

# Using a heating mat for newborn piglets increases the rectal temperature

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### Abstract

136 newborn piglets from seven litters were included in a study where rectal temperature in the first two hours after birth was recorded.

The study comprised three groups:

- 1) Piglets were placed on slatted floor (cast iron) for one hour (control).
- 2) Piglets were placed 15 minutes on a heating mat and 45 minutes on slatted floor.
- 3) Piglets were placed 60 minutes on a heating mat.

All piglets were placed by the sow's udder one hour after birth and were monitored for another hour.

All piglets in the study had a rectal temperature of 39.2-39.4 °C at birth. As expected, the rectal temperature dropped drastically within the first 30 minutes after birth regardless of which group the piglets were assigned to. The piglets that remained on the slatted floor with no additional heat source (control) experienced an average drop of 4.6 °C vs averagely 3.2-3.6 °C for the piglets given additional heat.

Data revealed no changes within the groups in rectal temperatures in the period 30-60 minutes after birth. In all groups, the piglets' rectal temperature increased after 60 minutes when they were placed by the sow/udder and continued to increase throughout the entire period.

Roughly half of the piglets in the control group had – at some point – a rectal temperature below 36 °C, and after two hours, 14 % of the piglets still had a temperature below 36 °C. And these piglets have a lower survival rate the first seven days of life.

The longer the piglets were placed on the heating mat, the higher their rectal temperature after 30 minutes. In addition, the percentage of piglets with a rectal temperature above 36 °C increased. Both increases were significant ( $p < 0.0001$ ).

The study was designed as a controlled setup where the piglets were unable to move around in the pen. It is recommended that newborn piglets be offered additional heat to reduce the impact of the natural drop in rectal temperature.

## Background

A large percentage of the piglets that die within the first few days of life are crushed, starved, or born weak [1]. At birth, piglets have the same body temperature as the sow during farrowing, around 39-39.5 °C, whereas the temperature in the farrowing facility is typically 20-22 °C.

Newborn piglets are covered in amniotic fluid and the relatively low room temperature combined with the evaporation of amniotic fluids leads to a 2-4 °C drop in body temperature within just a few minutes after birth [2].

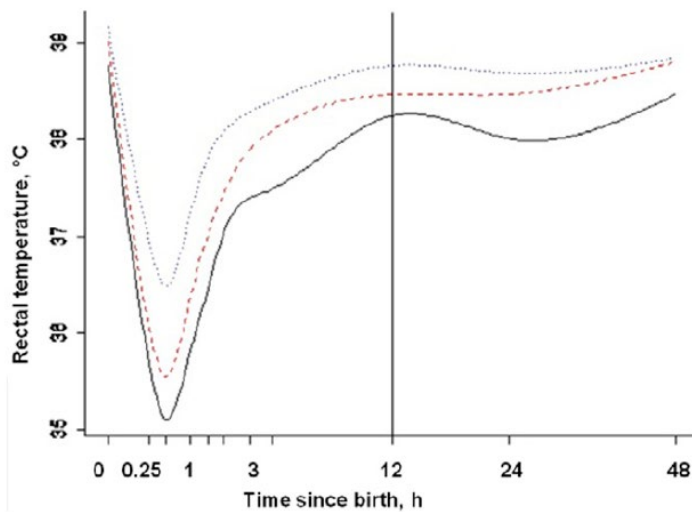
Newborn piglets need energy to raise their body temperature, but they are born with limited energy reserves in the form of glycogen in muscle and liver and with virtually non-existent fat reserves for heat production. The piglets use their energy reserves after birth on e.g., getting to the udder and producing - and maintaining – an optimum body temperature. It is therefore essential to prevent hypothermia of a newborn piglet as a very cold piglet is unable to utilise the energy in the milk or the energy reserves [3].

The thermoneutral zone is defined as the temperature interval in the environment where the piglet does not need to mobilise energy or require additional energy to maintain its body temperature. The lower critical temperature is defined as the point where the piglet needs to increase metabolism to maintain its body temperature.

A recent study investigated the thermoneutral zone of newborn piglets in respiration chambers from the piglets were nine minutes old and until three hours after birth. The study only comprised piglets with a birth weight above 1,100 g. This study found the lower critical temperature of the piglets to be 34 °C from birth and the subsequent three hours. From 45 minutes after birth and until 3 hours after birth, the thermoneutral zone was 38 °C. From 45 minutes after birth, a temperature of 40 °C constituted a risk of heat stress [4].

