Relationship between body temperature, growth rate and neonatal survival in puppies

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INTRODUCTION

Neonatal mortality (i.e. death during the first three weeks of life) is of high prevalence in puppies, accounting for 75-90% of all pre-weaning deaths [1,2], with majority of newborns dying during the first week. Hypothermia is described as one of the major causes of neonatal mortality, making temperature measurement a fundamental element of puppies' health evaluation. This study aimed:

- **to identify factors of variation of body temperature in puppies**
- **to evaluate the association between body temperature and puppies' health (growth and neonatal survival).**

MATERIALS AND METHODS

- All puppies included to the study (n=347) were identified at birth. Their birth weight was categorized into 4 quartiles (Q1: the lightest; Q4: the heaviest; table 1). Depending on the expected adult weight, puppies were classified into small (body weight <10kg), medium (10-25kg) or large breeds (>25kg). Puppies were kept with their mothers, under an infra-red lamp and on a heated ground (28-30 C).
- Rectal temperature was measured within the first 8 hours after birth (0d), at 1d, 2d, 7d, 14d and 21d (fig.1) on each puppy by a digital thermometer (Torm 10S; Cooper, Melun, France).
- Puppies were weighed on 0d and 2d. Mortality was registered from 0 to 21d.
- Multivariable statistical analysis (LMER proc; R software) was used to examine the impact of age, breed size, birth weight and sex of the puppy on rectal temperature. Linear regression models evaluated effect of rectal temperature on growth 0-2d. Impact of rectal temperature on puppies' survival was tested with logistic regression models.

Birth weight classification (g)				
Breed size	Q1	Q2	Q3	Q4
Small	< 208	208 – 215	216 – 234	> 234
Medium	< 210	210 – 250	251 – 280	> 280
Large	< 284	284 - 365	366 - 420	> 420

Table 1. Birth weight classification in quartiles depending on breed size.

Variation of body temperature

A total of 347 included puppies belonged to 17 different breeds: 40.6% (141/347) from small, 20.7% (72/347) from medium, 38.6% (134/347) from large breeds.
No influence of sex, but an effect of age, breed size and birth weight on rectal temperature was evidenced.

- Rectal temperature significantly increased from birth until 21d ($p<0.001$; table 2).

Age (days)	0	1	2	7	14	21
Mean rectal temperature (°C)	35.6	36.4	36.3	36.9	37.2	37.2
SD	2.1	1.1	1.3	1.1	0.6	0.5

Table 2. Evolution of the body temperature during the neonatal period in puppies (n=347).

- Rectal temperature was higher at 1d and 2d in large than small breeds ($p<0.001$; fig.2).

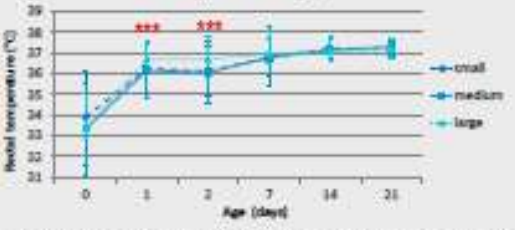

Fig.2. Mean rectal temperature (°C) in puppies from different group of breed size (n=347; p<0.001).

- Low-birth-weight puppies (Q1) had a significantly lower rectal temperature than those from other quartiles at 1d and 2d ($p<0.001$; fig. 3).

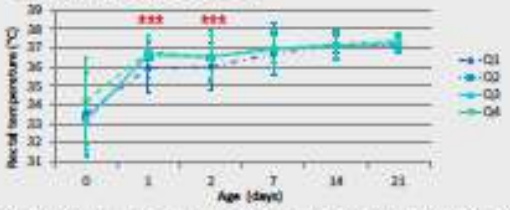

Fig.3. Mean rectal temperature (°C) in puppies with different birth weight. Birth weight is expressed in quartiles (from the lightest puppies in Q1 to the heaviest in Q4; n=347; p<0.001).

Fig.1. Schedule of the rectal temperature measurement performed in our study on 347 puppies during the neonatal period.

Relationship between temperature and growth

Growth 0-2d was not associated with rectal temperature at 0d (r=0.1; p=0.08), but with that at 1d and 2d (r=0.24; r=0.31, respectively, $p<0.001$; fig. 4).

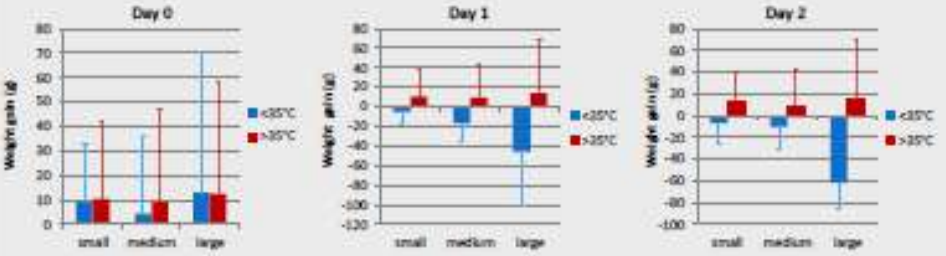

Fig.4. Mean weight gain (±SD) in puppies with hypothermia (rectal temperature below 35 °C) and normal body temperature (above 35 °C) at 0d, 1d or 2d in small, medium and large breed puppies (n=347).

