Relationship between birth order, birth weight, colostrum intake, acquisition of passive immunity and pre-weaning mortality of piglets

Jean Le Dividich1, Rui Charneca2 and Françoise Thomas1


Abstract

This study investigates the relation between birth order (BO), birth weight (BW0), colostrum intake (CI), level of passive immunity and pre-weaning mortality of piglets. The animals used were 551 cross-bred piglets [Piétrain × (Large-White × Landrace)] born from 40 sows. Colostrum immunoglobulins G (IgG) determinations were made from 17 sows. Colostrum samples were obtained at birth of the first piglet then at 3, 6, 12, 24, and 36 h later, and on the first-two and the last-two piglets born. Serum IgG determinations from 68 piglets were made at 2d of age and at weaning. Individual CI was estimated from body weight gain. Relative birth order (RBO) and BW0 within-litter were weakly \( R^2 = 0.05 \) but positively correlated \( (p<0.01) \). Colostrum intake of piglets was independent from RBO \( (p>0.10) \) but increased by 26 ± 1.6 g per 100 g increase in BW0 \( (p<0.001) \). Serum IgG concentrations of the last two born piglets were 29.5% lower \( (p<0.05) \) at the first two born at 2 d of age, and 25% \( (p<0.05) \) at weaning. They were also lower at weaning than at 2 d of age \( (p<0.001) \). Serum IgG concentrations of piglets at weaning and at 2 d of age were positively correlated \( (R^2 = 0.50, p<0.001) \). Within-litter, CI explained 11% \( (p<0.01) \) of the variation observed in piglets’ IgG at 2d of age. Mortality of piglets was irrespective of RBO \( (p>0.10) \). It was concluded that despite last-born piglets obtained less passive immunity than first-born, they were not at higher risk of dying before weaning. Major causes of mortality were low birth weight and insufficient colostrum (energy) intake.

Additional keywords: neonatal pig; colostrum consumption; immunoglobulin G; survival

Abbreviations used: BA (born alive piglets); BO (birth order); BW0 (birth weight); CI (colostrum intake); CP (crude protein); DE (digestible energy); Ig (immunoglobulins); IgG (immunoglobulin G); LG (light weight piglets category); NM (normal weight piglets category); RBO (relative birth order); SP (sucking piglets); TB (total born piglets); tfs (time elapsed from birth to the first sucking, min).

Authors’ contributions: Conception of the experiment, data acquisition, interpretation of data, drafting of the manuscript, supervising the work: JLD. Analysis and interpretation of data; statistical analysis; drafting of the manuscript: RC. Data acquisition, laboratory analysis; technical support: FT


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Introduction

Piglets are born with low energy reserves (Mellor & Cockburn, 1986; Theil et al., 2014) and deprived of immunoglobulins (Bourne, 1969). Therefore, it is of vital importance that piglets ingest adequate amounts of colostrum to provide enough energy and passive immunity to ensure their survival and development (Le Dividich et al., 2005; Quesnel et al., 2012). However, piglets in the same litter do not have a similar chance to obtain sufficient energy and colostral immunoglobulins (Ig). Compared with the first-born littermates, those born later in the birth order are reported to be lighter at birth (Friend & Cunningham, 1966; Hartscock & Graves, 1976; Motsi et al., 2006). However, according to Beaulieu et al. (2010) and Charneca et al. (2013a), birth weight and birth order are positively correlated. Additionally, late-born piglets are more prone to hypoxia during delivery, which may weaken the piglets and render them less capable to compete for colostrum (Herpin et al., 1996). Furthermore, the acquisition of passive immunity from the sow might be compromised in late-born piglets (de Passillé et al., 1988; Klobasa et al., 2004; Devillers et al., 2011; Kielland et al., 2015).
due to the rapid decline of colostral Ig concentrations (Klobasa et al., 1987; Markowska-Daniel et al., 2010) over time. In addition, there is little information available on colostrum intake by piglets born late in the farrowing process (Devillers et al., 2007). Therefore, the objective of the current experiment was to study the relationship between birth order and piglet’s birth weight, colostrum intake, acquisition of passive immunity, and pre-weaning mortality.

