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# Behavioural patterns of boars by breed depending on age, season, and type of ventilation

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**Abstract.** An important tool for improving the productive characteristics of pigs, including boars, is a thorough study of their behavioural patterns and reactions to compliance with housing conditions, which serves as an indicator of the protocol for assessing the welfare of this sex group in commercial pig farms. The purpose of the experiment was to identify the influence of age, season of the year, and type of ventilation on the duration of behavioural acts of boars by breeds to establish their behavioural patterns in industrial technology. The experiment involved 18 boars of the Large White, Landrace, and Duroc breeds. The boars selected for the experiments were clinically healthy and divided into two groups of 9 animals each. The control group of boars was kept in a room with a transverse ventilation system, and the animals of the experimental group were kept in geothermal air supply conditions for a year. In the process of visualising the behaviour parameters of boars of different breeds, it was found that: the duration of rest was significant ($P < 0.001$) affected by 49.1-67.6% – age, 10.9-23.2% – season of the year, 0.1-3.0% – type of ventilation; the duration of movement during the day was significant ($P < 0.001$) affected by 44.7-68.0% – age, 9.1-28.5% – season of the year, 0.5-3.2% – type of ventilation; the duration of admission feed and water were significant affected ($P < 0.001$) by 49.7-71.9% – age, 7.9-25.9% – season of the year, 0.1-2.4% – type of ventilation. A behavioural act that prevailed in duration and frequency ($P < 0.001$), especially

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in the summer-autumn period, was rest, which increased in time with age from 72.3% to 76.4%, regardless of the breed, season of the year, and type of ventilation. In summer and autumn, the transverse air supply system visualised abnormal apathetic behaviour during rest in animals (lying on their sides, stomach, eyes closed, without any reactions to indifferent stimuli, and the time that boars spent on stereotypical behaviour (head banging, jumping and licking the bars of the cage) increased by 3% ($P < 0.95$) and in the "position of sitting dog" by 2% ($P < 0.95$). The results obtained allow introducing the use of ethological factors in industrial pig production to increase boar sperm production, and identify individuals with behavioural deviations to develop ways to assess welfare and integrate them into production

**Keywords:** pigs; rest; movement; feed and water intake; welfare; three-factor variance analysis

## Introduction

According to the convincing opinion of J.J. McGlone *et al.* (2020), who published the peer-reviewed section of the textbook "Animal Reproduction in Veterinary Medicine" in the public domain, the successful development of pig production technologies is a case in maintaining and restoring the number of animals as raw materials for processing enterprises. Results of long-term research by A. Lykhach *et al.* (2023) confirm the fact that in Ukraine, most commercial pig farms keep boars to maintain successful pig breeding technologies and profitable management of the pig industry in general. Practical experience shows that for cost-effective pork production in pig farms, the main factor is effective artificial insemination of sows with the criterion of evaluating boars according to their qualitative and quantitative parameters of sperm production, which was the focus of experiments by S. Kondracki *et al.* (2021). In turn, the synthesis of sperm in boars depends on a number of factors, in particular: age, breed, intensity of use, time of year, ventilation system in the premises, type of higher nervous activity, signs of individual behavioural complex, etc., and is confirmed by the conclusions of I. Zapryanova & R. Malinova (2019), I. Michos *et al.* (2021), W.L. Flowers (2022).

Despite various technological challenges, Ukraine is adopting and implementing a number of highly innovative technologies with the use of energy efficiency in livestock facilities, in particular pig breeding, to combine intensive systems of pork production technology, which are operated with minimal costs, maximum production capacity in compliance with sanitary and hygienic requirements for keeping pigs of different sex and age groups and the transformation of the energy system of livestock premises at the expense of alternative fossil resources in the agricultural sector, in particular, geothermal energy. However, the use of geothermal energy (Kwak *et al.*, 2021) in pork production will reduce the impact of the industry on the environment, harmonise the compliance of conditions for keeping pigs with the biological needs of industrial-type sites (Kim *et al.*, 2023), as provided for by the legislation of Ukraine and the European Union (Council Directive 2008/120/EC, 2008; Order of the Ministry for Development of Economy No. 224, 2021).

Natural regulatory and temperature conditions for the development of pig breeding are not observed in every region of Ukraine. For example, data from the Ukrainian Hydrometeorological Centre of the State Emergency Service of Ukraine indicate that the average peak summer temperature in Ukraine in 2023 was +33°C, and in the southern area of the country, such as Zaporizhzhia, Kherson, Mykolaiv, Odesa regions, the peak summer temperature in August was recorded at +38°C (Ukrainian

Hydrometeorological Centre, 2023). In this regard, a long period of hot weather in these regions has a significant impact on the technology of the pig industry and its profitability in general. Therefore, pig production technology, at least in these regions, requires a clear energy-efficient environmental control system that not only adapts to hot environmental conditions, but also eliminates the effects of heat generated by pigs. However, processing large amounts of fresh air on hot summer days will inevitably lead to put up in the energy consumption of the cooling system, so a high-quality cooling system must provide an appropriate balance between air quality and energy consumption (Hu *et al.*, 2023).

Since the body temperature of pigs is a homeostatic value, and their productive characteristics increase if they are kept in the temperature comfort zone (Gourdine *et al.*, 2021), then as soon as the environment becomes hot and humid, the thermoregulation mechanism is triggered in pigs: reducing feed intake, slowing down the growth rate, developing heat stress, which is harmful to health and even leads to death (Liu *et al.*, 2022; Niu *et al.*, 2024).

An important strategy for improving the efficiency of the pig industry is to research the features of behaviour indicators of different breeds and production groups of pigs, which allows explaining and predicting their functional manifestation, and improving performance responses in the conditions of industrial technology, as noted by J.L. Gourdine *et al.* (2021). From the search results available, it was found that the behaviour of boars remains insufficiently researched, especially depending on age, breed, season of year or type of ventilation, compared with the behaviour of lactating sows, rearing piglets, or fattening pigs. In addition, the process of learning about the behaviour of boars is complicated by significant differences in the ways of keeping them in both sustainable and industrial pig breeding. Currently, the legitimate way to keep boars is individual, since the group method often shows stereotypical and homosexual behaviour, and acute and chronic aggression (Haigh & O'driscoll, 2019). Since visualisation of the behaviour of boars is an important tool for obtaining the necessary information about the compliance of conditions of keeping with the biological needs of animals and, as a result, an indicator of ensuring the welfare of the latter, the purpose of the experiment was to establish the influence of age, season of year and type of ventilation system on the duration of behavioural acts of boars in the context of breeds and, as a result, the establishment of their behavioural patterns in industrial technology.

## Materials and Methods

Experimental studies were conducted during 2021-2023 at the Ukrainian breeding farm PrJSC "Plemzavod Stepnoy" Zaporizhzhia Region. In total, 18 boars of Large White, Landrace, and Duroc breeds were used in the experiment (Fig. 1).