## Room temperature

Figure 1 illustrates the effect of a room temperature of 15, 20, and 25 °C, respectively, on piglets' rectal temperature. All piglets, regardless of birth weight, were included in the study. The results showed that a drop in rectal temperature of 3.7 °C the first 30 minutes in a room temperature of 15 and 20 °C vs 2.8 °C at a room temperature of 25 °C. Furthermore, piglets born in a room temperature of 15 °C needed more time to reach a rectal temperature of 37 °C compared with piglets born in a room temperature of 20 and 25 °C. The effect was enhanced, the lower the piglet weight, but data was not analysed in further detail. Data showed no differences in piglet survival under the different room temperatures [5].



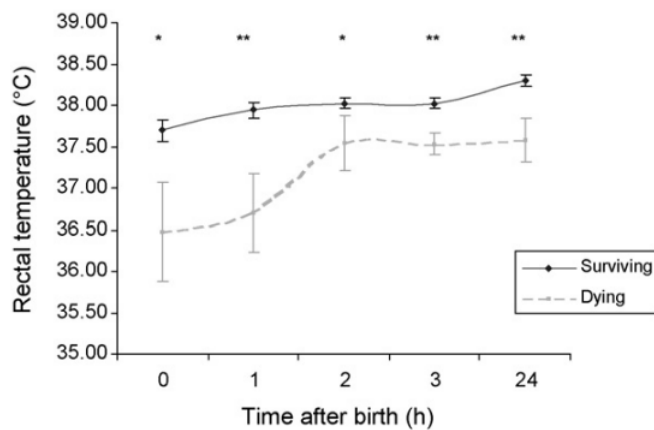
**Figure 1.** Effect of room temperatures of 15, 20 and 25 °C, respectively, on development in piglet rectal temperature the first 48 hrs after birth [5].

Line = room temperature of 15 °C. Red dotted line = 20 °C. Black dotted line = 25 °C

## Piglet survival

Pre-weaning survival rates are affected by piglets' rectal temperature as well as birth weight [6]. In a study including 135 newborn piglets, all piglets that survived the first 24 hours weighed averagely 1,485 g (+/-30.35 g), while the piglets that died had a lower weight (i.e., 1,176 g (+/-79.35 g)).

The piglets that survived had a higher rectal temperature both one hour after birth (37.9 °C) and 24 hours after birth (38.3 °C), compared with piglets that died (36.5 °C and 37.6 °C, respectively). Assuming that the temperature at birth was approx. 39 °C, the piglets that died before weaning experienced a 2.5 °C drop in temperature within the first hour after birth compared with a 1.1 °C drop for the piglets that survived.



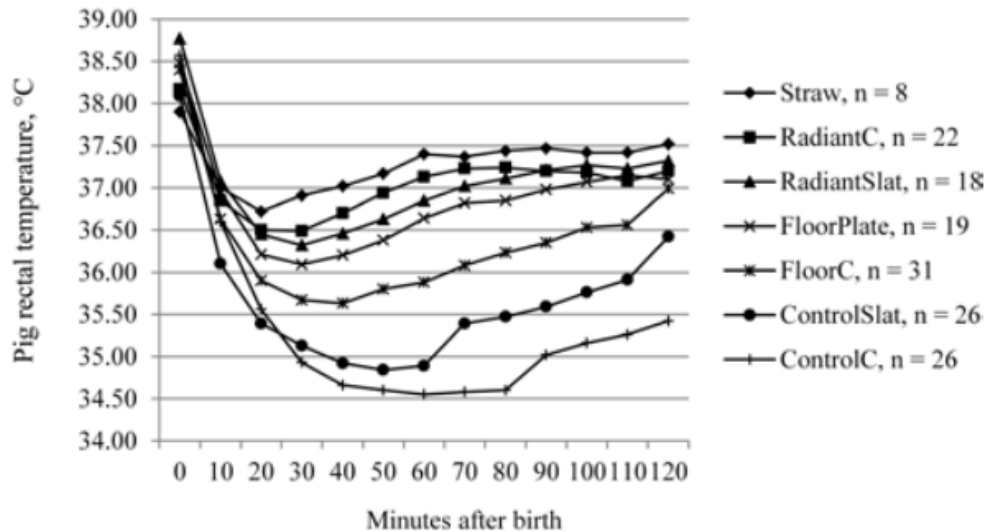
**Figure 2.** Correlation between the rectal temperature (°C) of new-born piglets the first 24 hrs after birth and pre-weaning survival [6].