Material and methods

Animals and housing

The experiment was conducted according to the European Community regulations concerning the use of animals for scientific purposes Directive 2010/63 (EU, 2010). Data were obtained from 40 sows and their litters of crossbred piglets [Piétrain × (Large-White × Landrace)]. Animals were kept at the experimental farm of INRA (Saint Gilles, France). Sows were fed a commercial diet twice a day at the rate of 2.6 to 2.8 kg/d until farrowing. From farrowing onwards, the feed offered was gradually increased (during 6-8 d of lactation) until ad libitum was reached. The gestation diet contained 132 g of crude protein (CP), 6.9 g total lysine and 12.5 MJ digestible energy (DE)/kg diet. The corresponding values for the lactation diet were 171 g CP, 9.1 g lysine and 13.0 MJ DE/kg diet. On d 104 ± 2 of gestation sows were moved to the farrowing rooms and housed in individual farrowing crates (2.0 m × 2.5 m). Environmental temperature of the farrowing rooms ranged between 22 and 24 °C. Farrowing pens were equipped with a heating lamp suspended above the creep area. In addition, an extra heating lamp was provided to piglets above the rear of the sow on the farrowing day. All sows farrowed naturally and farrowings were attended. At birth, piglets had their umbilical cord cut at 10-12 cm from the navel after which, they were identified, roughly dried and weighed. During weighing piglets were wrapped in a cloth to avoid movements and hence to limit biased measurements. Time of birth was registered. Piglets born in their placental envelopes had them removed without providing additional assistance. Duration of these operations did not exceed 2-3 min after which piglets were placed at their birth place. The number of total born piglets (TB); born alive piglets (BA), stillborn and mummified piglets, was recorded for each litter. Piglets that died after birth were also weighed but not clinically examined. Creep feed was offered to piglets from d 14 of lactation. Piglets were weaned at 28 ± 1 d.

Estimation of colostrum intake by piglets

The colostrum intake (CI, in g) of piglets during the first 24 h after birth was estimated using the equation of Devillers et al. (2004b): \[ CI = -217.4 + 0.217 \, T + 1861019 \, BW_{24} / T + BW_{0} (54.8 - 1861019 / T) (0.9985 - 3.7 \times 10^{-4} \, t_{fs} + 6.1 \times 10^{-7} \times t_{fs}^{2}), \] where: \( BW_{24} = \) pig body weight at 24 h (kg), \( BW_{0} = \) pig body weight at birth (kg), \( T = \) time elapsed from birth to weighing at \( t_{fs} \) (min) and \( t_{h} = \) time elapsed from birth to the first sucking (min). The interval from birth to the first sucking \((t_{fs})\) is estimated to be 15 to 30 min without major error (Devillers et al., 2004b). In the present study an average of 20 min was used. The 24 h time was calculated by adding 24 h to the mid duration of farrowing. Due to marked BW loss from birth to 24 h of age (between 93 and 244 g), 23 piglets had negative values for CI. Therefore, we considered the CI of those piglets to be nil. Colostrum production of the sow was defined as the sum of the individual CI of all piglets in the litter.

Colostrum and blood sampling, and analysis

From 17 of the 40 sows in the present experiment, colostrum samples (30-35 g/sow) were collected manually from most of the functional teats. Colostrum samples were collected at birth of the first piglet and at 3, 6, 12, 24 and 36 h later. Samples were pooled for each sow and collection time and immediately filtered and stored at –20 °C. From 3 h onwards, sows were administered intramuscularly a single dose of oxytocin (1 mL, 20 USP, Ocytovem CEV A Santé Animale, Libourne, France) to assist colostrum collection. At 2 d of lactation and at weaning, blood samples (1.0-1.5 mL) were obtained by vena cava puncture on the first two- and the last two piglets born in each litter. If a piglet died before the initial blood sampling, the nearest piglet in the birth order was sampled. Blood samples were allowed to clot at room temperature, were centrifuged at 5200g for 4 min and the serum was removed and frozen at –70 °C until analysis.