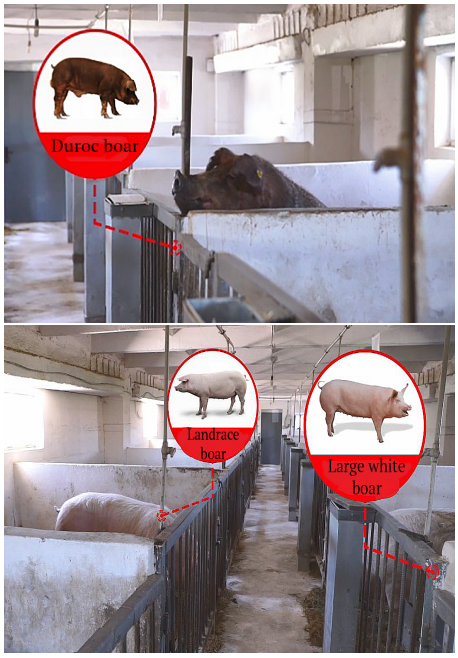


**Figure 1.** Breeds of boars kept on the farm
**Source:** photo by the authors

Boars were kept on bedding in individual pens with an area of 7 $m^2$, on a concrete floor with heat and moisture insulation. The boars of different breeds selected for the experiments were clinically healthy. The pigsty was equipped with forced transverse and geothermal ventilation with electronic control. Boars were fed individually with granulated complete mixed feed "Eber" at 2.8-3.0 kg of feed per animal/day with a nutritional value: crude protein content – 202,630 g/kg and metabolic energy of 12,406 MJ/kg. The composition of 1 kg of granulated feed produced by LLC "PC Alternativa" included the following ingredients (%): corn (20,000), wheat (18,355), wheat bran (25,000), soybean cake (22,645), sunflower meal (10,000), Aminomix Eber (4,000), (quality certificate according to the Technical Conditions DSTU 4508:2005). The feed was provided twice a day, at 8:00 am and 04:00 pm. The boars had constant access to drinking water from nipple drinkers. The microclimate parameters at the premises corresponded to Department Norms for Technological Design – Agro-Industrial Complex – 02.05 "Pig-breeding enterprises (complexes, farms, small farms)" (2005). The conditions of feeding, watering, keeping, care, prevention and treatment were in accordance with the European legislation on the protection of animals and their comfort (Council Directive 2008/120/EC (2008); Council Directive 2010/63/EC (2010) and Order of the Ministry for Development of Economy, Trade and Agriculture of Ukraine No. 224 (2021). The treatment of boars in the experiment fully met the requirements of bioethical standards for proper treatment of animals approved by the Bioethical Commission of the National University of Life and Environmental Sciences of Ukraine (007/2021).

A control group of boars with 3 animals of each breed was kept in the house by a transverse ventilation system with wall-mounted supply valves (1), wall-mounted exhaust fans (2), and an automated microclimate control system (3) (Fig. 2). Air entered the room through wall-mounted valves, and the speed of the exhaust fans and the opening of the valves were controlled by a computerised microclimate monitoring system.


1 2 3

**Figure 2.** Structural elements of transverse ventilation in the premises for boars of different breeds from the control group

**Source:** photo by the authors

The design features of the ventilation system (Fig. 3) in the house where the boars of the experimental group were kept, 3 animals of each breed, is the organisation of air circulation using a geothermal system: air inflow from the environment was carried out through an air intake shaft (1), then the air passed through an underground tunnel – air duct (2), where it was additionally heated in winter or cooled in summer due to soil energy before entering the house directly through the lower ventilation racks (3), which were evenly located near the

exhaust fans of the shafts that release air to the outside, and the functioning of the entire system was organised and controlled by a microclimate control device (4).

(1) (2) (3) (4)

**Figure 3.** Structural elements of geothermal ventilation in the premises for boars of different breeds from the experimental group

**Source:** photo by the authors

Both experimental groups of boars kept in house with different ventilation systems had identical construction, were made of the same building materials, and were equally spatially located relative to the prevailing wind rose. The number of cages in both buildings was the same, with an identical area and similar system for water and feed distribution, manure removal was carried out by horizontal TSN-3 conveyors and remote conveyors on tractor trailers.

During the experiment, the timing of behavioural acts of boars of different breeds was monitored using Full HD 1080p video recorders (with a maximum resolution of 1920x1080, 30 fps) with AVI recording format. In total, behavioural acts (rest, movement, food and water intake for 24 hours) were studied by visual observations in boars aged 6, 12, and 24 months of the following breeds: Large White, Landrace, Duroc. The assessment of behavioural acts of boars of each breed was measured in absolute terms as the number of minutes spent on the performance of a particular behavioural act during the day.

When analysing the influence of the age group, type of ventilation, and season of the year on the duration of rest, movement, and feed and water intake of pigs, the algorithm of three-factor variance analysis (with fixed factors) was used. In addition to the influence of the main factors, estimates of the variance ratio are also calculated for combinations of second-level factors ("age group" × "type of ventilation", "age group" × "season of the year", and "type of ventilation" × "season of the year"), and for combinations of third-level factors ("age group" × "type of ventilation" × "season of the year").

For each main factor and all their possible combinations, an estimate of the strength of the factor/combination influence was calculated ($h^2$) as the ratio of the corresponding sum of squares (*SS*) to the total sum of squares of the entire dispersion complex, expressed in %. Three-factor analysis of variance was performed separately for pigs of three breeds (Large White, Landrace, and Duroc). Group estimates of the arithmetic mean and its 95 confidence interval (95% CI) were also calculated for each combination of main factors. All calculations were performed using the *STATISTICA* software suite (*StatSoft Inc.*) based on the algorithms given in the manual (Kramarenko *et al.*, 2019).

## Results and Discussion

According to the conducted studies, it was found that in Large White boars, regardless of the type of ventilation, the duration of rest increases with age; although in winter the rest is shorter than in other periods of the year (Table 1).