0 = time of birth (temperature likely recorded shortly after birth as piglets are born with a rectal temperature close to the sow's temperature (figure 1)).

A Danish study found that piglets with a rectal temperature above 36 °C two hours after birth had a higher survival rate the first seven days of life compared with piglets with a rectal temperature lower than this. Average weight in this study was 1,296 g [7]. Similar results were found in another Danish study [8].

## Floor temperature

In one study, piglets weighing more than 700 g were housed individually in cages with different flooring and heat sources. The lowest rectal temperature of the piglet and the period within the first two hours after birth in which the temperature dropped below 35 °C were recorded. It showed that the lowest rectal temperature for piglets housed on concrete floor and with not additional heat (control), was 34 °C (a drop of roughly 5 °C), whereas the lowest rectal temperature of the piglets given 20 cm straw, a heat panel 90 cm above the floor or a heat plate, dropped roughly 3 °C. The piglets in the trial groups also experienced the shortest period with a rectal temperature below 35 °C compared with piglets in the control group [9].



**Figure 3.** Correlation between different flooring and heat sources\*, piglet rectal temperature and minutes after birth [12].  
 \*Straw=20 cm straw; RadiantC=heat panel 90 cm above solid floor; RadiantSlat=heat panel 90 cm above metal slatted floor; FloorPlate=heat plate; FloorC=floor heat; ControlSlat=no heating of slatted floor; ControlC=no heating of solid floor. [9].

The above literature review indicates that piglets that experience 1-2 °C drop in rectal temperature immediately after birth have a higher survival rate compared with piglets that experience a drop of 3-4 °C or more.

The aim of this study was therefore to investigate the effect on rectal temperature two hours after birth in new-born piglets placed on a heating mat for 15 or 60 minutes compared with piglets placed on un-heated metal slatted floor for 60 minutes.

## Materials and methods

The study was made on a farm with loose housing of farrowing sows where sows were crated in the period around farrowing. Farrowing pens were designed with 25% solid floor and 75% slatted floor (cast iron).

To verify that the room temperature was 20-22 °C during the study, minimum/maximum thermometers were installed approx. 40 cm above the slatted floor and over the heating mats.

The study comprised three groups:

Piglets placed on slatted floor, no heating mat, for 60 minutes (control)

Piglets placed on heating mat for 15 minutes followed by 45 minutes on slatted floor

Piglets placed on heating mat for 60 minutes.

In the first 60 minutes of the study, piglets were housed in separate cages (figure 4) according to group. At birth (within the first 10-15 seconds), each piglet was marked (figure 5) and weighed (figure 6) and its rectal temperature was measured with a

digital thermometer (figure 7). Rectal temperature was also measured 15, 30, 45, 60, 90 and 120 minutes after birth.

Each piglet was monitored for two hours after birth. After one hour, the piglets were placed by the sow's udder. When the rectal temperature was measured 90 and 120 minutes after birth, piglets were returned to the same area of the pen as before their temperature was measured (by the sow, in the creep, in the pen) and the location was recorded.

To ensure that the sow started milk letdown when farrowing began, piglets from other litters were placed by the udder. These piglets were not included in the study and were removed when the sow's own piglets were returned to the udder.

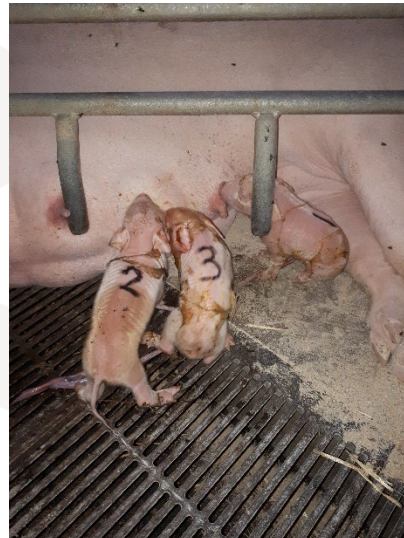
When approx. 10 piglets were placed by the udder, the three piglets older than two hours (no longer in the study) were moved to another sow to ensure that all piglets had good access to the udder.