IgG concentrations for colostrum and serum samples were determined by ELISA test (pig IgG ELISA Quantitation kit, Bethyl Laboratories, Montgomery, TX, USA) following the procedure described by Devillers et al. (2004a).

Statistical analysis

Data were submitted to ANOVA using the IBM SPSS Statistics software (v.21, 2012). To compare litters of different sizes and to determine whether position of the piglet in the birth order (BO) affected within-litter birth
weight (BW$_0$) and CI, position of the piglets in BO was expressed as relative BO (RBO) calculated as RBO = (BO - 1) / (Total born piglets - 1).

Regression analyses were used to determine the relationship between BW$_0$ and TB (with the exception of mummies and 4 stillbirths which were not weighed), BW$_0$ and BA piglets, CI and RBO. Regressions analyses were also used to determine the relationship between CI and BW$_0$, serum IgG concentrations of piglets at 2 d of age (IgG2d), and between IgG2d and RBO. In order to consider the litter effect, the values used for each regression were the unstandardized residues previously obtained by ANOVA, using litters as fixed effect.

To compare the characteristics of piglets that either died or survived during the suckling period within each litter, piglets were classified as either “light” (LG) [BW$_0$ ≤ (x-one SD)] or “normal” (NM) [BW$_0$ > (x-one SD)], where x is the average BW$_0$ of the litter, and SD its standard deviation. Although trait residues were normally distributed there was an unbalanced number of animals per group therefore the comparison of means was made using the Mann–Whitney U non–parametric test.

To examine the effects of RBO on pre-weaning mortality, piglets were classified into deciles on the basis of their RBO. Mortality across deciles was analysed using a Chi square test.

For colostrum IgG composition the repeated measures ANOVA procedure was used using time of collection as within–subjects factor. For serum IgG concentrations the repeated measures ANOVA procedure was used using time of collection as within–subjects factor and type of piglet (first two vs last two born piglets) as between–subject factor.

**Results**

**General**

Parity of the sows averaged 3.5 ± 0.3 (s.e.) (range 1-7). Duration of parturition averaged 233 ± 16 min and was independent of TB (r=0.012; p=0.808). On average, BA per litter was 13.4 ± 0.4. Relatively to TB, there were 2% of born dead piglets (0.25% mummified piglets and 1.75% of stillborn) with 43% of stillbirths being born in the last quarter of RBO. Birth weight of BA piglets averaged 1427 ± 30 g. From the 40 sows on experiment, 13 had a litter size (BA) greater than 15 (mean 16.4 ± 0.3). From these sows, 15 piglets with an average BW$_0$ of 1419 ± 75 g and a RBO of 0.44 ± 0.06 were removed soon after the completion of farrowing and withdrawn from the study. After fostering and withdrawal, litter size designated as sucking piglets (SP) averaged 13.2 ± 0.4 with piglets’ BW$_0$ averaging 1425 ± 31 g. At weaning, litter size (SP) and weight of piglets averaged 11.4 ± 0.4 and 6840 ± 93 g, respectively.

**Relationship between BW$_0$, CI and RBO of piglets**

The within-litter slope of the regression relating BW$_0$ of TB piglets to RBO was: $b_{BW0} = 116 ± 38$ g RBO ($R^2$=0.002, $p$=0.002) (Fig. 1). Corresponding values for BW$_0$ of BA piglets were...

