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Analysis of frequency piglet mortality causes in nucleus herds

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A large number of piglets born per litter does not guarantee production success, it is only rearing a large litter that makes production profitable. The aim of the study was to evaluate the frequency of different piglet mortality causes during rearing to 21 days of age depending on litter size. A total of 266 975 litters of Polish Large White and Polish Landrace sows and their crossbreds were analysed for causes of piglet mortality to day 21 of life. Causes of mortality were classified into seven classes: crushing, low birth weight, diarrhoea, cachexia, genetic defects, sow agalactia and others. Mortality was observed in 121 149 litters (45.4%), but it did not occur in 54.6% of litters. Litters with deaths were divided into three groups depending on the number of piglets born in the litter (≤10, 11-14, ≥15 piglets) and the following parameters were calculated: number of live-born piglets/litter, number of piglets on day 21 of life/litter and mortality rate/litter. The statistical analysis was based on the Kruskal-Wallis test. For group I and group III litter size at birth, piglet mortality rate to day 21 of life was 15.0 and 18.2%, respectively, which is higher by 2.7 and 5.9 percentage points (p.p.) than in group II. Piglet deaths were mainly due to low birth weight. A problem was also mortality due to genetic defects, which increased with an increasing litter size. Analysis of the results shows that particular attention should be given to eliminating reasons contributing to lower birth weight of piglets.

KEY WORDS: mortality / piglets / sows

Satisfactory production efficiency in breeding and commercial herds is determined by high prolificacy expressed as the number of piglets reared per sow per year. It

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depends, among others, on fertility, farrowing frequency and mortality of piglets reared by their mothers. Therefore, efforts are made in every herd to reduce the latter indicator.

High fertility and productivity in sows were attained through systematic selective breeding, shorter reproductive cycle, improved environmental conditions and health of animals, as well as better herd management [Rekiel and Więcek 2018]. The improvement of reproduction traits in pigs and measures to optimise multiple environmental aspects (housing and feeding) have increased the number of piglets weaned per sow per year: up to 24-25 piglets for the domestic maternal breeds Polish Landrace and Polish Large White, and by 23-23.5 for sire breeds [Stan hodowli, 2018]. In the best commercial herds in Poland and Europe prolificacy is 28-30 piglets/sow/year, with some reaching 33 piglets per sow per year [Koketsu 2016]. With actual fertility of 20.3 live-born piglets per litter, 15% rearing mortality, 2.32 farrowing frequency and 28-day lactation it is possible to rear as many as 40 piglets per sow per year [Koketsu *et al.* 2017]. Fertility of sows is determined by many factors, including environmental conditions and genotype. Primiparous sows with very low fertility increase it to 10-11 piglets born in parities 2 to 6, whereas in hyperprolific young females fertility decreases from about 16 to 13-12 piglets born in the next cycles [Iida *et al.* 2015].

The most common causes of piglet mortality during the perinatal period are connected with hypoxia and/or asphyxia, while in the maternal nursing period it is low birth weight of piglets, which is observed particularly in highly fertile sows [Quiniou *et al.* 2002, Boulot *et al*. 2008, Ambroziak and Rekiel 2017, Calderón Díaz *et al.* 2017, 2018]. In the leading pig producing countries, preweaning piglet mortality according to different authors is estimated at 17-20% [Dividich 2006], 12-25% [Alonso-Spilsbury 2007] or even as much as 35% [Mainau *et al.* 2015]. As reported by Dividich [2006], one piglet out of 5-6 born die on average by 3-4 weeks of life. At high productivity, stress-inducing factors have a strong immunosuppressive effect, which increases morbidity and mortality [Rekiel and Więcek 2018]. This is particularly frequent if colostrum available to newborn piglets is not of sufficient quantity, which is due to low milk production of the dams. This results from improper feeding of pregnant sows, which makes them excessively fat and sometimes favours the development of the MMA syndrome (*Mastitis Metritis Agalactie*). Neonatal mortality decreases when colostrum is produced and available at sufficient quantity [Declerck *et al.* 2016b]. Improper temperature and humidity parameters – lower than normal temperature, elevated humidity and poor hygienic standards in the farm environment – are conducive to lower immunity, diseases in mothers and infections in their offspring [Khosravi and Mazmanian 2013, Chase 2016, Fouhse *et al*. 2016]. Hypothermia and starvation [Edwards 2002], low energy reserves [Andersen *et al.* 2009, Declerck *et al.* 2016a] as well as crushing [Edwards 2002, Mainau *et al.* 2015] are events that occur collectively and cause mortality in the postnatal period. Low mortality indicates good rearing performance. It may be achieved in herds, which implement prevention programmes [Pineiro 2016], optimise sow nutrition and supplementary feeding of piglets [Rekiel *et al*. 2015, Viott *et al*. 2018], while also ensuring adequate environmental standards for housing and welfare [Onteru *et al.* 2011, Rekiel and Więcek 2018].