***Table 1.*** *Duration of the main behaviour parameters of boars of the Large White breed, depending on age, season of the year, and type of ventilation, min* $\bar{X} \pm S_{\bar{x}}$

| Behaviour parameter | Transverse ventilation | | | | Geothermal ventilation | | | |
|---|---|---|---|---|---|---|---|---|
| | winter | spring | summer | autumn | winter | spring | summer | autumn |
| **6 months and older** | | | | | | | | |
| Rest | 837.5 ± 0.43 | 870.4 ± 1.30 | 856.5 ± 0.58 | 873.6 ± 0.38 | 864.9 ± 0.34 | 872.7 ± 0.87 | 879.5 ± 2.46 | 871.8 ± 0.61 |
| Movement | 516.3 ± 0.37 | 495.1 ± 0.37 | 510.0 ± 0.38 | 494.2 ± 1.00 | 496.3 ± 1.30 | 494.2 ± 0.91 | 484.3 ± 2.53 | 493.7 ± 3.13 |
| Feed and water intake | 86.4 ± 0.84 | 74.7 ± 0.98 | 73.6 ± 0.63 | 72.8 ± 0.48 | 78.9 ± 0.60 | 73.2 ± 1.17 | 76.4 ± 0.84 | 74.6 ± 1.66 |
| **12 months and older** | | | | | | | | |
| Rest | 855.6 ± 3.83 | 967.2 ± 2.05 | 1,024.8 ± 3.14 | 993.4 ± 1.76 | 946.4 ± 2.33 | 951.2 ± 1.25 | 1,010.5 ± 1.30 | 960.4 ± 2.07 |
| Movement | 501.8 ± 0.77 | 407.2 ± 2.24 | 361.4 ± 5.99 | 382.4 ± 5.90 | 432.4 ± 2.24 | 428.6 ± 0.57 | 380.7 ± 1.11 | 418.7 ± 1.61 |
| Feed and water intake | 82.9 ± 2.70 | 65.6 ± 1.65 | 53.8 ± 2.40 | 64.2 ± 1.31 | 61.2 ± 0.66 | 60.0 ± 0.40 | 48.8 ± 0.20 | 60.9 ± 0.74 |
| **24 months and older** | | | | | | | | |
| Rest | 935.4 ± 7.92 | 946.1 ± 7.10 | 1,048.3 ± 0.50 | 945.6 ± 1.01 | 980.5 ± 1.20 | 996.7 ± 0.69 | 1,026.1 ± 1.14 | 993.4 ± 0.77 |
| Movement | 436.2 ± 1.84 | 429.7 ± 2.16 | 345.3 ± 3.46 | 427.7 ± 1.84 | 392.3 ± 0.93 | 381.4 ± 1.27 | 365.8 ± 1.54 | 384.3 ± 3.39 |
| Feed and water intake | 68.4 ± 1.11 | 64.2 ± 1.29 | 46.4 ± 0.97 | 66.7 ± 0.48 | 67.2 ± 1.11 | 61.9 ± 0.55 | 48.1 ± 0.54 | 62.3 ± 0.73 |

**Source:** developed by the authors

Based on the obtained data, it was found that the complex of behavioural acts in boars visualises an age-related decrease movement from 15%, regardless of their breed, season of the year, and ventilation system in the premises. According to A. Lykhach *et al*. (2023), boars are characterised by a behavioural stereotypical feature that becomes quite long with age – the "position of sitting dog", which accounts for about 12% of their rest time. The results of the studies coincide with the conclusions of the US and French researchers – S.P. Parois *et al.* (2017), the object of their study was pregnant and lactating sows. These researchers note that the behavioural strategy for dealing with stress is to reduce overall movement, as a result of which lactating sows reduced standing and sitting from 18% to 11.6% of the time of day and increased, respectively, rest, and barren sows – spent time in a state of lying down to 70%. In the experiment, the longest rest period was recorded in boars aged 24 months and older with the use of a transverse ventilation system in summer, which is 72.8% of the time. Similar data was obtained by S. Rohrmann & S. Hoy (2005) in three sperm processing centres in Germany, where 78 boars rested 81.0% of the 24 hours.

The results of a three-factor analysis of variance indicate the presence of a significant (in all cases $P < 0.001$) influence of the main factors on the duration of rest (Table 2).

***Table 2.*** *Results of a three-factor dispersion analysis of the influence of the age group, type of ventilation, and season of the year on the duration of rest of Large White boars*

| Source of variance | SS | df | MS | F | P | $h^2$, % |
|---|---|---|---|---|---|---|
| Age (1) | 533,250.4 | 2 | 266,625.2 | 4,705.2 | < 0.001 | 65.7 |
| Ventilation (2) | 20,835.4 | 1 | 20,835.4 | 367.7 | < 0.001 | 2.6 |
| Season (3) | 125,575.9 | 3 | 41,858.6 | 738.7 | < 0.001 | 15.5 |
| 1×2 | 2,535.2 | 2 | 1,267.6 | 22.4 | < 0.001 | 0.3 |
| 1×3 | 72,001.6 | 6 | 12,000.3 | 211.8 | < 0.001 | 8.9 |
| 2×3 | 22,145.0 | 3 | 7,381.7 | 130.3 | < 0.001 | 2.7 |
| 1×2×3 | 25,202.2 | 6 | 4,200.4 | 74.1 | < 0.001 | 3.1 |
| Error | 9,519.8 | 168 | 56.7 | | | 1.2 |
| Total | 811,065.5 | 192 | | | | 100.0 |

**Notes:** SS – sum of squares of deviations; df – number of degrees of freedom; MS – middle square; F – variance ratio; R – probability level; h2 – the strength of the factor's influence

**Source:** developed by the authors

The most significant impact on the duration of rest was observed for the indicators age (65.7%) and the season of the year (15.5%), while the impact of the type of ventilation was the lowest (2.6%). Among the combinations of factors of the first and third levels, the highest strength of influence, as might be expected, was noted for the combination "age group" × "season of the year" (8.9%). On the other hand, quite a significant influence was recorded for the combination of all three main factors, that is, "age group" × "type of ventilation" × "season of the year" (3.1%), and for the combination "type of ventilation" × "season of the year" (2.7%). The results of three-factor analysis of variance indicate the presence of a significant (in all cases $P < 0.001$) influence of the main factors on the duration of movement (Table 3).

***Table 3.*** *Results of a three-factor dispersion analysis of the influence of the age group, type of ventilation, and season of the year on the duration of movement of Large White boars*

| Source of variance | SS | df | MS | F | P | $h^2$, % |
|---|---|---|---|---|---|---|
| Age (1) | 382,542.9 | 2 | 191,271.4 | 3,946.7 | < 0.001 | 68.0 |
| Ventilation (2) | 7,989.0 | 1 | 7,989.0 | 164.8 | < 0.001 | 1.4 |
| Season (3) | 72,542.4 | 3 | 24,180.8 | 499.0 | < 0.001 | 12.9 |
| 1×2 | 7,558.3 | 2 | 3,779.1 | 78.0 | < 0.001 | 1.3 |
| 1×3 | 41,367.2 | 6 | 6,894.5 | 142.3 | < 0.001 | 7.3 |
| 2×3 | 17,091.6 | 3 | 5,697.2 | 117.6 | < 0.001 | 3.0 |
| 1×2×3 | 25,739.5 | 6 | 4,289.9 | 88.5 | < 0.001 | 4.6 |
| Error | 8,141.8 | 168 | 48.5 | | | 1.4 |
| Total | 562,972.6 | 192 | | | | 100.0 |

**Source:** developed by the authors

As with the duration of rest, the most significant effects on the duration of movement were observed for the age group (68.0%) and season (12.9%), while the effect of ventilation type was relatively low (1.4%). Among the combinations of factors, the highest influence on the duration of movement was registered for the combination "age group" × "season of the year" (7.3%). On the other hand, a fairly significant influence was observed for the combination of all three main factors, i.e.: "age group" × "type of ventilation" × "season of the year" (4.6%), and for the combination "type of ventilation" × "season of the year" (3.0%). The results of a three-factor analysis of variance indicate the presence of a significant (in all cases $P < 0.001$) influence of the main factors on the duration of feed and water intake (Table 4).

