Low birth weight as a risk factor for early neonatal puppy mortality

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Adaptation from the totally protected intra-uterine life to an extra-uterine existence is a considerable challenge for the newborn. It has to insure his food intake and is particularly susceptible to environment, pathogens and temperature (1). Despite the progresses of veterinary medicine, neonatal mortality rate from birth to weaning remains stubbornly high in the canine species (around 20%) (2). In numerous species, low birth weight has been identified as a risk factor for neonatal mortality (3). The objectives of this study were (1) to evaluate the relationship between birth weight and puppy mortality during the first two days of life and (2) to determine for each breed, the critical thresholds of birth weight defining puppies at higher risk of death during the first two days of life. Weight data have been recorded by breeders and retrospectively collected for the study on a voluntary basis. Litter size (including stillborn), breed and sex of puppies were recorded. Data processing was performed using Microsoft Excel. We included only puppies from French breeders, with known birth weight and which status at two days (dead or alive) was known. Within-litter birth weight variation was defined through the coefficient of variation (CV, ratio of the standard deviation to the mean). Statistical analyses were performed using R software (version 3.3.2). First, binary logistic regression was fitted to determine factors affecting 0-2 days mortality. Five parameters were included in the model: litter size, birth weight CV, presence of stillborn in the litter, sex and birth weight of the puppy). Receiver operating characteristic (ROC) curves were then plotted by breed to identify birth weight thresholds based on Youden's index. Areas under the ROC curves were calculated to estimate the ability of birth weight to discriminate between puppies of different status, i.e. dead or alive at two days of life. Results: Data on 6772 puppies from 27 breeds, 1222 litters and 75 breeders were included. Sex ratio in live-born puppies was 1 (3358 males to 3346 females). Puppy losses during the first two days of life consisted of 221 puppies (3.3%, confidence interval CI: 2.8-3.7%) with variations between breeds (from 0% in Alaskan Malamute to 9.8% in West Highland White Terrier). From all parameters evaluated, only birth weight and within-litter birth weight variation were significantly associated with mortality during the first 48h after birth (P = 0.002 et P <0.001 respectively). A significant interaction existed between these two variables: puppies with low birth weight born in a litter with great interpuppy heterogeneity of birth weights are at higher risk of mortality. Birth weight critical thresholds have been established in 13 breeds (AUC≥0.7). In these breeds, 77% (97/126) of puppies dying during the first two days were of low birth weight. Lhasa Apso puppies with birth weight lower than 166 grams had an increased risk of early neonatal mortality (sensitivity: 88.9%, specificity: 77.1% and AUC: 0.87). For Leonberger puppies, the threshold was calculated at 410 grams (sensitivity: 75%, specificity: 86,1% and AUC: 0,84). Moreover, in these two breeds, puppies with birth weight higher than the determined threshold were of very high probability to be still alive at 2 days (negative predictive values: 99%). Birth weight critical thresholds, established in 13 breeds, would allow breeders and veterinary practitioners to identify puppies at higher risk of early mortality, providing them with appropriate nursing and medical care.

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