Material and methods

Sample: 95 breeding and 198 production holdings. Ten pens randomly selected in each holding. Freshly voided faeces pooled from at least 10 animals in each pen were collected.

Information on potential risk factors for *Salmonella*, at holding and pen-level, using a questionnaire. Laboratory assay by ISO 6579:2002/Amd 1:2007. Serotyping according to Kaufmann-White scheme.

Three outcomes assessed, based on the pens' faecal pools: one binomial (*Salmonella* positive or negative); two multinomial: one with *S*. Typhimurium positive, *S*. non-Typhimurium positive or *Salmonella* negative pools, other with *S*. Derby positive, *S*. non-Derby positive or *Salmonella* negative pools.

A total of 2930 pens (12 pen-level variables) within 293 holdings (7 holding-level variables) analysed. Multi-level logistic regression analysis (GLMM) used. Models were fitted separately for each of the three outcome variables. Pens were nested into holdings. Holdings were modelled as a random effect. Two-way interactions with biological meaning were investigated. IBM SPSS version 22

Results

S. Derby, Typhimurium and Infantis accounted for 80% of the total of isolates (Fig. 1).

Lower infection load in herds infected with *S.* Typhimurium than in herds with Derby (Fig. 2)

Data referring to boar replacement policy (Fig. 3). Count of positive samples: (3a) *S.* Typhimurium positive (+); (3b) *S.* Derby positive (+) from positive to other serotypes or *Salmonella* negative (-)

Table 1 displays results from the three final models , for variables with P<0.05:

- "*Salmonella"* positivity: 1) risk increase with number of breeding pigs; 2) "boar replacement policy" affects the risk; 3) feeding with "Cobbs/rolls/nuts/pellets" seemed to pose an increased risk.
- "*S*. Typhimurium": 1) boar replacement policy did not affect the risk of *S.* Typhimurium but have an effect on other *Salmonella* serotypes; 2) "Porridge/liquid" feed reduce the risk of infection for *S.* Typhimurium and other serotypes.
- "*S*. Derby": 1) herds having more than 90% homebred boars had reduced risk of *S.* Derby; 2) Type of feed influenced the risk of *S.* Derby but not of other serotypes and 3) "home mixed mill" had the same effect .
- The holding as random factor, remained significant in all models.

Variables	Salmonella binomial		*S.* Typhimurum multinomial				*S.* Derby multinomial			
	All serotypes		*S.* Typhimurium		Other serotypes		*S.* Derby		Other serotypes	
	OR	p	OR	p	OR	p	OR	P	OR	p
Total number of breeding pigs	***(p=0.040)***									
<100	**0.151**	**0.014**								
100-399	**0.357**	**0.023**								
400-999	0.517	0.131								
>999	1.0	-								
Boar replacement policy	***(p=0.003)***		***(p=0.029)***				***(p=0.010)***			
No boars on farm	1.0	-	1.0	-	1.0	-	1.0	-	-	-
>90% homebred	**0.374**	**0.002**	0.655	0.331	**0.385**	**0.007**	**0.354**	**0.025**	**0.448**	**0.017**
>90% purchased/10-90% purchased	**0.363**	**0.004**	0.543	0.212	**0.340**	**0.006**	0.399	0.067	**0.367**	**0.008**
Feed	***(p=0.001)***		***(p=0.012)***				***(p=0.031)***			
Cobbs/rolls/nuts/pellets	1.0	-	1.0	-	1.0	-	1.0	-	1.0	-
Others	**0.232**	**0.005**	0.326	0.128	**0.287**	**0.035**	**0.124**	**0.028**	0.431	0.130
Meal/mash	**0.577**	**0.045**	0.474	0.066	0.563	0.059	**0.271**	**0.024**	0.876	0.724
Porridge/liquid	**0.323**	**<0.001**	**0.387**	**0.034**	**0.369**	**0.005**	**0.234**	**0.016**	0.481	0.059
Source of feed							***(p=0.034)***			
Home mill mixed							1.0	-	1.0	-
Commercial compound or mixture							**0.339**	**0.042**	1 726	0.114
Random Effects (holding level)	s^2	p	s^2	p	s^2	p	s^2	p	s^2	p
	2.686	**<0.001**	**2.477**	**<0.001**	**3.226**	**<0.001**	**3.811**	**<0.001**	**2.580**	**<0.001**

Discussion

- There were significant differences among risk factors for *S*. Typhimurium, *S*. Derby and other *Salmonella.*
- Feed associated risk factors shows strong association with *S.* Derby, not with other serotypes
- Herd size not associated with *S.* Typhimurium or *S.* Derby
- Boar replacement policy associated with risk of infection for "other serotypes". *S.* Typhimurium not associated with this variable.
- The serotype-specific risk factor investigation found different risk factors for *S.* Typhimurium in Portugal and Denmark. Knowledge of country-specific risk factors is necessary for efficient control.
- Further investigation is required to clarify the hypothesis of serotype-dependent risk factors.

References

The work was carried out as part of the integrated master study "Evaluation of Risk Factors for Salmonella Infection in Danish Pig Breeding Herds" at ICBAS-UP, available in http://sigarra.up.pt/icbas/en/PUBLS_PESQUISA.FORMVIEW?p_id=115677. Reference list for this manuscript in http://www.mediafire.com/view/izph2kaht7nhk40/Salmonella_Dk_biblio.pdf.

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