Piglet vitality: determinants and consequences for survival

Sandra Edwards & Emma Baxter

Do piglets in loose farrowing systems require different characteristics?

- Aids to survival are not as readily available:
  - Targeted heat
  - Protection from crushing
  - Human intervention

- Causes of death are different

Causes of mortality

- Stillbirth
- Crushing Low viability
- Starved
- Congenital Savaging
- Other

BUT BEWARE: Misdiagnosis is common

42% incorrectly attributed to stillbirths (Edwards et al. 1994)
32% incorrectly attributed to crushing (Vaillicourt et al. 1990)

How do we make neonates more viable?

- What characteristics do viable and non-viable piglets have?
- Generalised Linear Mixed Models
  - Allowing a binomial structure (piglet either dead (1) or alive (0))
  - Sow random factor
  - Adjusted for litter and sex effects

- **Stillborn** mortality vs. Surviving piglets
- **Live-born** mortality vs. Surviving piglets
What are the most important prenatal survival indicators?

- **Birth weight (BW)**
  Stillborn piglets were lighter (~200g lighter). Known indicator.

- **Ponderal index (PI) - birth weight/crown-rump**
  In human literature considered a better predictor of morbidity and mortality than birth weight (Fay et al., 1991). Measure of soft tissue growth

- **Body Mass Index (BMI) - birth weight/crown-rump**
  A measure of fat covering

Stillborn piglets were disproportionately long and thin (low PI and BMI) – can be a sign of intra-uterine growth retardation (IUGR)

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Stillborn piglets were disproportionately long and thin (low PI and BMI) – can be a sign of intra-uterine growth retardation (IUGR).

Stillborn piglets experienced low placental efficiency → could lead to IUGR.

Stillborn piglets were born later in the birth order.

Why do piglets die?

Adapted from P R English.
Results – Piglet factors
(Baxter et al.)

Survives

Physiology
Higher Birth Weight (1520g)

Vs.

Dies pre-weaning

Physiology
Lower Birth Weight (1289g)

Risk of live-born mortality of piglets associated with birth weight

Logistic mixed model

(Poehe & Kalm 2000)

Piglet birthweight

• Increased risk of mortality with increased within litter birth weight variation (Poehe & Kalm 2000)

THE IMPORTANCE OF PIGLET BIRTHWEIGHT
**Results – Piglet factors**

*Survives* vs. *Dies pre-weaning*

**Physiology**
- Higher Birth Weight (1520g)
- Higher Birth Temp (37.74°C)
- Higher 2h Temp (38.00°C)
- Higher 24h Temp (38.55°C)

**Physiology**
- Lower Birth Weight (1289g)
- Lower Birth Temp (37.13 ºC)
- Lower 2h Temp (37.57 ºC)
- Lower 24h Temp (37.56 ºC)

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**Vitality determinants**

- **Blood lactate at birth** (indicative of hypoxia)
  - Positively correlated with cumulative farrowing duration (***)
  - Positively correlated with blood glucose (***)
  - Negatively correlated with Birth rectal temperature (*)

*(Adeleye 2012)*

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**Thermoregulation**

Newborn = 0

- +1 minute
- +30 minutes
- +45 minutes

At risk – no suckling

Suckling improves thermoregulation
### Results – Piglet factors

(Baxter et al.)

#### Physiology
- **Survives**
  - Higher Birth Weight (1520g)
  - Higher 24h Weight (1628g)
  - Higher Birth Temp (37.74°C)
  - Higher 2h Temp (38.00°C)
  - Higher 24h Temp (38.56°C)

- **Dies pre-weaning**
  - Lower Birth Weight (1289g)
  - Lower 24h Weight (1326g)
  - Lower Birth Temp (37.13°C)
  - Lower 2h Temp (37.57°C)
  - Lower 24h Temp (37.56°C)