***Table 4.*** *Results of a three-factor dispersion analysis of the influence of the age group, type of ventilation, and season of the year on the duration of feed and water intake of Large White boars*

| Source of variance | SS | df | MS | F | P | $h^2$, % |
|---|---|---|---|---|---|---|
| Age (1) | 13,861.4 | 2 | 6,930.7 | 669.8 | < 0.001 | 49.7 |
| Ventilation (2) | 491.2 | 1 | 491.2 | 47.5 | < 0.001 | 1.8 |
| Season (3) | 7,217.7 | 3 | 2,405.9 | 232.5 | < 0.001 | 25.9 |
| 1×2 | 7,84.4 | 2 | 392.2 | 37.9 | < 0.001 | 2.8 |
| 1×3 | 2,538.6 | 6 | 423.1 | 40.9 | < 0.001 | 9.1 |
| 2×3 | 869.8 | 3 | 289.9 | 28.0 | < 0.001 | 3.1 |
| 1×2×3 | 377.1 | 6 | 62.8 | 6.1 | < 0.001 | 1.4 |
| Error | 1,738.4 | 168 | 10.3 | | | 6.2 |
| Total | 27,878.7 | 192 | | | | 100.0 |

**Source:** developed by the authors

As with the duration of rest and the duration of movement, the most significant effect on the duration of feed and water intake was observed for the age group (49.7%) and the season of the year (25.9%), while the effect of the type of ventilation was also very low (1.8%). Among the combinations of factors, the highest strength of influence on the duration of feed and water intake was registered for the combination "age group" × "season of the year" (9.1%). On the other hand, quite a significant influence was noted for the combination of factors "type of ventilation" × "season of the year" (3.1%) and "age group" × "type of ventilation" (2.8%).

Thus, the greatest influence on the duration of various behaviour parameters of Large White boars was noted for the main factor "age group". Its role in determining the duration of rest or movement was significantly higher than for the duration of feed and water intake. In the second place, according to the proportion of variability on the duration of various behaviour indicators of Large White boars, was the influence of the main factor "season of the year". However, the opposite situation was established here – its effect on the duration of feed and water intake was almost twice as high as on the duration of rest or movement. As for the combination of factors, the greatest impact was observed either for the combinations "type of ventilation" × "season of the year" and "age group" × "type of ventilation" × "season of the year" (for the duration of rest and movement), or for combinations "age group" × "season of the year", "type of ventilation" × "season of the year" and "age group" × "type of ventilation" (for the duration of feed and water intake).

Considering the estimates of the arithmetic mean ( ± 95% CI) of the duration of rest in different groups of Large White boars, depending on the age group, type of ventilation, and season of the year, the following patterns can be noted. At the age of 6 months and older, for Large White boars, the duration of rest for geothermal ventilation almost did not differ in different seasons of the year, while for transverse ventilation it was the same in spring and autumn, but differed significantly from the estimates for winter and summer.

The duration of rest increased in animals aged 12 and 24 months. An increase in the duration of rest at the age of 12 months for geothermal ventilation was noted for animals in summer and autumn. With the transverse type of ventilation, boars of the same breed had an increase in the duration of rest – in summer and autumn. For animals aged 24 months, two patterns of dependence of the duration of rest on the type of ventilation were established. The first pattern was observed during the autumn-winter-spring period of the year, but boars spent more time resting in premises with geothermal ventilation than during transverse ventilation. The second pattern was observed for animals of the same breed in summer, since for them the duration of rest, on the contrary, was significantly higher with transverse ventilation than with geothermal ventilation.

The duration of movement at the age of 6 months for Large White boars did not differ much in different seasons of the year with geothermal ventilation. But with the transverse type of ventilation, it grew – in summer and winter. Overall, movement duration was significantly reduced in animals aged 12 and 24 months. At the age of 12 months, it was highest in the autumn-winter-spring period of the year and significantly lower in the summer with geothermal ventilation. With transverse ventilation, the duration of movement increased significantly for animals in winter, but decreased almost proportionally in spring, summer, and autumn. For boars aged 24 months, two patterns of dependence of the duration of movement on the type of ventilation were also established. The first pattern was observed during the autumn-winter-spring period of the year, but for geothermal ventilation, this behavioural act was significantly reduced compared to the transverse type of ventilation. The second pattern was observed for boars in summer, where the duration of movement, on the contrary, was significantly higher with geothermal ventilation than with transverse ventilation.

For boars aged 6 months, the duration of feed and water intake almost did not differ in different seasons of the year, both with geothermal ventilation and with transverse ventilation. With the exception of the winter season, when this behaviour was significantly higher with transverse ventilation type. Overall, the duration of feed and water intake decreased in animals aged 12 and 24 months. At the age of 12 months, the duration of feed and water intake was almost the same in spring and autumn for both types of ventilation systems. In winter, the duration of feed and water intake was significantly higher with transverse ventilation, and in summer, this behaviour parameter was the lowest with both geothermal ventilation and transverse ventilation, although it tended to increase with transverse ventilation. At the age of 24 months, the duration of feed and water intake was lowest in summer and autumn and was the same for both geothermal and transverse ventilation. In spring, the duration of this behaviour was higher, and in winter even higher, however, the duration of feed and water intake of boars in these seasons also did not differ with different types of ventilation.

It is worth noting that a similar analysis of variance was performed by S.V. Zhyzhka (2021) in the dissertation paper on the reproductive qualities of sows in conventional ventilation and negative pressure air supply in different seasons of the year. Thus, the researcher established the probable strength of the influence

of the indoor ventilation system on the number of piglets at weaning by 3.38% ($P < 0.05$), the weight of the piglets' nest at weaning by 5.95% ($P < 0.01$), and the absence of this factor on number and weight of piglets. The season of year factor had a significant effect on nest weight at weaning 26.58% ($P < 0.001$), sow multiple fertility 3.47% ($P < 0.01$), number of piglets at weaning 2.38% ($P < 0.01$), and piglet survival before weaning 1.87% ($P < 0.05$). The significant influence of this factor on the size of piglets has not been established. The interaction of these factors had little effect on the weight of the piglets' nest at weaning.

