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Assessment of fallen equine data in France and their usefulness for epidemiological investigations

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ABSTRACT

Quantitative information about equine mortality is relatively scarce, yet it could be of great value for epidemiology purposes. Several European projects based on the exploitation of data from rendering plants have been developed to improve livestock surveillance. Similar data are available for equines in France but have never been studied to date. The objective of this research was to evaluate the potential of the French Ministry of Agriculture's Fallen Stock Data Interchange (FSDI) database to provide quantitative mortality information on the French equine population. The quality of FSDI equine data from 2011 to 2014 was assessed using complementary data registered in the French equine census database, SIRE. Despite a perfectible quality, the FSDI database proved to be a valuable source for studying the basal patterns of mortality over time in the French equine population as illustrated by the spatial representation of the number of deaths. However, improvements in the FSDI database are needed, in particular regarding the registration of animal identification numbers, in order to detail equine mortality for epidemiology purposes.

The usefulness of mortality data analysis in both human and animal health surveillance has already been demonstrated (Josseran et al., 2006; Kanieff et al., 2010; Nogueira et al., 2010; Perrin et al., 2012a; Perrin et al., 2012b; Simonsen et al., 1997). In animal health, the growing interest in quantitative mortality data for epidemiology purposes has led to the recent development of several projects in Europe, including PROVIMER (Programa de Vigilància de la mortalitat de les Explotacions Ramaderes) in Spain, O48M (Over 48 Months fallen stock) in the United Kingdom and OMAR (Observatoire de la Mortalité des Animaux de Rente) in France (Dupuy et al., 2013; Perrin, 2015, Accessed May 25). These projects are mainly based on the use of rendering plant data and to date have only concerned livestock. This kind of data is also available in France for the equine population, but their usefulness for surveillance purposes has never been evaluated. Indeed, the equine data collected by fallen stock companies have never been studied nor a quality assessment carried out, although this is a prerequisite to their analysis and interpretation of results (Boden et al., 2012; Bronner et al., 2015). The overall objective of this study was therefore to assess the quality of the French Ministry of Agriculture's Fallen Stock Data Interchange (FSDI) database and to evaluate its potential for providing quantitative mortality information on the French equine population.

In France, the main source of equine mortality data is the FSDI database, as all equine cadavers have to be collected by one of the fallen stock companies working in mainland France (law 75-1334 of 31 December 1975). The FSDI database is composed of removal visits, each visit corresponding to the removal of one or more animals from the same location. The main data collected for each visit are the date and time of the removal request, the date of removal, the zip code of the removal location, the number of animals collected and their age/breed category, the individual identification number and an estimation of global cadaver weight. Additional individual equine data (date of birth and exact breed) are available in the France's centralized SIRE database, which collates the identification data for all equines born in or imported into France, managed by the IFCE (French horse and riding institute). These SIRE data can be considered as a gold standard to determine the age and the breed category of equines.

All the data management and analyses were performed with R software (R core team, 2015, Accessed April 5). To explore equine mortality data, we used the 139,821 visits registered in the FSDI database from

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January 1st 2011 to December 31st 2014 since records before 2011 were not comprehensive. Ninety-five visits were considered erroneous and were eliminated from the dataset. From the 139,726 selected visits we extracted a subset of 19,192 animals for which the identification number registered in the FSDI database was traceable in the SIRE database (Table 1). Data quality was assessed in two steps. Firstly we evaluated the completeness and accuracy of the important fields on the 139,726 visits included in the study. Secondly we quantified the accuracy of age/breed categorization on the data subset of 19,192 individuals using the SIRE database information and indicators designed to evaluate the performance of a biological test: sensitivity, specificity and both positive and negative predictive values for each category.

The number of animals collected was nearly always registered (98.7%). Almost all visits concerned a single animal (99.3%). For 803 visits (0.6%) two animals were removed by the renderers, and three to thirteen animals were removed in the remaining 184 visits (0.1%). The accuracy of the number of animals collected seemed satisfactory as it was always consistent with the estimated weight of removed animals that was registered exhaustively. The zip code for the removal location was also always available. The completeness of the location and number of removed animals made possible to draw a mortality map (Fig. 1). The spatial distribution of the number of animals collected from 2011–2014 was heterogeneous. This number was higher in the western part of France (Bretagne, Pays-de-la-Loire, Basse-Normandie and Haute-Normandie regions), in the most northern part of France (Nord-Pas-de-Calais region) and more locally in the South West (Gironde *département*) and the Center East (Saône-et-Loire *département*) (Fig. 1). The completeness and accuracy of temporal parameters were satisfactory and provided an approximation of the date of death based on the date of the removal request (available in 98.5% of cases) or the date of removal (1.5%). The age/breed category was always available. Nevertheless, the subset (19,192 individuals) used for assessing the quality of age/breed category data was not representative of the FSDI database regarding the distribution of age/breed categories (Chi-square test, $p < 0.05$), in particular because of an under-representation of young animals (Table 1). The accuracy of the age categorization in the FSDI subset varied greatly according to the age group, with very low sensitivity and high specificity for "stillbirth and foal" and, in contrast, high sensitivity but low specificity for "adult" (Table 1). The classification errors mainly concerned "stillbirth and foal" categorized by mistake as "yearling". The accuracy of the breed categorization for adults in the FSDI subset (18,197 individuals) depended on the group with the best sensitivity and specificity values for "donkey" (Table 1). The categorization was correct for 16,590 (91.2%) animals and the classification errors mainly concerned "saddle horse" categorized by mistake as "pony" and conversely "pony" categorized by mistake as "saddle horse".