The aim of the study was to evaluate the frequency of different piglet mortality causes during rearing to 21 days of age depending on litter size.

Material and methods

The study used data on a total of 266 975 litters of Polish Large White (56 283) and Polish Landrace (124 367) sows and their crossbreds (86 325), born in the period of 2007-2016 in nucleus herds throughout Poland. Mortality until day 21 of life was reported in 121 149 litters (45.4%), while it did not occur in 145 826 litters (54.6%). Further analyses were performed only for litters with reported mortality cases. Breeding documents (litter records) accounted for seven causes of mortality: crushing, low birth weight, diarrhoea, cachexia, genetic defects, sow agalactia and other causes (difficult to determine). Litters with deaths were divided into three groups depending on the number of piglets born per litter (group I – ≤10, group II – 11-14, group III – ≥15 piglets). Differences for the number of live-born piglets/litter, number of piglets at day 21 of life/litter and mortality rate/litter were determined by the Kruskal-Wallis test. These computations were performed using the SPSS Statistics 24 software (2019).

Results and discussion

As expected, the mean number of piglets at days 1 and 21 of life differed significantly between groups I, II and III. The differences for the number of live-born piglets were as follows: groups I-II – 2.9 piglets, groups II-III – 3.5 piglets, groups I-III – 6.4 piglets, while those for the number of piglets at day 21 of life were 2.8, 2.1 and 4.9 piglets, respectively. Piglet mortality was highest in group III and lowest in

Table 1. Litter size at days 1 and 21 of life and mortality rate

Trait	Litter size at day 1						P-value
	≤10 (group I) n = 16 958		11-14 (group II) n = 89 697		≥15 (group III) n = 14 494		
	mean	SD	mean	SD	mean	SD	
Number of live-born piglets per litter							
n	9.5^A	0.92	12.4^A	1.02	15.9^A	1.25	0.001
Number of piglets at day 21 of life per litter							
n	8.1^A	1.24	10.9^A	1.14	13.0^A	1.59	0.001
Piglet mortality per litter							
n	1.43^A	0.81	1.53^A	0.83	2.90^A	1.77	0.001
%	15.0		12.3		18.2		

^{A}Within row means bearing the same superscript differ significantly at P≤0.01.

Table 2. Number of litters at day 1 of life

Trait	Litter size on 1 day of life		
	≤10 (group I)	11-14 (group II)	≥15 (group III)
Total number of litters			
n	16 958	89 697	14 494
%	100	100	100
including first parity			
n	5 685	17 582	1 798
%	33.5	19.6	12.4
including parity ≥8			
n	1 770	7 358	1 120
%	10.4	8.2	7.7

Table 3. Piglet mortality rate per litter (%)

Number of mortality causes per litter	Litter size on 1 day of life		
	≤10 (group I)	11-14 (group II)	≥15 (group III)
	16 958 (100%)	89 697 (100%)	14 494 (100%)
1	95.1	91.7	72.3
2	4.7	7.9	23.9
3 and more	0.2	0.4	3.8