Relationship between temperature and mortality

Sixty five puppies died within three weeks of age (18.7%). Rectal temperature at 1d, 2d and 7d was found associated with risk of neonatal mortality ($p<0.05$ for all models; fig. 5, 6).

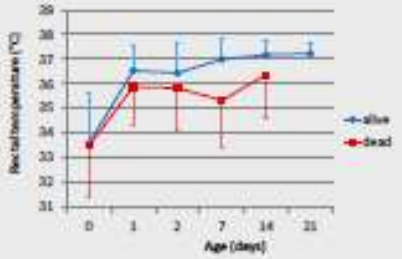

Fig.5. Rectal temperature profiles in puppies dying before 21d after birth and puppies alive at 21 days after birth (n=347).

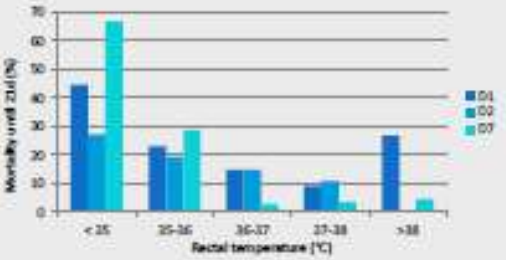

Fig.6. Proportion of puppies dying before 21d of age depending on body temperature at 1,d 2d or 7d of life (1d n=65; 2d n=24; 3d n=295).

DISCUSSION & CONCLUSIONS

- This study evidences the variability of rectal temperature in puppies depending on their age, breed size and body weight, but not their sex.
- It demonstrates that early measurement of temperature allows to identify puppies at higher risk of mortality and of weight loss.
- All those factors are related to energy intake through colostrum, which all together reinforces the importance of adequate nursing at the early stage of life.

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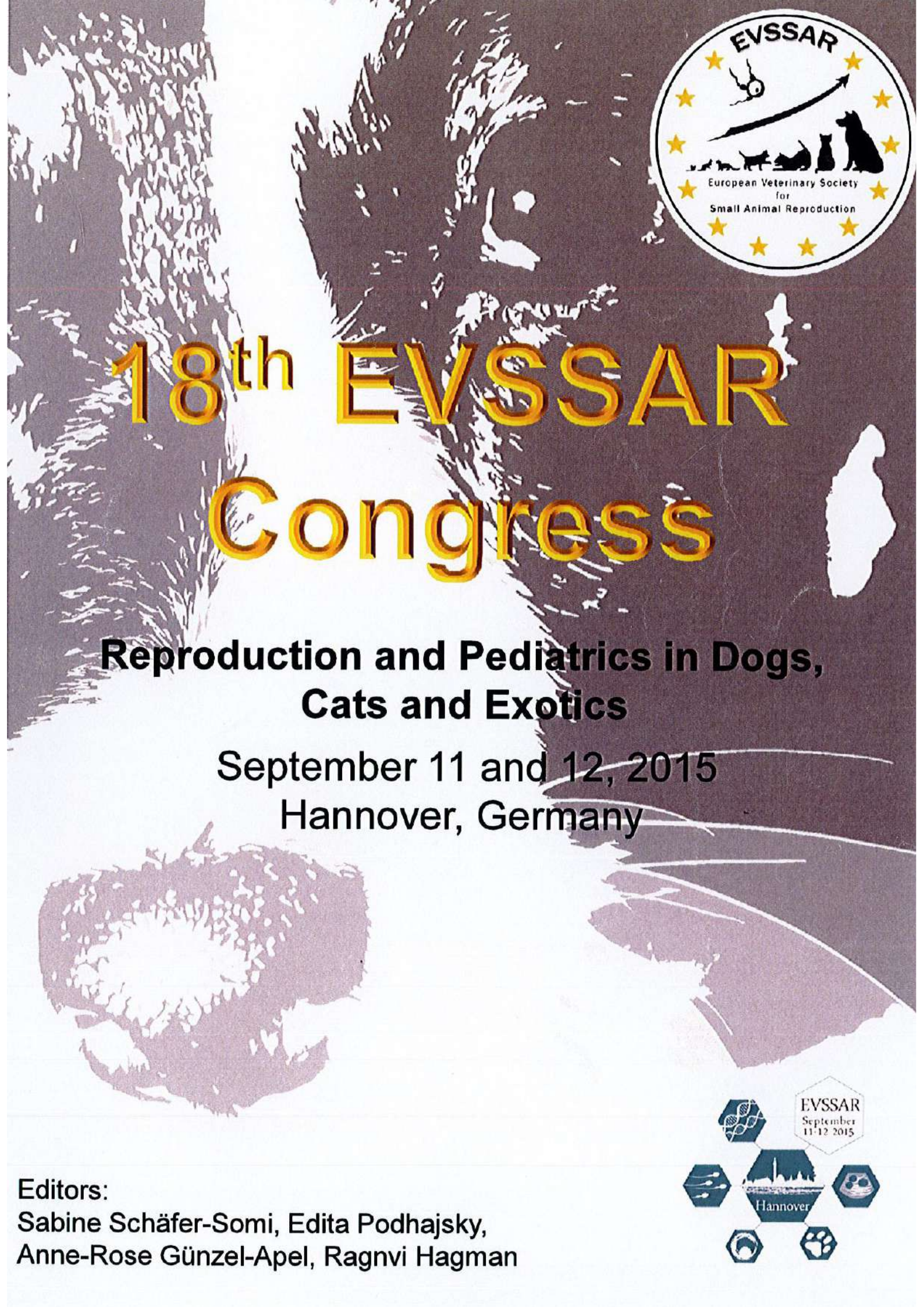
Introduction and aims. Neonatal mortality (i.e. death during the first three weeks of life) is of high prevalence in puppies, accounting for 75-90% of all pre-weaning deaths [1,2], with majority of newborns dying during the first week. Hypothermia is described as one of the major causes of neonatal mortality, making temperature measurement a fundamental element of puppies' health evaluation. The aims of this study were i) to identify factors of variation of body temperature in puppies and ii) to evaluate the association between body temperature and puppies' health (growth and neonatal survival).