Despite a perfectible quality, the FSDI database appears to be a valuable source of quantitative equine mortality data. The completeness and accuracy of temporal parameters (dates of removal requests and visits) were excellent and we estimated that they were a good proxy for the date of death. The location of mortality was also assumed to be correct as zip codes for the removal location were always complete and corresponded to actual '*communes*' (the smallest administrative units in France). The FSDI database also proved useful in correctly quantifying equine mortality since the completeness of the number of animals removed per visit was also very satisfactory. Finally, the completeness of the categorization by age/breed groups was excellent, probably due to the use of this field for billing purposes. Nevertheless, it was found that the quality of categorization varied greatly with equine type, even though the non-representativeness of the data subset used for the evaluation did not allow us to extrapolate the results to the FSDI database. The main shortcoming of the age categorization appeared to be an unclear delineation of the age categories for young animals, with an overlap between the current two categories ("stillbirth and foal" and "yearling"). The issue of age categories in young animals is a major challenge, but could be overcome. Indeed, if the animal is already identified, registration of its identification number would provide access to its exact age in the SIRE records. Moreover, for foals under 6 months that are often non-identified, the systematical registration of their dam's identification number would give access to the mating or insemination date of the mare recorded in the SIRE database, and thus indirectly to an estimation of the foal's age. For adult equines, the categorization by breed group appeared reasonably satisfactory, but the "saddle horse" category seemed too broad to allow a detailed description of equine mortality by breed. Thus, the systematic registration of identification numbers is the most crucial improvement required of the FSDI database, as this is the link to individual data recorded in the SIRE database. It would therefore allow very detailed and representative descriptions of

Table 1
Description of the French Ministry of Agriculture's Fallen Stock Data Interchange (FSDI) data (139,726 visits) and the data subset containing 19,192 equines with an identification number traceable in the French equine census database (SIRE). Quality of age/breed categorization in the data subset. Period 2011–2014.

Age/breed categories in the FSDI	Dataset of the 139,726 selected visits		Subset of 19,192 equines with valid ID number		Breed categories in the SIRE database				Quality of age/breed categorization in the data subset			
	N	%	N	%	"Saddle horse"	"Draft horse"	"Pony"	"Donkey"	SeCat i (%) [IC 95%]	SpCat i (%) [IC 95%]	PPVCat i (%) [IC 95%]	NPVCat i (%) [IC 95%]
"Saddle horse"[a]	71,473	51.2	11,542	60.1	10,747	274	506	15	93.6 [93.3–93.9]	88.2 [87.7–88.7]	93.1 [92.7–93.5]	89.0 [88.6–89.4]
"Draft horse"	7545	5.4	1113	5.8	152	936	23	2	75.4 [74.8–76.0]	99.0 [98.9–99.1]	84.1 [83.6–84.6]	98.2 [98.0–98.4]
"Pony"	34,063	24.4	4525	23.6	570	30	3913	12	87.8 [87.3–88.3]	95.5 [95.2–95.8]	86.4 [85.9–86.9]	96.0 [95.7–96.3]
"Donkey"	10,662	7.6	1017	5.3	9	2	12	994	97.2 [97.0–97.4]	99.9 [99.9–99 .9]	97.7 [97.5–97.9]	99.8 [99.8–99.8]
Age categories in the SIRE database												
					"Adult"	"Yearling"	"Stillbirth and foal"					
"Adult"[b]	123,743	88.5	18,197	94.8	17,898	286	13		98.9 [98.8–99.0]	72.3 [71.7–72.9]	98.4 [98.2–98.6]	79.0 [78.4–79.6]
"Yearling"[c]	10,036	7.2	949	4.9	189	568	192		65.5 [64.8–66.2]	97.9 [97.7–98.1]	59.5 [58.8–60.2]	98.4 [98.2–98.6]
"Stillbirth and foal"[d]	5947	4.3	46	0.2	18	9	19		8.5 [8.1–8.9]	99.9 [99.9–99.9]	41.3 [40.6–42.0]	98.9 [98.8–99.0]

SeCat i: sensitivity for each category i.
SpCat i: specificity for each category i.
PPVCat i: positive predictive value for each category i.
NPVCat i: negative predictive value for each category i.
[a] "Saddle horse": all the individuals that don't fit into the "draft horse", "pony" or "donkey" categories.
[b] The categories "saddle horse", "draft horse", "pony" and "donkey" contained individuals two years old and over and are grouped into "adult".
[c] "Yearling": animals over one but under two years old.
[d] "Stillbirth and foal": animals under one year old.