**Figure 1.** Within-litter relationship between birth weight (g) of total born piglets and relative birth order. Data presented are residues calculated after correction for litter effect.
and SP piglets were: $b_{BA} = 112 \pm 37$ g RBO ($R^2=0.016$, $p=0.003$), and $b_{SP} = 115 \pm 38$ g RBO ($R^2=0.017$, $p=0.002$), respectively. The CI and the colostrum production of sows averaged $287 \pm 13$ g (range 0-882 g) and $3660 \pm 160$ g (range 1810-5770 g), respectively. The average within-litter CV for CI was 45% (ranging from 20 to 66%). The CI was independent from RBO ($p=0.700$), but positively related to BW$_0$ ($b_{CI} = 0.26 \pm 0.016$ BW$_0$ (g), $R^2=0.29$, $p<0.001$; Fig. 2). An increase of 100 g in BW$_0$ was associated with an increase of 26 g in CI. Colostrum production of sows was independent from SP litter size ($p=0.132$) and from litter weight ($p=0.560$). Consequently, colostrum per piglet decreased by $16 \pm 5$ g ($p=0.006$) per additional SP.

IgG concentration of colostrum

Colostrum IgG concentration at the different sampling moments are presented in Fig. 3. Immunoglobulin G concentration was highest at birth of the first piglet (75.4 ± 7.0 mg/mL) and showed a 10-fold decline ($p<0.001$) to 7.5 ± 1.3 mg/mL at 36 h after the birth of the first piglet ($p<0.001$). Furthermore, the CV of IgG concentration observed among sows for samples collected at the birth of the first piglet and at 12 h were 32% and 72%, respectively.

Serum IgG concentration of the first-two and the last-two piglets born sampled at 2 d of age and at weaning

The first two- and the last two-born piglets had similar BW$_0$ and CI, averaging 1466 ± 52 g and 314 ± 26 g, respectively. RBO of the first two- and the last two-piglets sampled averaged 0.05 ± 0.02 and 0.93 ± 0.02, respectively. Time elapsed between birth of the first two- and the last two- sampled piglets averaged 156 ± 13 min.

At 2 d of age, serum IgG concentrations (Fig. 4) were 29.5% lower ($p=0.002$) in the last two-born than in the first two-sampled piglets and it remained lower ($p=0.030$) at weaning. Irrespective of RBO, serum IgG concentrations were lower at weaning than at 2 d of age ($p<0.001$). There was a positive within-litter relationship between serum IgG concentrations at 2 d of age and CI ($R^2=0.11$, $p=0.005$). Within-litter, serum IgG concentrations at 2 d of age and at weaning were positively correlated ($R^2=0.50$, $p<0.001$)

Characteristics of pigs that died before weaning

Total pre-weaning mortality of SP piglets averaged 12.4%, with 51% of deaths occurring within 3 d of birth. The effect of birth weight on the characteristics of piglets that died after birth compared to those of survivors is presented in Table 1. Because of the imposed differences in BW$_0$ between the two groups, CI was expressed as CI/kg BW$_0$. Overall, piglets that died before weaning were lighter at birth (1141 ± 45 vs 1449 ± 14 g, $p<0.001$) and consumed less colostrum (85 ± 10 vs 211 ± 4 g/kg BW$_0$, $p<0.001$) than surviving piglets. Post-natal mortality was irrespective of deciles based on RBO ($p=0.410$). As expected, mortality was higher (38.4%) in the LG group, representing 51% of total

![Figure 2. Within-litter relationship between colostrum intake (g) and birth weight of sucking piglets. Data presented are residues calculated after correction for litter effect.](image-url)
mortality, and lower (7.3%) in NM group. Piglets from
the LG group that survived until weaning consumed
15.4% more colostrum \((p=0.013)\) than their counterparts
from the NM group. Piglets that died in the LG group
had lower BW\(_0\) than surviving piglets \((p<0.001)\). No
difference \((p=0.065)\) in BW\(_0\) was observed between
dead and alive piglets in NM group. In both groups,
dead piglets consumed less colostrum than their
surviving littermates \((p<0.001)\) and their body weight
at death was not significantly different from their BW\(_0\)
(LG group, \(p=0.130\); NM group, \(p=0.160\)).

