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# The role of birth weight on litter size and mortality within 24 h of life in purebred dogs: What aspects are involved?

D. Groppetti[a,*], G. Ravasio[a], V. Bronzo[b], A. Pecile[a]

[a] Department of Veterinary Science and Public Health, Faculty of Veterinary Medicine, Università degli Studi di Milano, Via G. Celoria 10, 20133 Milano, Italy
[b] Department of Health, Animal Sciences and Food Safety, Faculty of Veterinary Medicine, Università degli Studi di Milano, Via G. Celoria 10, 20133 Milan, Italy

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ABSTRACT

In humans, scientific evidence emphasizes the role of birth weight on neonatal welfare, morbidity and mortality. In canine species, defining normal ranges of birth weight is a harder issue due to a great morphological variability in size, body weight and breed.

The aim of this study was to correlate birth weight with litter size and mortality within 24 h of life in 789 pups from 140 litters of purebred dogs and to investigate the aspects that might affect these factors.

Birth weight was influenced by maternal size, weight and age ($P < 0.001$). The lightest pups were from toy sized or weighing up to 10 kg bitches. Conversely, bitches aged 2–8 years whelped heavier pups than younger and older mothers. Birth weight was also related both to litter size, with heavier pups in smaller rather than in larger litters from medium sized bitches, and breed ($P < 0.05$). Unexpectedly, birth weight did not differ between live born and stillborn pups. However, birth weight was lower in pups dying within 24 h of life ($P < 0.05$). High mortality of pups was related both to short pregnancies ($P < 0.05$), also showing lighter litters ($P < 0.001$), and to dystocic parturitions ($P < 0.001$). Litter size was associated with parity, type and number of mating, and length of pregnancy ($P < 0.001$).

Low birth weight appears to predispose to early neonatal mortality suggesting a predominant role of the breed rather than size and weight in determining birth weight in pups.



## 1. Introduction

Physical characteristics, which consist of large surface area-to-volume ratio, little body fat, poor vasomotor control, and inability to shiver, make neonates extremely susceptible to hypothermia with underweight infants even more prone to its potential complications (Manani et al., 2013). Moreover, since babies are born with limited capacities for gluconeogenesis and glycogen stores, they are at great risk for developing hypoglycaemia (Marom et al., 2010; Fawcett, 2014). In human perinatal clinics and research, low birth weight is regarded as a reflection of the immaturity of the organism and used as a predictor of mortality and morbidity risk (Melve and Skjaerven, 2003).

Similar to humans, it can be assumed that underweight newborn pups are more exposed to hypothermia than littermates on account of their reduced adipose tissue as well as to hypoglycaemia due to sibling competition for maternal resources (nipples and milk) with important implications for neonatal survival.

* Corresponding author.
*E-mail address:* debora.groppetti@unimi.it (D. Groppetti).

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Stillbirth and neonatal mortality are quite common in canine species and involve many factors including the quality of labour, congenital and acquired disorders, and neonatal environment (Davidson, 2003). While some factors are not controllable, the easily evaluation of birth weight could optimize neonatal attendance focusing it on needy underweight pups.

Fetal development and the resulting birth weight is also considered a predisposing factor for elective Caesarean-section in canine reproduction as the size of the pups in case of singleton pregnancy may cause dystocia (Smith, 2007; Lopate, 2008).

Various factors can influence body weight at birth: environmental, nutritional and genetic components, besides fetal uterine position in polytocous species (Bautista et al., 2015). In Boxer, also the genetic role in birth weight was reported (Nielen et al., 2001).

Due to different birth weight distributions in different ethnic groups, a population-specific standard for birth weight has been proposed in human medicine (Wilcox and Russell, 1990). Domestic dog (*Canis familiaris*) shows the greatest morphological variability of any mammal (Sutter et al., 2008). In fact, adult canine size and body weight may vary from 15 to 120 cm height at the withers and from 500 g to 120 kg, respectively, depending on the breed (Fiszdon and Kowalczyk, 2009). This heterogeneity makes it challenging to determine the physiological ranges of birth weight in this species.

We firstly investigated which maternal feature (size, weight, age and breed) can affect birth weight in purebred dogs. Then, birth weight was correlated to litter size and neonatal mortality within 24 h of life. Moreover, some reproductive aspects that might influence birth weight, litter size and early neonatal mortality were explored (parity, type and number of mating, length of pregnancy, type of parturition, sex of new-born).

## 2. Materials and methods

### 2.1. Clinical records

This study is based on data collected by a questionnaire administered to breeders/owners from January 2012 to September 2014.

One hundred and forty litters from 119 bitches belonging to 31 different breeds were enrolled (Table 1). Body weight, age and the reproductive history of bitches were carefully recorded. The height at the withers for each breed was taken from Federation Cynologique Internationale (F.C.I.), Ente Nazionale Cinofilia Italiana (E.N.C.I.) and breed clubs. The length of pregnancy was calculated both from the estimated LH surge by blood progesterone measurement, when available (Concannon et al., 1977; Kutzler et al., 2003; Michel et al., 2011), and from the day of mating/artificial insemination (AI) with fresh semen when hormonal monitoring of the reproductive cycle was not

**Table 1**
Distribution of the bitches based on their breed and size and the corresponding number of litters and pups.

| Breed | Size | Number of bitch | Number of litters | Number of pups |
|---|---|---|---|---|
| Appenzeller Mountain dog | Medium | 2 | 2 | 11 |
| Beagle | Small | 1 | 1 | 7 |
| **Bernese Mountain dog** | Medium | 14 | 16 | 88 |
| Border collie | Medium | 3 | 4 | 30 |
| Boston terrier | Small | 3 | 5 | 10 |
| Bullmastiff | Large | 1 | 1 | 10 |
| Cane Corso | Medium | 1 | 1 | 6 |
| Cavalier King Charles spaniel | Medium | 1 | 1 | 8 |
| **Chihuahua** | Toy | 9 | 12 | 34 |
| Chinese crested dog | Small | 1 | 2 | 5 |
| Dobermann | Large | 1 | 1 | 9 |
| Drahthaar | Medium | 1 | 1 | 9 |
| English bulldog | Small | 1 | 1 | 6 |
| Epagneul Breton | Medium | 3 | 4 | 26 |
| French bulldog | Small | 5 | 5 | 30 |
| **German shepherd** | Medium | 16 | 18 | 114 |
| Golden retriever | Medium | 2 | 3 | 25 |
| Great Dane | Large | 1 | 1 | 11 |
| **Hovawart** | Medium | 3 | 7 | 59 |
| Jack russel terrier | Small | 3 | 3 | 14 |
| **Labrador retriever** | Medium | 19 | 21 | 117 |
| Little Lion dog | Small | 1 | 1 | 4 |
| Miniature dachshund | Toy | 2 | 2 | 11 |
| Newfoundland | Large | 3 | 3 | 13 |
| **Pug** | Small | 5 | 7 | 28 |
| Rhodesian ridgeback | Large | 4 | 4 | 40 |
| Rottweiler | Medium | 1 | 1 | 4 |
| Segugio dell'Appennino | Medium | 1 | 1 | 6 |
| **Staffordshire bull terrier** | Small | 8 | 8 | 42 |
| Yorkshire terrier | Toy | 1 | 1 | 1 |
| Zwergpinscher | Small | 2 | 2 | 11 |
| Total | | 119 | 140 | 789 |

Bold indicates a breed showing significant numbers of litters/pups.

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