Table 4. Frequency of different piglet mortality causes

Cause of mortality	Litter size on 1 day of life		
	≤10 (group I)	11-14 (group II)	≥15 (group III)
	16 958 (100%)	89 697 (100%)	14 494 (100%)
1. Crushing	14.8	11.2	10.8
2. Low birth weight	65.2	67.2	52.5
3. Diarrhoea	1.7	0.9	2.0
4. Cachexia	2.3	1.1	0.7
5. Genetic defects	6.9	10.0	22.9
6. Sow agalactia	3.3	2.2	3.3
7. Other	5.8	7.4	7.8

group II, in which the number of live-born piglets ranged from 11 to 14 (Tab. 1).

In group I (≤10 piglets), there were 1/3 first-parity litters and 1/10 eighth- and later-parity litters (Tab. 2). The lowest proportion of first-parity, eighth- and later-parity litters was observed in group III.

In all the groups, losses due to a single cause were predominant (Tab. 3). A single cause of mortality was recorded in over 90% of the litters in groups I and II, and in around 72% of those in group III. In the case of large litters (group III) two causes of piglet mortality were reported in about 24% of the litters, while three and more causes in about 4% of the litters.

Regardless of litter size at birth, low birth weight of the piglets was the most frequent cause of mortality (Tab. 4). In litters of small and intermediate size (groups I and II), the second most frequent cause of mortality was crushing, while in litters with 15 and more piglets (group III) it was genetic defects. Piglet mortality due to diarrhoea, cachexia and sow agalactia was not very common.

The highest mortality (18.2%) was observed in the largest litters, intermediate (15.0%, group I) in the smallest litters, and lowest (12.3%, group II) in litters of 11-14 live-born piglets. The 15.0% mortality rate in group I could be due to the large proportion of first-parity litters. Our findings agree with the results reported by Hagan and Etim [2019].

The results of our study show that the highest piglet mortality rate was caused by low neonatal weight, regardless of litter size on the first day of life. Although information concerning causes of low birth weight was not available to us, the literature on the subject offers multiple explanations. Large litters are characterized by a greater number of stillborn piglets, lower survival rates of piglets reared by their mothers, and large differences in piglet body weight at birth and during rearing [Wolf *et al.* 2008]. According to Rekiel *et al.* [2013], an increased litter size does not affect the level of mortality provided that the scale of change is small, the level of fertility is moderate and in keeping with the breed's potential. Optimised birth weights and equalised body weights of piglets in the litter provide equal opportunities for their growth and development. If mortality of maternally nursed piglets is high, postweaning and fattening mortality rates are much lower [Calderón Díaz *et al.* 2017, 2018]. However, the lower the birth weight of piglets, the higher their total mortality in the successive three phases. In the studies cited above, the mortality rate of piglets was 37% for piglets weighing less than 1 kg at birth, while it was 13, 10 and 4% for piglets with birth weights of 1-1.3, 1.3-1.7 and over 1.7 kg, respectively. This indicates advisability of optimising neonatal piglet weight. Similar results were presented by Quiniou *et al*. [2002], who observed 35% mortality among piglets with birth weight of less than 0.8 kg compared to only 4% mortality among those weighing 1.2-1.4 kg at birth. When body weight declined from 1.8 to <0.61 kg, survival rates decreased from 95 to 15%, and when litter size increased from 11 to 16 piglets the mortality rate increased from 6-8 to 28%. Similar trends were reported by Boulot *et al*. [2008] and Jarczyk *et al*. [2009]. In the study by Ambroziak and Rekiel [2017], piglet survival rates increased with an increase in average birth weight, with body weight ≥ 1.60 kg guaranteeing the best growth rate and survival of the piglets. Gonçalves *et al.* [2016 a, b] and Mallmann *et al.* [2018] stressed the positive effect of administering greater amounts of feed to pregnant sows, especially sows in advanced pregnancy, on individual birth weight of their piglets. The benefits are due to a higher energy supply. In addition, in the group of females fed high amounts of amino acids, preweaning mortality of piglets was lower than in the control group. Neonatal piglet weight is significantly affected by sow nutrition during the second trimester of pregnancy, especially in the context of the intrauterine growth retardation (IUGR) syndrome, the preliminary diagnosis of which is associated with lower neonatal body weight. This syndrome impairs the function and development of the gonads, brain, heart, small intestine, liver, thymus, hair follicles and mammary glands [Rekiel and Królewska 2014], which contributes to piglet mortality regardless of litter size.