**Discussion**

Reproductive performance of sows (litter size at birth
and at weaning) and pre-weaning mortality observed
in the present study were consistent with the national
French results (IFIP, 2011). Stillbirths recorded in the
present study (1.75%) were considerably less than those
reported in the national French results (7%), which is
probably due to the supervision of farrowings (Holyoake
et al., 1995). Duration of farrowing was independent of
litter size (TB) and in the range of the 160 to 217 min
reported by Le Cozler et al. (2002), Canario (2006), and
Motsi et al. (2006). In this study, birth weight increased
with RBO in agreement with Beaulieu et al. (2010) and
Charneca et al. (2013a). However, RBO accounted only
for approximately 1.6% of the variations observed in
piglet birth weight. In contrast, several authors reported
that piglets born earlier during farrowing were heavier
than those born later (Friend & Cunningham, 1966;
Hartsock & Graves, 1976; and Motsi et al., 2006).
Average colostrum production of sows and CI of piglets
Table 1. Characteristics of piglets dying pre-weaning in comparison with survivors in relation to birth weight category.

<table>
<thead>
<tr>
<th>Birth weight (BW&lt;sub&gt;0&lt;/sub&gt;) category&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>LG&lt;sup&gt;(2)&lt;/sup&gt;</th>
<th>NM&lt;sup&gt;(2)&lt;/sup&gt;</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piglets surviving to weaning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N pigs</td>
<td>53</td>
<td>407</td>
<td></td>
</tr>
<tr>
<td>BW&lt;sub&gt;0&lt;/sub&gt;, g</td>
<td>1046 ± 29&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1501 ± 14&lt;sup&gt;*a&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CI, g/kg BW&lt;sub&gt;0&lt;/sub&gt;</td>
<td>240 ± 13&lt;sup&gt;*a&lt;/sup&gt;</td>
<td>208 ± 4&lt;sup&gt;*a&lt;/sup&gt;</td>
<td>0.005</td>
</tr>
<tr>
<td>Piglets dying pre-weaning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N pigs</td>
<td>33</td>
<td>32</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mortality, %</td>
<td>38.4</td>
<td>7.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>BW&lt;sub&gt;0&lt;/sub&gt;, g</td>
<td>882 ± 38&lt;sup&gt;*a&lt;/sup&gt;</td>
<td>1407 ± 49&lt;sup&gt;*a&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>CI, g/kg BW&lt;sub&gt;0&lt;/sub&gt;</td>
<td>6 ± 11&lt;sup&gt;*a&lt;/sup&gt;</td>
<td>109 ± 14&lt;sup&gt;*a&lt;/sup&gt;</td>
<td>0.018</td>
</tr>
<tr>
<td>Weight at death, g</td>
<td>793 ± 45&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1628 ± 52&lt;sup&gt;b&lt;/sup&gt;</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Age at death, d</td>
<td>1.8 ± 0.3</td>
<td>6.9 ± 0.3</td>
<td>0.002</td>
</tr>
</tbody>
</table>

<sup>(1)</sup> LG category, birth weight ≤ [x- one SD]; NM category, birth weight > [x- one SD], where x = average birth weight of the litter and SD is its standard deviation. Within birth weight category, different superscript lower case letters in the same traits indicates significant differences. <sup>(2)</sup> Intra LG category, compared with survivors, BW<sub>0</sub> and CI, g/kg BW<sub>0</sub> were lower in piglets dying (p<0.001). Intra NM category, compared with survivors, CI, g/kg BW<sub>0</sub> was lower in piglets dying (p<0.001) but not BW<sub>0</sub> (p=0.054). In both categories, body weights at death were not different from BW<sub>0</sub> (p>0.05).