#### Behaviour
- **Survives**
  - Quicker to udder (17mins)
  - Quicker to teat (24mins)
  - Quicker to suckle (33mins)

- **Dies pre-weaning**
  - Slower to udder (25mins)
  - Slower to teat (38mins)
  - Slower to suckle (51mins)

#### Vigour
- **Survives**
  - Higher vitality score (2.28)
  - Higher rooting response (1.42m)

- **Dies pre-weaning**
  - Lower vitality score (1.77)
  - Lower rooting response (0.47m)

### Viability Scoring

(Okere et al., 1997)

<table>
<thead>
<tr>
<th>Score</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td>absent</td>
<td>&lt;120/m</td>
<td>&gt;120/m</td>
</tr>
<tr>
<td>Respiration onset</td>
<td>absent</td>
<td>&gt;15s</td>
<td>&lt;15s</td>
</tr>
<tr>
<td>Muscle tone</td>
<td>flaccid</td>
<td>poor</td>
<td>good</td>
</tr>
<tr>
<td>Colour</td>
<td>pale</td>
<td>cyanotic</td>
<td>pink</td>
</tr>
<tr>
<td>Standing attempt</td>
<td>&gt;5m</td>
<td>1-5m</td>
<td>&lt;5m</td>
</tr>
</tbody>
</table>

### Asphyxia and Mortality

(Herpin et al., 1996)

<table>
<thead>
<tr>
<th>% high viability score</th>
<th>Time to udder (m)</th>
<th>% mortality to 10d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphyxiated</td>
<td>36</td>
<td>63</td>
</tr>
<tr>
<td>Control</td>
<td>79</td>
<td>32</td>
</tr>
</tbody>
</table>

P<0.05 P=0.06
Vitality Score (in first 15 secs pp)

0- Stillborn or resuscitated
1- Remains in the same position after expulsion, does not move, breathes or attempts to breathe
2- Moves onto sternum and can move its head, but the rest of the body does not move
3- Moves a lot and attempts to stand

(Sacy & Le Treut, 2011; modified from Baxter et al., 2008)

Piglet rooting test shows “vitality”

Difference is not explained just by birthweight

(Baxter et al., 2006)

Do we need different piglets for different farrowing systems?

Probably not

- EU Welfare Quality Project

Determinants of survival not significantly different
  - Outdoor v indoor pen (Baxter et al., 2011)
  - Indoor pen v crate (Pedersen et al., 2011)

How can we improve viability?

- Genetic approaches
  - selection for survival, weight, vitality

- Nutritional approaches
  - improving birthweight, vitality

- Management approaches
  - reducing hypoxia, hypothermia
Genetic Improvement of Viability

- Large genetic study – “GENOMUM”
  - unique (<22k records) cross-over selection experiment for piglet survival (High vs. Average) on a Scottish outdoor unit

Direct heritabilities and correlations of survival traits and individual birth weight

<table>
<thead>
<tr>
<th>Trait</th>
<th>(SVB)</th>
<th>(SVNP)</th>
<th>(IBW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival at birth (SVB)</td>
<td>0.21</td>
<td>0.08</td>
<td>0.17</td>
</tr>
<tr>
<td>(0.14 to 0.28)</td>
<td>(-0.18 to 0.35)</td>
<td>(0.02 to 0.32)</td>
<td></td>
</tr>
<tr>
<td>Survival during the nursing period (SVNP)</td>
<td>0.24</td>
<td>0.16</td>
<td></td>
</tr>
<tr>
<td>(0.14 to 0.35)</td>
<td>(0.01 to 0.31)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Birth weight (IBW)</td>
<td>0.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.31 to 0.45)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No indication of G x E interaction

(Roche et al., 2008)

Selection experiment for direct and maternal genetic effects of liveborn piglet survival