The time spent on parameters of the behaviour of boars of the Landrace breed, depending on age, season of the year and type of ventilation, is shown in Table 5. The results of the behavioural range of boars of the Landrace breed indicate that the predominant behaviour in terms of duration and frequency in this breed, as well as Large White and Duroc breeds, is a stationary state, which is visualised at pig farms as behaviour in a state of rest. However, in the course of observation, it was noticed that boars of the Landrace breed, differing in a more excitable type of higher nervous activity when kept with a transverse type of air ventilation, spent up to 3% ($P < 0.95$) of the time on stereotypical behaviour, which manifested itself in the form of head banging and licking the cage grate, especially in the hot summer and autumn, which is consistent with the study by I. Petak *et al*. (2010), identified a similar phenomenon from 13 studied behavioural complexes of sire boars. J.W. Ross *et al.* (2015) suggest that this behaviour of pigs is a consequence of heat stress, where extreme heat in the summer months of the year is likely to affect both pork production and welfare of pigs. According to V. Miclea *et al.* (2016), the behavioural complex of boars has a significant impact on their sperm production. Most animals without heat stress showed stable sexual reflexes, and they were awarded 5 points. In turn, ejaculates were collected from the same boars twice a week in the spring for two years and it was noted that ejaculates were characterised by age and breed-appropriate volume, concentration and mobility, and could be processed into the largest number of doses for insemination. This had an obvious positive economic effect. However, the researchers found that age affected the quality of ejaculate in young boars, with the exception of a few animals that had reduced sexual reflexes.

***Table 5.*** *Duration of the main behaviour parameters of boars of the Landrace breed, depending on age, season of the year, and type of ventilation, min* $\bar{X} \pm S_{\bar{x}}$

| Behaviour parameter | Transverse ventilation | | | | Geothermal ventilation | | | |
|---|---|---|---|---|---|---|---|---|
| | winter | spring | summer | autumn | winter | spring | summer | autumn |
| **6 months and older** | | | | | | | | |
| Rest | 832.4 ± 1.71 | 868.9 ± 0.93 | 904.3 ± 7.18 | 871.3 ± 1.41 | 896.3 ± 7.02 | 873.3 ± 0.82 | 900.4 ± 7.80 | 875.3 ± 2.33 |
| Movement | 517.6 ± 0.57 | 498.2 ± 9.09 | 442.8 ± 5.57 | 493.8 ± 1.31 | 469.8 ± 3.00 | 495.6 ± 0.40 | 466.8 ± 7.45 | 494.5 ± 1.93 |
| Feed and water intake | 90.1 ± 0.41 | 72.9 ± 0.67 | 92.9 ± 0.23 | 74.9 ± 0.30 | 73.9 ± 1.35 | 71.1 ± 0.56 | 72.8 ± 1.08 | 70.2 ± 0.40 |
| **12 months and older** | | | | | | | | |
| Rest | 862.2 ± 4.87 | 898.6 ± 16.27 | 1,021.4 ± 0.90 | 929.3 ± 10.61 | 929.3 ± 10.61 | 939.8 ± 3.98 | 967.5 ± 6.67 | 965.4 ± 1.99 |
| Movement | 498.9 ± 0.69 | 475.6 ± 8.47 | 366.5 ± 4.37 | 449.1 ± 7.29 | 436.4 ± 1.87 | 418.3 ± 3.08 | 408.9 ± 4.03 | 414.5 ± 1.01 |
| Feed and water intake | 78.9 ± 1.25 | 65.8 ± 1.60 | 52.1 ± 2.09 | 61.6 ± 1.04 | 65.6 ± 1.18 | 54.2 ± 1.03 | 58.4 ± 0.25 | 60.1 ± 0.61 |

Table 5. Continued

| Behaviour parameter | Transverse ventilation | | | | Geothermal ventilation | | | |
|---|---|---|---|---|---|---|---|---|
| | winter | spring | summer | autumn | winter | spring | summer | autumn |
| | 24 months and older | | | | | | | |
| Rest | 934.8 ± 7.64 | 954.6 ± 5.47 | 1,010.1 ± 0.44 | 956.4 ± 4.15 | 938.6 ± 8.38 | 965.1 ± 9.20 | 1,021.0 ± 2.01 | 951.3 ± 10.02 |
| Movement | 446.8 ± 4.58 | 429.3 ± 2.17 | 380.0 ± 5.20 | 431.8 ± 1.31 | 442.3 ±v11.96 | 414.5 ± 4.87 | 369.8 ± 1.95 | 410.7 ± 5.16 |
| Feed and water intake | 58.4 ± 0.97 | 56.4 ± 1.35 | 49.8 ± 1.06 | 51.8 ± 1.19 | 59.1 ± 0.77 | 60.4 ± 1.22 | 49.2 ± 0.67 | 67.0 ± 1.59 |

**Source:** developed by the authors

The results of the three-factor analysis of variance indicate the presence of a significant (in all cases: $P < 0.001$) influence of the main factors on the duration of rest (Table 6).

***Table 6.*** *Results of a three-factor variance analysis of the influence of age group, type of ventilation, and season of the year on the duration of rest of Landrace boars*

| Source of variance | *SS* | *df* | *MS* | *F* | *P* | $h^2$, % |
|---|---|---|---|---|---|---|
| Age (1) | 27,3483.6 | 2 | 136,741.8 | 368.7 | < 0.001 | 49.1 |
| Ventilation (2) | 16,474.3 | 1 | 16,474.3 | 44.4 | < 0.001 | 3.0 |
| Season (3) | 129,346.5 | 3 | 43,115.5 | 116.3 | < 0.001 | 23.2 |
| 1×2 | 6,512.0 | 2 | 3,256.0 | 8.8 | < 0.001 | 1.2 |
| 1×3 | 16,872.9 | 6 | 2,812.1 | 7.6 | < 0.001 | 3.0 |
| 2×3 | 25,016.1 | 3 | 8,338.7 | 22.5 | < 0.001 | 4.5 |
| 1×2×3 | 27,408.6 | 6 | 4,568.1 | 12.3 | < 0.001 | 4.9 |
| Error | 62,302.1 | 168 | 370.8 | | | 11.2 |
| Total | 557,416.1 | 192 | | | | 100.0 |

**Source:** developed by the authors

The most significant effect on rest duration was observed for the age group (49.1%) and season of the year (23.2%), while the effect of ventilation type was the lowest (3.0%). Among the combinations of factors of the second and third levels, the highest strength of influence was noted for the combination "age group" × "type of ventilation" × "season of the year" (4.9%), and "type of ventilation" × "season of the year" (4.5%).

The results of three-factor analysis of variance indicate the presence of a significant (in all cases: $P < 0.001$) influence of the main factors on the duration of movement (Table 7).