In our study, mortality due to crushing accounted for almost 11 up to slightly below 15 % of all deaths. This is a complex problem, because piglet crushing is a result of factors attributable to both the dam and the offspring. A reduced mothering instinct increases the risk of piglets being starved or crushed. Low neonatal weight and the associated poor neonatal vitality are conducive to hypothermia, resulting in starvation that predisposes to crushing [Edwards 2002, Mainau *et al.* 2015]. Because neonatal piglets have a poor thermoregulatory system, inadequate heating causes chilling of the skin, hypoxia and ischemia, leading to a decline in motor activity, failure to ingest sow's milk, reduced weight gain, compromised immunity and consequently infections. Hypothermia, which is accompanied by an increased carbohydrate metabolism, is the cause of hypoglycemia. A rapid decrease in blood glucose level leads to coma and death [Edwards 2002, Andersen *et al.* 2009, Declerck *et al.* 2016b]. In our study, mortality due to crushing probably resulted from an accumulation of the events described above.

In our study diarrhoea, which was responsible for a small percentage of piglet mortality cases in groups I, II and III, may have resulted not only from bacterial or viral infections, but also from sow agalactia, which was found to be a slightly more frequent cause of piglet losses. Bacteria and their toxins act directly on the intestinal epithelial cells, whereas viruses impair resorption at the intestinal membrane level [Pelaseyed *et al.* 2014]. Cachexia may be prevented by providing piglets with an early and full access to sow's colostrum and milk [Alexopoulos *et al.* 2018]. Sow agalactia is mainly caused by bacterial and mycoplasma infections during parturition and lactation. They are promoted by long parturitions, retention of fetal membranes, uterine inertia or abnormal uterine involution. Milk from sick sows is characterised by a higher somatic cell count (above 2 million/ml), altered contents of chlorides, Na, K, Ca, P and lactose, as well as elevated pH (>7.0) [Rekiel 2002, 2006]. Colostrum and milk production is also determined by teat number and quality [Alexopoulos *et al.* 2018, Rekiel *et al*. 2019]. Abnormalities in this area may be temporarily corrected with milk replacers [Viott *et al*. 2018].

Proper selection of animals for mating minimises the incidence of genetic defects; nevertheless, such defects were observed also in our study. It is essential that breeding records are kept and animals properly identified in the herd. Errors may lead to increased inbreeding, which may also be one of the factors increasing susceptibility to stress, expressed by a higher blood level of stress hormones [Reed *et al.* 2012]. Congenital developmental abnormalities in piglets may also result from environmental factors, genetic factors, unknown causes determined by many factors or genes, as well as spontaneous developmental errors. The associated developmental defects in offspring include the splay-leg syndrome, imperforate anus, internal hydrocephalus, and defects of the reproductive system as well as cleft palate, inguinal and umbilical hernia; as a result some piglets are born weak or dead [Charon and Świtoński 2012].

The highest mortality rate (18.2%) was observed in the largest litters, it was medium (15.0%, group I) in the smallest litters, and lowest (12.3%, group II) in litters of 11-14 live-born piglets. Based on the analysed frequency of different mortality causes in 121 149 litters, it was found that low birth weight was the most common cause of piglet losses up to day 21 of life. This cause was not related to litter size at day 1 of life. Analysis of the results shows that particular attention should be given to eliminating reasons contributing to lower birth weight of piglets.

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