Selection: 1st Generation

Direct genetic effect

Maternal genetic effect

Selection: 2nd Generation

Genetic Improvement of Viability

- Large genetic study – “GENOMUM”
  - unique (<22k records) cross-over selection experiment for piglet survival (High vs. Average) on a Scottish outdoor unit
  - results indicate that genetic selection could be an effective route to improving piglet survival in outdoor conditions
  - possibly also other non-crate farrowing systems

- genetic improvement in survival: 3% better in HS lines (over 2 generations)
**Genetic effects on vitality**

(Baxter et al., 2007)

**Nutrition to improve oocyte quality**

Diets with fermentable substrates fed through lactation & pre-service (157 litters)

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Dextrose + Lactose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litter size</td>
<td>14.09</td>
<td>14.40 ns</td>
</tr>
<tr>
<td>Birthweight (g)</td>
<td>1.46</td>
<td>1.55 P=0.05</td>
</tr>
<tr>
<td>Cv birthweight (%)</td>
<td>23.7</td>
<td>20.5 P=0.04</td>
</tr>
<tr>
<td>Total mortality (%)</td>
<td>20.4</td>
<td>17.2 P=0.09</td>
</tr>
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(van den Brand et al., 2009)

**Nutrition to improve placental quality (1)**

†25g L-arginine/d (Hazeleger et al, 2007)

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>+Arginine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embryo survival (%)†</td>
<td>68%</td>
<td>77%</td>
</tr>
<tr>
<td>Placenta vascularisation score†</td>
<td>2.6</td>
<td>2.9</td>
</tr>
<tr>
<td>Birth weight (kg)‡</td>
<td>1.36</td>
<td>1.41</td>
</tr>
</tbody>
</table>

**Nutrition to improve placental quality (2)**

**Pigs less than 800 g**

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>L-carnitine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number nonviable/litter</td>
<td>P &lt; .03</td>
<td></td>
</tr>
<tr>
<td>Trial 1</td>
<td>0.75</td>
<td>1.0</td>
</tr>
<tr>
<td>Trial 2</td>
<td>0.5</td>
<td>0.75</td>
</tr>
<tr>
<td>Trial 3</td>
<td>0.25</td>
<td>0.5</td>
</tr>
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Eder et al., 2001 & 2002
Nutrition to improve neonatal vitality

100 sows per treatment
Trial diets with DHA supplement fed from after breeding until weaning

% mortality of piglets

P<0.05

Piglet birthweight:
Vegetable oil (control) = 1.54 kg
Salmon oil (16.5g/kg) = 1.47 kg

(Rooke et al. 2001)

Piglet Brain DHA and Brain Weight with increasing Maternal Fish Oil Intake

5 g/kg equivalent to ~ 3 g 20:5 n-3 + 22:6 n-3 / day
0.3% Digestible Energy

(Rooke et al 2001)

Improved piglet vitality by maternal n-3 fatty acids

<table>
<thead>
<tr>
<th>Diet</th>
<th>Basal</th>
<th>Tuna –1</th>
<th>Tuna-2</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to suckle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(min)</td>
<td>25</td>
<td>26</td>
<td>21</td>
<td>*</td>
</tr>
<tr>
<td>At 28 days of age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>8.2</td>
<td>8.7</td>
<td>8.9</td>
<td>*</td>
</tr>
<tr>
<td>Plasma IgG (mg/ml)</td>
<td>7.8</td>
<td>9.0</td>
<td>9.6</td>
<td>*</td>
</tr>
</tbody>
</table>

1- 17.5 g oil/kg day 63-91
2- 17.5 g oil/kg day 92-term

(Rooke et al 2001)

Conclusions and Implications

- **Stillborn mortality**
  - Regardless of environment, body conformation, placental efficiency and birth order are the most important prenatal survival indicators

- **Live-born mortality**
  - Regardless of environment, birth weight, thermoregulation, vitality and landmark behaviours are important postnatal survival indicators

- **Genetic selection** for all environments possible
  - selection for survival influenced thermoregulation

- **Nutritional and management** interventions are also possible