***Table 7.*** *Results of a three-factor variance analysis of the influence of age group, type of ventilation, and season of the year on the duration of movement of Landrace pigs*

| Source of variance | *SS* | *df* | *MS* | *F* | *P* | $h^2$, % |
|---|---|---|---|---|---|---|
| Age (1) | 165,723.5 | 2 | 82,861.7 | 407.1 | < 0.001 | 44.7 |
| Ventilation (2) | 12,034.9 | 1 | 12,034.9 | 59.1 | < 0.001 | 3.2 |
| Season (3) | 105,796.7 | 3 | 35,265.6 | 173.3 | < 0.001 | 28.5 |
| 1×2 | 4,132.5 | 2 | 2,066.3 | 10.2 | < 0.001 | 1.1 |
| 1×3 | 8,966.4 | 6 | 1,494.4 | 7.3 | < 0.001 | 2.4 |
| 2×3 | 21,805.4 | 3 | 7,268.5 | 35.7 | < 0.001 | 5.9 |
| 1×2×3 | 18,363.1 | 6 | 3,060.5 | 15.0 | < 0.001 | 4.9 |

Table 7. Continued

| Source of variance | *SS* | *df* | *MS* | *F* | *P* | $h^2$, % |
|---|---|---|---|---|---|---|
| Error | 34,191.4 | 168 | 203.5 | | | 9.2 |
| Total | 371,013.8 | 192 | | | | 100.0 |

**Source:** developed by the authors

Similarly, as with respect to the duration of rest, the most significant effect on the duration of movement was observed for the age group (44.7%) and the season of the year (28.5%), and the influence of the type of ventilation was low (3.2%). Among the combinations of factors of the second and third levels, the highest strength of influence on the duration of movement of boars of the Landrace breed, and in the previous case, was noted for the combination of "age group" × "type of ventilation" × "season of the year" (4.9%) and "type of ventilation" × "season of the year" (5.9%). The results of a three-factor analysis of variance indicate the presence of a significant (in all cases: $P < 0.001$) influence of the main factors on feed and water intake (Table 8).

***Table 8.*** *Results of a three-factor dispersion analysis of the influence of the age group, type of ventilation, and season of the year on the duration of feed and water intake of Landrace boars*

| Source of variance | *SS* | *df* | *MS* | *F* | *P* | $h^2$, % |
|---|---|---|---|---|---|---|
| Age (1) | 14,892.1 | 2 | 7,446.1 | 826.2 | < 0.001 | 55.7 |
| Ventilation (2) | 632.2 | 1 | 632.2 | 70.2 | < 0.001 | 2.4 |
| Season (3) | 2,123.0 | 3 | 707.7 | 78.5 | < 0.001 | 7.9 |
| 1×2 | 1,980.2 | 2 | 990.1 | 109.9 | < 0.001 | 7.4 |
| 1×3 | 3,056.1 | 6 | 509.3 | 56.5 | < 0.001 | 11.4 |
| 2×3 | 969.9 | 3 | 323.3 | 35.9 | < 0.001 | 3.6 |
| 1×2×3 | 1,589.7 | 6 | 265.0 | 29.4 | < 0.001 | 5.9 |
| Error | 1,514.0 | 168 | 9.0 | | | 5.7 |
| Total | 26,757.1 | 192 | | | | 100.0 |

**Source:** developed by the authors

As with the duration of rest and duration of movement, the most significant effect on the duration of feed and water intake was observed for the age group (55.7%). But the assessment of the strength of the influence of the season of the year was significantly lower than for the previous two behaviour indicators of Landrace pigs (7.9%). The effect of the type of ventilation was also relatively low (2.4%). Among the combinations of factors, the highest strength of influence on the duration of movement was recorded for the combination "age group" × "season of the year" (11.4%) and "age group" × "type of ventilation" (7.4%).

Consequently, the greatest influence on the duration of various behaviour parameters of Landrace boars was observed for the main factor "age group". Its role in determining the duration of rest or movement, in contrast to other boars of the Large White breed, was lower than for the duration of feed and water intake. In the second place, according to the proportion of variability on the duration of various indicators of boar behaviour, was the influence of the main factor "season of the year". But here the opposite situation was established – its effect on the duration of feed and water intake of Landrace boars was significantly lower than on the duration of rest or movement. As for the combination of factors, the greatest influence was observed for the "type of ventilation" combinations × "season of the year" (for the duration of rest and movement), and for "age group" × "season of the year" and "age group" × "type of

ventilation" (for the duration of feed and water intake). Ultimately, for all behaviour indicators of Landrace boars, a significant influence was also noted for the combination of third-level factors, that is, "age group" × "type of ventilation" × "season of the year".

Estimation of the arithmetic mean (± 95% CI) of the duration of rest in different groups of boars of this breed depending on the age group, type of ventilation, and season of the year shows that at the age of 6 months for Landrace animals, the duration of rest with geothermal ventilation was almost the same in different seasons of the year, while with the transverse type of ventilation the highest estimates of this behavioural trait were obtained for the summer season, slightly lower – in spring and autumn, and finally the shortest duration of rest was observed in winter. A significant influence of the type of ventilation on the duration of rest was noted only in winter. Overall, the duration of rest increased in animals aged 12 and 24 months. At the age of 12 months, for Landrace animals, the duration of summer rest with transverse ventilation significantly increased compared to geothermal ventilation, while during the remaining seasons of the year, on the contrary, it significantly decreased. Especially, this decline was also noted in winter. At the age of 24 months, during the autumn-winter-spring period, the duration of rest of boars did not significantly differ, while during the summer season it was significantly higher, but, again, did not depend on the type of ventilation.

An estimate of the arithmetic mean (± 95% CI) duration of movement in different groups of Landrace boars, depending on the age group, type of ventilation and season of the year, indicates that at the age of 6 months, the duration of movement did not significantly differ in spring and autumn with both geothermal and transverse ventilation. Overall, movement duration tended to decrease in animals aged 12 and 24 months. At the age of 12 months, the duration of movement of boars of this breed was almost the same in different seasons of the year with geothermal ventilation. Although in winter it was still slightly higher than in summer. But with transverse ventilation, the duration of movement of Landrace pigs significantly increased during all seasons of the year, except for summer. At the age of 24 months, the duration of movement was almost independent of the type of ventilation, and to a greater extent depended on the season of the year. It was lowest in summer, grew during the spring and autumn seasons, and peaked in winter.

Estimation of arithmetic means (± 95% CI) of the duration of feed and water intake in different groups of Landrace boars depending on age group, type of ventilation and season of the year shows that at the age of 6 months the duration of this behaviour was the same among Landrace boars in all seasons of the year with geothermal ventilation. While with transverse ventilation, it increased significantly in winter and summer, or, conversely, remained unchanged during spring or autumn. Overall, the duration of feed and water intake tended to decrease in animals aged 12 and 24 months. At the age of 12 months, with geothermal ventilation, the duration of feed and water intake in boars was greatest in winter. With transverse ventilation, on the contrary, there was a significant off-season differentiation in the duration of feed and water intake; it was lowest in animals during the summer, highest in spring and autumn, and finally reached its maximum in winter. The significant influence of the type of ventilation was observed in all seasons of the year, except autumn. At the age of 24 months, the duration of feed intake during the summer season was lowest with both types of ventilation. Significant differences for boars kept under different types of ventilation were observed in the autumn: with geothermal ventilation, the duration of feed and water intake in this season was the highest, while with transverse ventilation – as low as in summer. The type of ventilation did not affect the duration of feed

and water intake of Landrace boars in winter and did not significantly affect them in autumn.