All recordings were made by staff from SEGES Innovation.

Before recordings started, the efficiency of the heating mats was verified with a thermal image FLUKE IR camera TI32. Images of the surface of the heating mats were produced 15-20 minutes after the mats were turned on.



**Figure 4.** New-born piglet placed in cage on heating mat



**Figure 5.** Consecutive numbering was used to assign piglets to one of the three groups.



**Figure 6.** New-born piglet is being weighed.



**Figure 7.** Rectal temperature is measured on a piglet.

## Statistical analyses and hypothesis

Rectal temperature above or below 36 °C 30 minutes after birth constituted the primary parameter and was subject to analysis in a generalized linear model. Piglet birth weight and time from farrowing began constituted explanatory variables, group constituted systematic variable and sow was the random variable.

Hypothesis: Piglets that are placed on a heating mat immediately after birth experience a positive effect on the drop in rectal temperature, so that 30% fewer piglets have a temperature below 36 °C 30 minutes after birth compared with piglets that are not placed on a heating mat after birth.

## Results

The study comprised seven litters with a litter size of 16-23 liveborn piglets (average 19.4 piglets/litter). Farrowing duration averaged 5.1 hours (2.8-8 hours). Table 1 shows the average birth weight and rectal temperature of the piglets (mean and standard deviation).

Recordings showed a temperature of 22.3-26,8 °C 40 cm above the floor and of 24.4-25.8 °C above the heating mats. Surface temperature on the heating mats during the study was roughly 45 °C (mean).

**Table 1.** Number, birth weight and rectal temperature on piglets (raw data). Mean and standard deviation in parentheses.

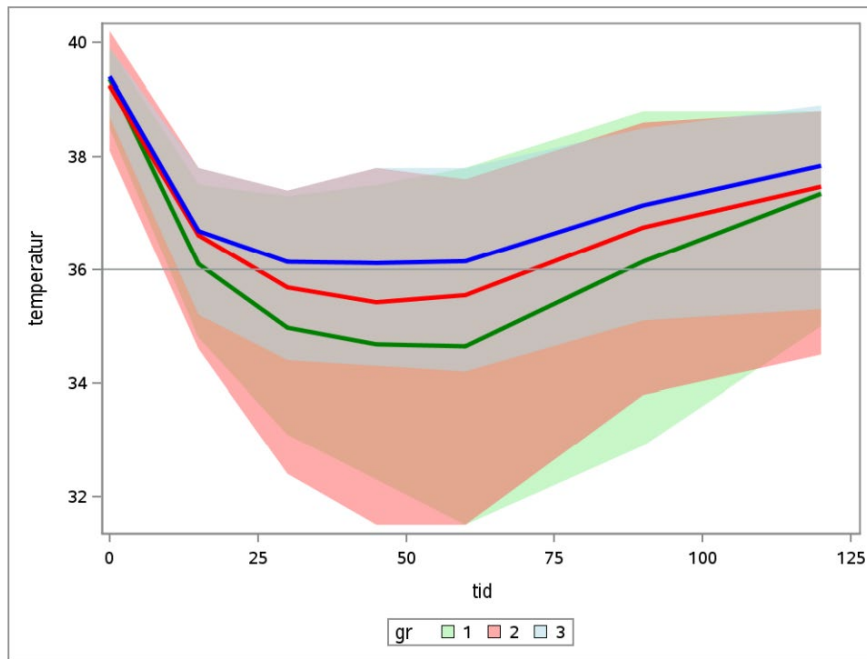
	On slatted floor (Control)	15 min on heating mat (Group 2)	60 min on heating mat (Group 3)
Number of piglets included	45	47	44
Average birth weight, kg	1.37 (0.30)	1.32 (0.31)	1.27 (0.28)
Average rectal temperature at birth, °C	39.4 (0.4)	39.2 (0.6)	39.4 (0.4)
Average rectal temperature after 30 minutes, °C	35.0 (1.4)	35.7 (1.4)	36.1 (1.0)
Average drop in temperature from birth until 30 minutes, °C	4.6 (2.2)	3.6 (2.2)	3.2 (2.1)
Average rectal temperature after 120 minutes, °C	37.2 (3.4)	37.5 (3.3)	37.9 (3.4)
% recordings with rectal temperature below 38 °C within the first 2 hrs after birth, %	76 (0-100)	74 (29-100)	74 (43-86)
% recordings with rectal temperature below 36 °C within the first 2 hrs after birth, %	51 (0-86)	31 (0-86)	29 (0-85)
% recordings with rectal temperature below 34 °C within the first 2 hrs after birth, %	16 (0-71)	8 (0-71)	9 (0-57)
% recordings with rectal temperature above 36 °C after 2 hrs, %	86 (58-96)	94 (76-99)	97 (85-100)