were similar to that previously described in the literature: 3.4-4.9 kg/sow and 300-380 g/piglet (Devillers et al., 2007; Quesnel, 2011; Loisel et al., 2013; Charneca et al., 2015). Moreover, colostrum production was independent from litter size (SP) and litter weight. Consequently, CI decreased by 16 g per additional SP born. This reduction in CI is in agreement with that reported by Devillers et al. (2007) (a decrease of 22 g per additional piglet born). Therefore, in larger litters, piglets are more likely to have a reduced/inadequate colostrum intake due to competition. According to Quesnel et al. (2012), an intake of about 180 g colostrum/kg BW<sub>0</sub> is required to provide the piglet with sufficient energy and IgG for survival. On this basis, 71% of the sows of this study could nurse 13 piglets averaging 1300 g birth weight. However, individual CI within-litter was very variable, with a CV ranging from 20 to 66%. An important factor accounting for this variability was the piglet birth weight. In this study, CI increased 26 g per 100 g increase in birth weight, which is similar to the increase of CIs (22-28 g) found by Devillers et al. (2007) and Charneca et al. (2015). In agreement with Fraser & Rushen (1992) and Devillers et al. (2007), birth order had no significant effect on CI despite later born piglets had shorter time and greater competition to suck. This is likely because the rate of CI is the highest during the first few hours after birth (Castrén et al., 1991; Fraser & Rushen, 1992; Le Dividich et al., 1997).

We hypothesise that, when last- piglets were born, the first-born were sated and therefore less active, allowing last-born piglets to display more teat seeking activity. The pattern of colostrum IgG concentrations over the first 36 hours after the onset of parturition was similar to that previously reported (Klobasa et al., 1987; Rooke et al., 2003; Markoswska-Daniel et al., 2010; Charneca et al., 2015). The fact that the serum IgG concentrations at 2 d of age were lower in late-born piglets than in their earlier born littermates is in agreement with the findings of de Passillé et al. (1988), Bland et al. (2003), Devillers et al. (2007) and Cabrera et al. (2012). Similar observations were also made on 1d old piglets (Kielland et al., 2015). Piglets deprived of sucking for 4 h after birth had also lower serum IgG concentrations than their non-deprived of sucking littermates (Coalson & Lecce, 1973). In contrast, only marginal effect of birth order on serum IgG concentrations was observed by Cabrera et al. (2012) while no effect was found by Nguyen et al. (2013). The lower serum IgG concentrations in the last-born piglets are commonly attributed to the intake of colostrum with a lower concentration in IgG (Lay et al., 2002). It could also be caused by a lower intake of colostrum. However, according to present results, this is not the case as CI was independent of RBO. Further, despite the fact that colostrum is the unique source of IgG for piglets, CI explained only 11% of the total variability found in piglet IgG concentrations. Similarly, Cabrera et al. (2012) reported that colostral IgG concentrations explained only 6% of the variation observed in piglet IgG concentrations, while no correlation was found by Markoswska-Daniel et al. (2010). Yet, Werhahn et al. (1981) reported a dose response relationship between the porcine IgG administrated to the newborn pig and
the plasma IgG concentrations at 12 h post-feeding. However, in the present study, the amount of ingested colostral IgG could not be determined accurately due to the combination of the various decreasing patterns of IgG concentrations of colostrum and the various intake behaviours of piglets over time.

Late born piglets are reported to have a higher mortality rate after birth than earlier born littermates (Hartsock & Graves, 2000; Tuchscherer et al., 2000; Rootwelt et al., 2012; Panzardi et al., 2013). In addition to obtaining less immune protection, late-born piglets are reported to be at greater risk of hypoxia and of death during or just after birth (Randall, 1972). In this study, this is illustrated by the fact that 43% of stillbirths were born in the last quarter of RBO, which is in accordance with the previous results of Herpin et al. (1996), Pedersen et al. (2011) and Rootwelt et al. (2012). However, post-natal mortality was similar across deciles suggesting that mortality of live born piglets was evenly distributed in the birth order which is in agreement with Cabrera et al. (2012) and Charneca et al. (2015). Present study indicates that birth weight and CI are the major determinants of post-natal mortality. However, while CI is independent on RBO (Devillers et al., 2011; Quesnel et al., 2012), birth weight is positively, although marginally, related to RBO, accounting only for 1.6% of the birth weight variation.

