

# Usefulness of fallen stock data in describing quantitative equine mortality in France

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## Abstract

Information about quantitative mortality is scarce while it could be of great value for improving knowledge of the equine population health and welfare. In France, a potential source of quantitative mortality data is represented by the Fallen Stock Data Interchange (FSDI) database managed by the French Ministry of Agriculture. In fact, all equine cadavers have to be collected by one of the fallen stock companies and since 2011, data from rendering plants have been comprehensively transmitted via computerized data transfer to the FSDI database. The objective of our research was to evaluate the quality of the FSDI database in the context of its use to provide quantitative mortality information on the French equine population. The quality of FSDI equine data from 2011 to 2014 was assessed by evaluating the completeness and reliability of the important fields for 139,726 removals of dead equines and by quantifying the accuracy of their age/breed categorization in the FSDI. For that, we used complementary data registered in the French equine census database (SIRE) managed by the French horse and riding institute (IFCE). The FSDI database proved to be a very valuable source of quantitative equine mortality data and useful for thoroughly describing the spatial distribution of deaths for different age and breed categories. However, improvements in the FSDI database are needed, in particular regarding the registration of animal identification numbers, in order to detail equine mortality for epidemiological purposes. However, FSDI data could immediately allow temporal description and modeling of equine mortality and objectifying excess mortality, thus suggesting potential interest for equine health surveillance.

**Keywords:** *equine, horse, mortality, spatial distribution, epidemiological surveillance*

## Introduction

Equine mortality is both an animal health and welfare issue. Many studies have focused on the causes of death (natural or euthanasia) in horses, relying on different data sources such as post-mortem examinations (1,2), insurance data (3,4) or owner-reported information (5). These studies provide descriptive epidemiologic data on the main equine diseases and are fundamental in establishing current disease trends in different population and suggesting control and prevention measures. Unfortunately, besides this useful information about qualitative mortality, information about quantitative mortality is relatively scarce and European studies have

focused on population samples (3,6-7). In France, fallen data are available for the whole equine population. In fact, all equine cadavers have to be collected by one of the fallen stock companies and since 2011, data from rendering plants have been comprehensively transmitted via computerized data transfer to the Fallen Stock Data Interchange (FSDI) database managed by the French Ministry of Agriculture (8). The objective of our research was to evaluate the quality of the FSDI database in the context of its use to provide quantitative mortality information on the French equine population.

## Materials and methods

The main data collected in the FSDI database are the date of 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. All data management and analyses were performed with R software (9). The quality of FSDI equine data from 2011 to 2014 was assessed by evaluating the completeness and accuracy of the important fields for 139,726 removals of 141,008 dead equines. The accuracy of the fallen stock age/breed categorization was quantified for a data subset of 19,192 equines with an identification number registered in the FSDI database and traceable in the French equine census database (SIRE) managed by the French horse and riding institute (IFCE). The SIRE database centralized the identification data for all equines born in or imported into France. For the subset of 19,192 equines, SIRE data for the breed and age can be considered as a gold standard, so the performance of the fallen stock age/breed categorization was evaluated using indicators designed to evaluate the performance of a biological test: sensitivity, specificity and both positive and negative predictive values.

Numbers of equine deaths were described per *département* (a *département* being a French administrative unit) and maps generated with the R “maps” software package. The maps were based on the 141,008 dead equines from the study dataset, the location of deaths being extracted from the zip code of the removal location.

## Results

The zip code, date of visit, age/breed category and estimated weight were always available (Table 1). The completeness and accuracy of temporal parameters were satisfactory and

provided a good approximation of the date of death through the date of removal request (available in 98.5% of cases) or the date of removal (1.5%). The completeness (98.7%) and consistency with the estimated weight of the number of animals collected were satisfactory. An identification number was registered in the FSDI database for 46.9% (65,521) of the visits, but only 29.3% (19,192) of these identification numbers were traceable in the SIRE database (Table 1). However, a progressive improvement in the traceability of identification numbers recorded by the renderers was observed from 2011 (5.3%) to 2014 (20.1%).

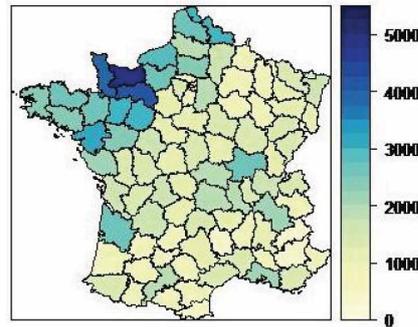
**Table 1.** Completeness of the FSDI data from 2011 to 2014.

Fields	Completeness
Date of removal request	98.5%
Date of removal	100%
Zip code of the removal location	100%
Number of animals collected	98.7%
Estimated weight	100%
Identification number	46.9%
Age/breed category	100%

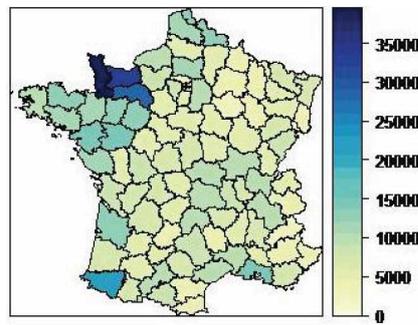
The quality of age /breed category data was evaluated on the subset of 19,192 equines with a valid identification number. This subset was not representative of the FSDI database regarding the distribution of age/breed categories (Chi2,  $p < 0,05$ ) as it had a higher proportion of saddle horses, a lower proportion of donkeys and above all an under-representation of young animals ( $\leq 2$  years). The accuracy of age categorization in the FSDI subset varied greatly according to age category, with very low sensitivity (9%) and very high specificity (100%) for the stillbirths and foals ( $\leq 1$  year) and, in contrast, high sensitivity (99%) but low specificity (72%) for adults ( $> 2$  years). The accuracy of breed categorization depended on the breed category, sensitivity varying from 75% for draft horses to 97% for donkeys and specificity ranging from 88% for saddle horses to 100% for donkeys. Positive and negative predictive values (98% and 100%) were best for donkeys.