The study by M.B. Shpetnyi (2019) is somewhat consistent with the conducted experiments, and according to the results of the analysis of variance, it was found that the main economic useful features were significantly affected by the type of lattice floor in the piglet rearing machine – 9.7-13.6%, while the time of year affected the same features by 3.5-5.6%, and their combined interaction by 2.9-4.9%. The time spent on behaviour parameters of boars of the Duroc breed, depending on age, season of the year and type of ventilation, is shown in Table 9.

***Table 9.*** *Duration of the main behaviour parameters of boars of the Duroc breed, depending on age, season of the year, and type of ventilation, min* $\bar{X} \pm S_{\bar{x}}$

| Behaviour parameter | Transverse ventilation | | | | Geothermal ventilation | | | |
|---|---|---|---|---|---|---|---|---|
| | winter | spring | summer | autumn | winter | spring | summer | autumn |
| **6 months and older** | | | | | | | | |
| Rest | 905.3 ± 1.10 | 911.2 ± 1.48 | 976.4 ± 5.51 | 966.2 ± 1.91 | 926.1 ± 0.64 | 937.7 ± 1.10 | 949.2 ± 6.78 | 940.1 ± 3.66 |
| Movement | 472.3 ± 5.96 | 468.2 ± 4.21 | 408.4 ± 0.96 | 414.2 ± 0.97 | 453.2 ± 5.66 | 453.1 ± 3.38 | 443.1 ± 3.66 | 441.1 ± 1.88 |
| Feed and water intake | 62.12 ± 0.55 | 60.0 ± 0.46 | 55.9 ± 0.99 | 59.5 ± 0.89 | 60.5 ± 0.50 | 59.1 ± 0.52 | 57.9 ± 0.52 | 58.9 ± 0.35 |
| **12 months and older** | | | | | | | | |
| Rest | 862.6 ± 4.83 | 922.5 ± 9.38 | 1,069.4 ± 4.84 | 984.4 ± 2.76 | 964.9 ± 5.91 | 960.4 ± 3.91 | 985.2 ± 7.12 | 966.7 ± 1.66 |
| Movement | 489.2 ± 2.29 | 442.8 ± 8.80 | 327.9 ± 6.40 | 396.8 ± 2.46 | 406.7 ± 0.93 | 414.3 ± 1.42 | 400.0 ± 3.14 | 416.9 ± 0.97 |
| Feed and water intake | 88.3 ± 0.90 | 74.3 ± 0.59 | 42.0 ± 0.65 | 58.6 ± 0.50 | 68.3 ± 0.25 | 65.4 ± 0.82 | 52.9 ± 0.72 | 56.0 ± 0.46 |
| **24 months and older** | | | | | | | | |
| Rest | 1,065.8 ± 2.94 | 1,064.5 ± 1.23 | 1,100.7 ± 2.97 | 1,072.6 ± 2.01 | 1,068.6 ± 8.38 | 1,049.6 ± 0.71 | 1,050.3 ± 6.79 | 1,042.1 ± 1.54 |
| Movement | 342.9 ± 7.71 | 337.5 ± 4.28 | 319.0 ± 4.04 | 332.5 ± 3.46 | 334.6 ± 4.04 | 354.1 ± 6.45 | 359.0 ± 4.82 | 364.8 ± 6.82 |
| Feed and water intake | 31.0 ± 0.33 | 38.8 ± 1.22 | 20.4 ± 0.26 | 35.3 ± 1.29 | 36.5 ± 0.42 | 35.0 ± 0.53 | 30.4 ± 0.38 | 33.4 ± 0.50 |

**Source:** developed by the authors

Visualisation of behavioural acts of Duroc boars depending on the season of the year and the type of ventilation parameters that in animals aged 24 months, the duration of time for rest ranged from 72.3% to 76.4%, considering the phlegmatic temper of representatives of this breed. During rest, the animals lay on their sides, stomachs, with their eyes closed, sometimes not responding to any indifferent stimuli in the house where they were kept, especially in the hot season. Such indifference, according to D.M. Broom & A. Fraser (2007) refers to abnormal apathetic behaviour, which in this study was observed in boars of the Duroc breed with a transverse air ventilation system. In addition, boars of this breed showed stereotypical behaviour in the form of jumping on the cage grid – up to 1% (Fig. 1) and the "position of sitting dog" – 2% ($P < 0.95$), which is consistent with the experiments conducted by I. Petak *et al*. (2010) and in their case, this figure was 3% ($P < 0.99$).

The results of a three-factor analysis of variance indicate the presence of a significant ($P \leq 0.001...0.003$) influence of the main factors on the duration of rest (Table 10).

***Table 10.*** *Results of a three-factor dispersion analysis of the influence of the age group, type of ventilation and season of the year on the duration of rest of Duroc boars*

| Source of variance | *SS* | *df* | *MS* | *F* | *P* | $h^2$ |
|---|---|---|---|---|---|---|
| Age (1) | 560,717.4 | 2 | 280,358.7 | 2,013.2 | < 0.001 | 67.6 |
| Ventilation (2) | 1,233.7 | 1 | 1,233.7 | 8.9 | 0.003 | 0.1 |
| Season (3) | 90,471.7 | 3 | 30,157.2 | 216.6 | < 0.001 | 10.9 |
| 1×2 | 8,933.9 | 2 | 4,467.0 | 32.1 | < 0.001 | 1.1 |
| 1×3 | 52,316.7 | 6 | 8,719.4 | 62.6 | < 0.001 | 6.3 |
| 2×3 | 65,405.7 | 3 | 21,801.9 | 156.6 | < 0.001 | 7.9 |
| 1×2×3 | 26,650.5 | 6 | 4441.7 | 31.9 | < 0.001 | 3.2 |
| Error | 23,395.3 | 168 | 139.3 | | | 2.8 |
| Total | 829,124.9 | 192 | | | | 100.0 |

**Source:** developed by the authors

The most significant effect on the duration of rest for Duroc boars was observed for the age group (67.6%) and the season of the year (10.9%), while the influence of the type of ventilation was very low (0.1%). Among the combinations of factors of the second level, the highest strength of impact was noted for the combinations "type of ventilation" × "season of the year" (7.9%) and "age group" × "season of the year" (6.3%). The results of three-factor analysis of variance indicate the presence of a significant (in all cases: $P < 0.001$) influence of the main factors on the duration of movement (Table 11).