Yet, high mortality has been correlated with low levels of serum IgG (Hendrix et al., 1978; Blecha & Kelley, 1981; Klobasa et al., 1981; Devillers et al., 2011). However, these mortalities may simply be associated with an insufficient nutrition rather than disease. This is illustrated by the study of Devillers et al. (2011) showing that piglets dying during the first three post-natal days had 44% less serum IgG concentrations at 2 d of age than survivors but had consumed 2.3 times less colostrum (147 vs 333 g) and hence energy. From this, the probability of dying is not increased in last-born piglets despite their lower intake of IgG than the earlier born piglets. Present findings agree with the observation of Tyler et al. (1990), and Rootwelt et al. (2012) which state that serum IgG concentrations at 24-60 h of age is a poor predictor of piglet survival. However, in the present study, piglets were sampled at 2 d of age when the largest part (51%) of mortality had occurred, and it is not known whether insufficient passive immunity was the real cause of these deaths. Further, present results and others (Rooke et al., 2003; Markowswska-Daniel et al., 2010; Devillers et al., 2011) show a close positive within-litter relationship between serum IgG concentrations shortly after birth and at weaning indicating that level of systemic immunity at weaning is, at least partly, influenced by the level of passive immunity acquired through colostrum.

Piglets dying pre-weaning are characterized by low birth weight and low colostrum intake. The low-birth-weight piglets are recognized to be at a greater risk of pre-weaning mortality (English & Morrison, 1984; Gardner et al., 1989; Tuchscherer et al., 2000). Moreover, due to the low heat conserving capacity of the piglet (Berthon, 1994; Herpin et al., 2002) and its low body energy stores (Mellor & Cockburn, 1986; Theil et al., 2014), adequate intake of colostrum is vital not only to provide immunological protection but also to ensure sufficient supply of energy for metabolism. In this study, LG category piglets represented 16.4% of the pig population, but they contributed to 51% of the total pre-weaning mortality. In fact, most of these piglets could be classified as runt, and as such, are at physical disadvantage in competing with larger littermates for colostrum and milk. Indeed, from the 33 piglets dying from this category, 31 (94%) consumed less than 180 g colostrum/kg BW₀ (mean, 52 ± 10 g). Interestingly, piglets from this group which survived to weaning consumed 15.4% more colostrum/kg BW₀ than their counterparts of the NM category. Similarly, Ramackers et al. (2012) reported that survival of light piglets (≤1000 g) is more dependent on their body weight gain from birth to 24 h of age (and hence on their colostrum intake), than that of “normal piglets” (>1000 g). Other study by Ferrari et al. (2014) observed that the probability of death of low birth weight piglets (1.1-1.2 kg) compared to newborn heavy piglets (1.3-1.7 kg) was substantially reduced when CI of low birth weight piglets reached 250 g. In other words, to survive, light piglets must consume more colostrum per kg birth weight than heavier littermates which is consistent with the fact that the lower the birth weight, the greater the surface area per unit body weight and therefore the greater the energy required per unit body weight to maintain homeothermic balance (Curtis, 1970). This suggests that the determination of the amount of colostrum needed to survive and to thrive must take into account the birth weight of the piglets.

In conclusion, results reported here indicate that birth order has no significant effect on the within-litter birth weight, colostrum intake and post-natal mortality of piglets. Yet, compared to the first born, piglets born last in the birth sequence are underprivileged in the acquisition of passive immunity. However, they do not appear to be at higher risk of dying pre-weaning. In this study, low birth weight and insufficient colostrum intake were the major underlying causes of postnatal mortality. Results suggest that improving colostrum production of sows and selection of sows for litter uniformity (Damgaard et al., 2003; Bouquet et al., 2014), thus allowing a more uniform intake of colostrum by littermates (Charneca et al., 2013b) would reduce piglet mortality. Additionally,
management strategies (De Vos et al., 2014) of low birth weight piglets should be considered in order to reduce mortality and improve performance at farm level.

References