For the overall population, the spatial distribution of equine mortality on a *département* scale was heterogeneous with a higher number of deaths in the western part and in the most northern part of France (Figure 1). Moreover, the map of equine deaths was very similar to the map of live equines in professional structures in 2010 (Figure 2) (10,11). However, some clear differences can also be noted. Spatial variations of mortality were even more marked for stillbirths and foals, with the highest number of dead animals concentrated in a small part of the West of France (Basse-Normandie region) (Figure 3). The spatial distribution of the number of deaths was similar for saddle horses, ponies and donkeys. On the contrary, for draft horses, the spatial distribution of mortality was very specific with the highest mortality concentrated in the West (Bretagne region) and in the Center (Auvergne region) (Figure 4).

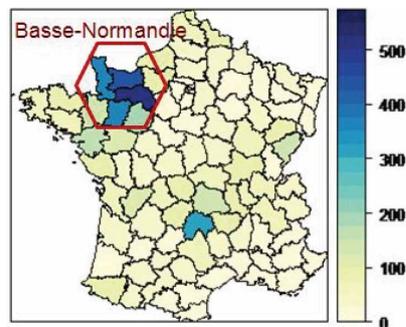
**Figure 1.** Spatial distribution of the number of dead equines collected over the period 2011-2014.



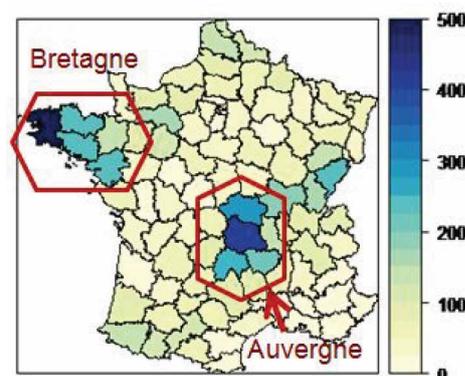
**Figure 2.** Spatial distribution of the number of live equines in professional structures in 2010 (10,11).



**Figure 3.** Spatial distribution of mortality for stillbirths and foals over the period 2011-2014.



**Figure 4.** Spatial distribution of mortality for draft horses over the period 2011-2014.



## Discussion

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. Due to the use of an automatic registration system for fallen stock removal requests, the vast majority of calls are made on the day of death, with a delay of up to three days around the weekend (closure days) as described for bovines (12). 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 as the completeness of the number of animals removed per visit was very satisfactory and the consistency of this number with the estimation of global cadaver weight was always respected. Anyway, one limit of an accurate quantification of equine mortality is the possible illegal burial of small cadavers. Finally, the completeness of categorization by age/breed groups was excellent, probably due to the use of this field for billing purposes. It was found that the quality of categorization appeared reasonably satisfactory even though the representativeness of the data subset used for the evaluation was imperfect and despite variations with equine type. Nevertheless, some groups (such as saddle horses or adults) are too large to allow a detailed description of equine mortality by breed and age subpopulations. In fact, the solution lies in improving the recording of the animal identification number to access their individual information stored in the SIRE database. Indeed, despite the improvement noted from 2011 to 2014, the registration of identification numbers in the FSDI database is still insufficient.

The similarity between the map of overall deaths and the map of the live equine population in professional structures demonstrated that the distribution of mortality overlaps the distribution of live populations. It clearly showed that for very young animals ( $\leq 1$  year), the highest number of deaths was concentrated in the major breeding area. Indeed, Basse-Normandie region is France's leading breeding region (all breeds taken together) (13). For draft horses, the spatial distribution of mortality was logically concentrated in the Bretagne and Auvergne regions since these regions are the leading regions for breeding and use of draft horses (13). The map of the live population concerned only equines in professional structures and did not take into account horses kept by private owners (the location of which remains unknown to date) (10,11). Certain discrepancies between the spatial distribution of overall deaths and the map of live equines in professional structures therefore caused us raise questions. Areas with relatively fewer deaths but relatively more live animals in professional structures suggested several hypotheses. Either animals in these areas are really

kept by professionals or/and mortality ratios in these areas are particularly low. Another hypothesis applicable to mountainous areas where there is extensive breeding is that carcasses cannot be collected but are instead eaten by wild animals, especially vultures. This underscores the importance of having thorough knowledge of the underlying population of live equines and their location to be able to describe mortality reliably.

The FSDI database proved to be a very valuable source of quantitative equine mortality data and useful for thoroughly describing the spatial distribution of deaths for different age and breed categories. The systematic registration of identification numbers is the most crucial improvement required of the FSDI database. Indeed, such an improvement would enable comprehensive interoperability of the FSDI and SIRE databases. In fact, this would make it possible to detail equine mortality by sex, age and breed subpopulations for epidemiological purposes. Moreover, FSDI data could allow temporal description and modeling of equine mortality figures and objectifying excess mortality, thus suggesting potential interest for equine health surveillance.

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