The development in piglets' rectal temperature from birth and the following two hours is shown in table 1 and in figure 8. Data shows a correlation between the duration of the piglets' stay on the heating mat and the drop in rectal temperature and to the rectal temperature measured two hours after birth.

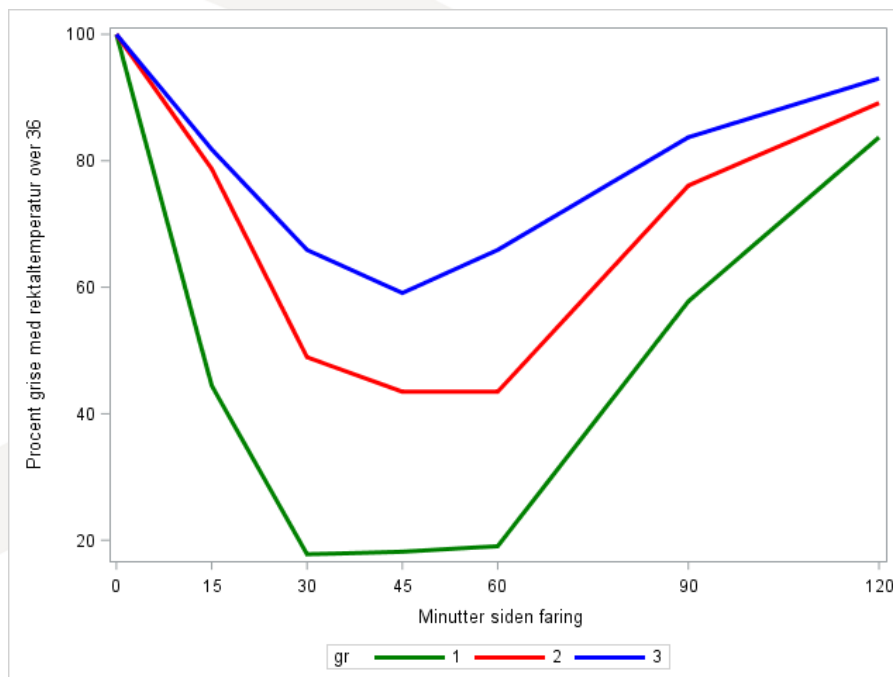
Regardless of group, the rectal temperature dropped drastically the first 30 minutes after birth as expected. The piglets that were not given additional heat (control) experienced an average drop of 4.6 °C vs an average drop of 3.2-3.6 °C for the piglets offered additional heat. Analysis of data within group revealed no changes in rectal temperature in the period from 30-60 minutes. All piglets experienced an increase in rectal temperature 60 minutes after birth when they were placed by the sow/udder, and this increase continued throughout the study.

As shown in table 1 and in figure 9, approx. 50% of the piglets in the control group had at some point a rectal temperature below 36 °C, and two hours after birth, 14% still had a temperature below 36 °C. A previous study demonstrated that piglets with a rectal temperature above 36 °C 2 hours after birth had a far greater chance of surviving the first seven days of life compared with piglets with a lower temperature [7].





**Figure 8.** Correlation between minutes after birth (time), group and rectal temperature (line). Confidence interval 5/95% (area). Control=green, 15 minutes on heating mat=red and 60 minutes on heating mat=blue. Horizontal grey line = average temperature



**Figure 9.** Percentage piglets with a rectal temperature above 36 °C the first 2 hrs after birth. Control=green, 15 minutes on heating mat=red and 60 minutes on heating mat=blue

As shown in table 2, estimates of piglets' rectal temperature after 30 minutes increased the longer they stayed on the heating mat. In addition, the percentage of piglets with a rectal temperature above 36 °C increased. Both increases were significant ( $p < 0.0001$ ).