Materials and methods. All puppies included to the study (n=437) were identified at birth. Their birth weight was categorized into 4 quartiles (Q1: the lightest; Q4: the heaviest). Depending on the expected adult weight, puppies were classified into small (body weight <10kg), medium (10-25kg) or large breeds (>25kg). Puppies were kept with their mothers, under an infra-red lamp and on a heated ground (28-30°C). Rectal temperature (RT) was measured within the first 8 hours after birth (0d), at 1d, 2d, 7d, 14d and 21d on each puppy by a digital thermometer (Torm 10S; Cooper, Melun, France – accuracy: 0.1°C between 35.5 and 42°C, and 0.2°C out this range). Puppies were weighed on 0d and 2d. Mortality was registered from 0 to 21d. Multivariable statistical analysis (LMER proc; R software) was used to examine the impact of age, breed size, birth weight and sex of the puppy on RT. Linear regression models evaluated effect of RT on growth 0-2d. Impact of RT on puppies' survival was tested with logistic regression models. Data are presented as mean ± SD.

Results. A total of 437 included puppies belonged to 17 different breeds (40.3% from small, 20.6% from medium, 39.1% from large breeds). No influence of sex, but an effect of age, breed size and birth weight on RT was evidenced ($p<0.001$ for all factors). RT significantly increased from birth until 21d ($p<0.001$): 33.6±2.1°C 0d, 36.4±1.1°C 1d, 36.3±1.3°C 2d, 36.9±1.1°C 7d, 37.2±0.6°C 14d, 37.2±0.5°C 21d. RT was higher at 1d and 2d in large than small breeds: at 1d, 36.2±1.2°C vs 36.7±0.9°C, respectively. Low-birth-weight puppies (Q1) had a significantly lower RT than those from other quartiles at 1d and 2d: at 1d, 35.9±1.3°C in Q1 vs 36.8±0.9°C in Q4. Growth 0-2d was not associated with RT at 0d ($r=0.1$; $p=0.08$), but with that at 1d and 2d ($r=0.24$; $r=0.31$, respectively, $p<0.001$). When RT was below 33°C at 1d, growth 0-2d was -21.1±25g vs 3.7±24.5g for puppies with higher RT. Sixty four puppies died within three weeks of age (14.6%). RT at 1d, 2d and 7d was found associated with risk of neonatal mortality ($p<0.05$ for all models). At 1d, mortality rate was 48% for puppies with RT lower than 35°C, 21% for RT 35-36°C, 16% for RT 36- 37°C and 10% for RT 37-38°C.

Conclusions. This study evidences the variability of rectal temperature in puppies. It demonstrates that early measurement of temperature allows to identify puppies at higher risk of mortality and of lower growth. All those factors are related to energy intake through colostrum, reinforces the importance of adequate nursing at the early stage of life.

References. (1) Indrebø et al., Acta Vet Scand. 2007;49:S2. (2) Gill. PhD thesis. Sydney University 2001.



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