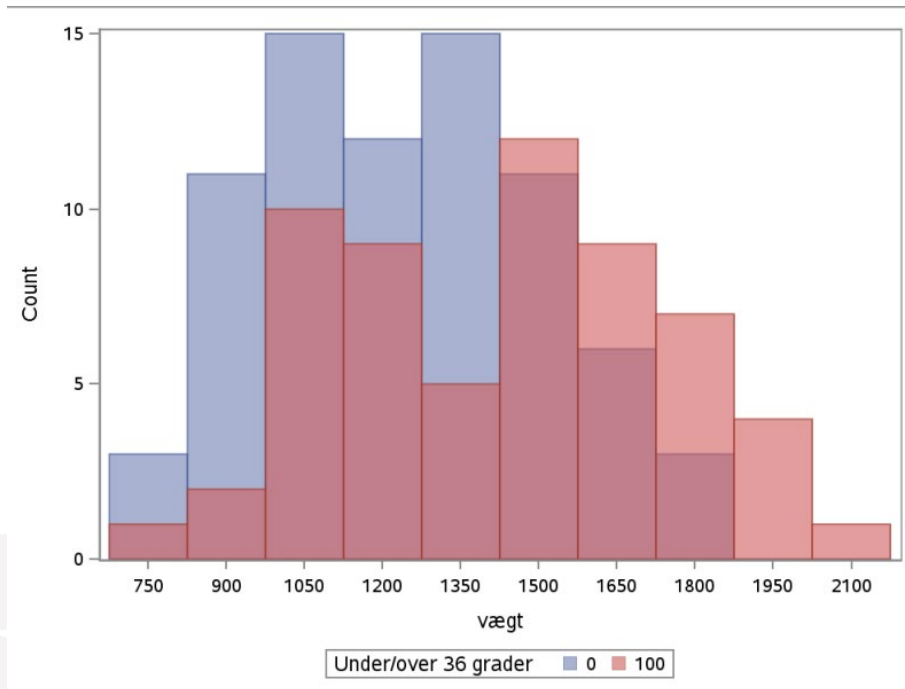
**Table 2.** Estimates of piglets' rectal temperature 30 minutes after farrowing.

	On slatted floor (Control)	15 min on heating mat (Group 2)	60 min on heating mat (Group 3)	P-value
Rectal temperature, °C	34.8	35.7	36.3	<0.0001
Piglets with a rectal temperature above 36 °C, %	5	41	78	<0.0001

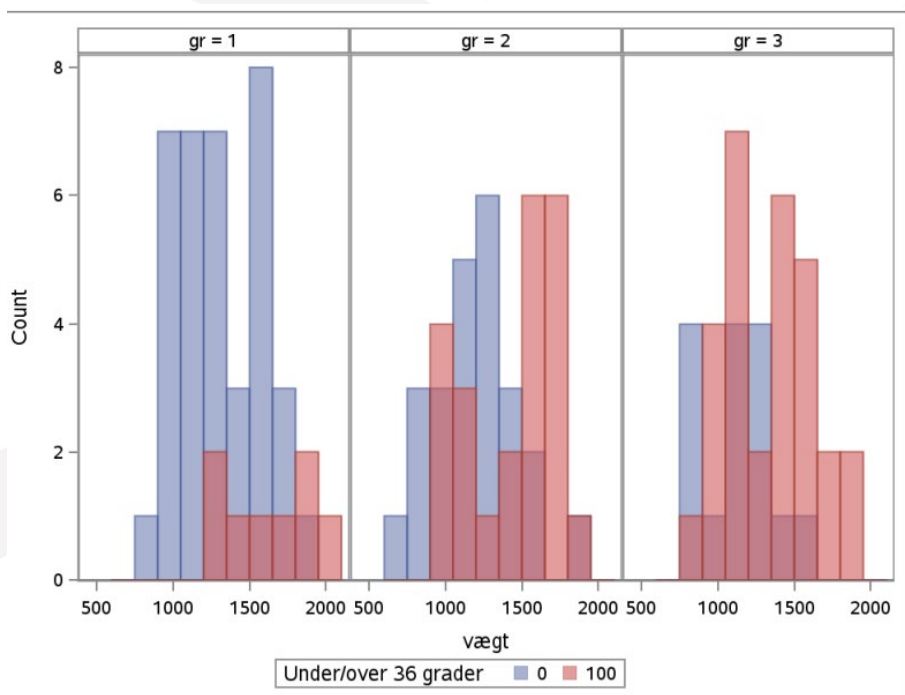
When piglets are placed on a heating mat immediately after birth, a loss in body temperature was expected. After 30 minutes, 30% fewer piglets have a temperature below 36 °C compared with piglets that are not placed on a heating mat after birth. As shown in table 2, 5% of the piglets in the control group had a rectal temperature above 36 °C after 30 minutes vs 41% and 78% of the piglets in groups 2 and 3, respectively. This confirms the hypothesis as the difference between the control group and both trial groups exceeded 30%.

Regardless of group and birth order, all piglets had an average rectal temperature at birth of 39 °C; in fact, piglets born as number 11 and onwards were born with an average temperature of 39.5 °C. Birth order also influenced rectal temperature after 30 minutes: piglets born as number 11 experienced a drop in rectal temperature of 0.6 °C compared with the first ten piglets. Birth weight was unaffected by birth order, ie. there are no indications that the drop in rectal temperature 30 minutes after birth between the first ten piglets and the following piglets was attributed to birth weight.

However, piglets' birth weight did affect rectal temperature after 30 minutes. As shown in figure 10, there was a majority of small piglets with a rectal temperature below 36 °C. Figure 11 illustrates the correlation between birth weight and rectal temperature according to group. Not surprisingly, the percentage of piglets below 36 °C increases; in particular in the control group and the group where piglets stayed 15 minutes on a heating mat.



**Figure 10.** Number of piglets after 30 min with a rectal temperature below (blue) and above (red) 36 °C shown according to birth weight. A darker red = overlap between red and blue.



**Figure 11.** Percentage piglets with a rectal temperature below (blue) and above (red) 36 °C according to birth weight and group. Rectal temperature measured 30 min after birth. A darker red = overlap between red and blue.

## Conclusion

All piglets in this study were born with a rectal temperature of 39.2-39.4 °C. Regardless of the group they were assigned to, data revealed an expected drastic drop in rectal temperature the first 30 minutes after birth. Piglets that were not



offered additional heat (control) experienced an average drop of 4.6 °C vs 3.2-3.6 °C for the piglets that were placed on a heating mat.

Analyses of data within group showed no changes in rectal temperature from 30 to 60 minutes after birth. All piglets experienced an increase in rectal temperature after 60 minutes when they were placed by the sow/udder, and this increase continued throughout the study.

Approximately 50% of the control piglets had at some point a rectal temperature below 36 °C, and after two hours 14% still had a temperature below 36 °C. These piglets have a lower survival rate the first seven days of life.

The longer the piglets stayed on the heating mat, the higher their rectal temperature after 30 minutes. Furthermore, the percentage of piglets with a rectal temperature above 36 °C increased. Both increases were significant ( $p < 0.0001$ ).

The hypothesis was that if piglets are placed on a heating mat immediately after birth, a positive effect is expected on the loss in body temperature, so that after 30 minutes, 30% fewer piglets have a temperature below 36 °C compared with piglets that are not placed on a heating mat after birth. This was confirmed as 5% of the piglets in the control group had a rectal temperature above 36 °C after 30 minutes vs 41% and 78% of the piglets in groups 2 and 3, respectively.

All piglets, regardless of group and birth order, had an average rectal temperature of 39 °C at birth; in fact, piglets born as number 11 or later had an average temperature of 39.5 °C. In addition, data showed an average difference of 0.6 °C in rectal temperature after 30 minutes between piglets born as number 1-10 and piglets born later. This could not be attributed to a difference in birth weight or to birth intervals (0-5 minutes, 5-15 minutes, or more than 15 minutes) between the piglets.

However, piglets' birth weight did affect rectal temperature after 30 minutes when data showed an majority of small piglets (below 1,050 g) with a rectal temperature below 36 °C.

It is recommended to offer new-born piglets additional heat to minimise the impact of the natural drop in temperature. This will, in particular, benefit the smallest piglets and the piglets born as number 11 and later.

## Acknowledgements

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