***Table 11.*** *Results of a three-factor dispersion analysis of the influence of age group, type of ventilation, and season of the year on the duration of movement of Duroc boars*

| Source of variance | *SS* | *df* | *MS* | *F* | *P* | $h^2$ |
|---|---|---|---|---|---|---|
| Age (1) | 341,522.3 | 2 | 170,761.1 | 1081.0 | < 0.001 | 64.9 |
| Ventilation (2) | 2,653.0 | 1 | 2,653.0 | 16.8 | < 0.001 | 0.5 |
| Season (3) | 48,134.6 | 3 | 16,044.9 | 101.6 | < 0.001 | 9.1 |
| 1×2 | 4951.9 | 2 | 2,476.0 | 15.7 | < 0.001 | 0.9 |
| 1×3 | 35,051.4 | 6 | 5,841.9 | 37.0 | < 0.001 | 6.7 |
| 2×3 | 51,467.6 | 3 | 17,155.9 | 108.6 | < 0.001 | 9.8 |
| 1×2×3 | 15,771.8 | 6 | 2,628.6 | 16.6 | < 0.001 | 3.0 |
| Error | 26,538.6 | 168 | 158.0 | | | 5.0 |
| Total | 526,091.2 | 192 | | | | 100.0 |

**Source:** developed by the authors

As with the duration of rest, the most significant effect on the duration of movement of Duroc boars was observed for the age group (64.9%) and the season of the year (9.1%), while the influence of the type of ventilation was significantly low (0.5%). Among the combinations of factors of the second level, the highest force of influence on the duration of movement was also registered for the combinations "type of ventilation" × "season of the year" (9.8%) and "age group" × "season of the year" (6.7%). The results of a three-factor analysis of variance indicate the presence of a probable (in all cases: $P < 0.001$) influence of the main factors on the duration of feed and water intake (Table 12).

***Table 12.*** *Results of a three-factor dispersion analysis of the influence of the age group, type of ventilation, and season of the year on the duration of feed and water intake of Duroc boars*

| Source of variance | *SS* | *df* | *MS* | *F* | *P* | $h^2$, % |
|---|---|---|---|---|---|---|
| Age (1) | 35,502.9 | 2 | 17,751.4 | 4,986.0 | < 0.001 | 71.9 |
| Ventilation (2) | 47.0 | 1 | 47.0 | 13.2 | < 0.001 | 0.1 |
| Season (3) | 5,974.2 | 3 | 1,991.4 | 559.3 | < 0.001 | 12.1 |
| 1×2 | 477.2 | 2 | 238.6 | 67.0 | < 0.001 | 1.0 |
| 1×3 | 4,234.9 | 6 | 705.8 | 198.2 | < 0.001 | 8.6 |
| 2×3 | 1,275.4 | 3 | 425.1 | 119.4 | < 0.001 | 2.6 |
| 1×2×3 | 1,238.6 | 6 | 206.4 | 58.0 | < 0.001 | 2.5 |
| Error | 598.1 | 168 | 3.6 | | | 1.2 |
| Total | 49,348.3 | 192 | | | | 100.0 |

**Source:** developed by the authors

As with rest and movement time, the most significant effect on feed and water intake for Duroc boars was observed for age group (71.9%) and season (12.1%), while the effect of ventilation type was also very low (0.1%). Among the combinations of the second-level factors, the highest strength of influence on the duration of feed and water intake of Duroc boars was observed for the combination "age group" × "season of the year" (8.6%).

Thus, the greatest influence on the duration of various behaviour indicators of Duroc pigs was noted for the main factor "age group". Its role in determining the duration of feed and water intake was higher than for the duration of rest and movement. The season of the year to the greatest extent determined the variability of the duration of feed and water intake. The combination of factors "age group" × "season of the year" played an important role in shaping the duration of all behaviour indicators of Duroc boars, while the combination "type of ventilation" × "season of the year" was essential for determining the length of rest and movement. Ultimately, the combination of all three factors under study also influenced the development of behavioural responses of Duroc boars in this experiment. According to A. Lopez Rodriguez *et al.* (2017), the change in the indicators of various forms of behaviour of boars, which is genetically determined, is influenced by the design features of the pen, seasonal effects, indoor microclimate, age, and especially elevated temperature (heat stress), increasing to 34.5°C within 8 hours and 31°C – 16 hours daily for 90 days provoked low movement, increased rest, and also reduced fertility compared to a similar group of boars kept at 23°C.

An estimate of the arithmetic mean (± 95% CI) duration of rest indicates that at the age of 6 months in boars in summer and autumn with transverse ventilation, this indicator was higher with the transverse type of ventilation, and, on the contrary, lower in winter and spring than with the geothermal type. In general, the duration of rest increased in animals at the age of 12 and, especially, at the age of 24 months. At the age of 12 months, the highest duration of rest with transverse ventilation was observed during the summer season and significantly decreased during the autumn, spring and winter seasons, respectively. The difference between different seasons of the year in terms of the duration of rest was probable and this range of off-season variability was about 200 minutes. The type of ventilation (geothermal or transverse) did not affect the duration of rest only during the autumn. At the age of 24 months, the probable effect of the type of ventilation was observed only during the summer – with transverse ventilation, the duration of rest was significantly higher than with geothermal ventilation.

An estimate of the arithmetic mean (± 95% CI) of the duration of movement indicates that

at 6 months of age in the summer and autumn, with transverse ventilation, this behaviour parameter was lower, and in the winter and spring, on the contrary, higher than with geothermal ventilation. Overall, the duration of movement decreased in animals at the age of 12 and, especially, at the age of 24 months. At the age of 12 months, the highest duration of movement with transverse ventilation was observed during the winter, while this feature took lower values during the spring, autumn, and summer seasons, respectively. The difference between different seasons of the year in terms of movement duration was significant and this range was almost 160 minutes. Ultimately, the type of ventilation (geothermal or transverse) had little effect on the duration of movement only during the autumn; for the remaining seasons, the differences between different types of ventilation were very pronounced. At the age of 24 months, the duration of boars' movement did not depend on the type of ventilation during the winter and spring. While, during the summer and autumn, their duration of movement significantly decreased with transverse ventilation type.

Estimates of the arithmetic mean (± 95% CI) of the duration of feed and water intake at the age of 6 months indicate that neither the type of ventilation nor the season of the year affected this behaviour. At the age of 12 months, these indicators were slightly higher, and at the age of 24 months, on the contrary, significantly lower than at the age of 6 months. At the age of 12 months, the highest duration of feed and water intake with transverse ventilation was observed during the winter, and this trait took lower values during the spring, autumn, and summer seasons, respectively. The difference between seasons of the year in terms of the duration of feed and water intake was significant and its range between seasons was almost 50 minutes. The type of ventilation (geothermal and transverse) did not affect the duration of feed and water intake, again, only during the autumn. At the age of 24 months, the duration of boars' feed and water intake with geothermal ventilation was almost the same throughout all seasons of the year, although it differed significantly between the winter and summer. With transverse ventilation, the duration of feed and water intake was almost the same. The duration of this type of behaviour of Duroc boars was significantly lower only during the summer. Based on the conducted experiment, models of behaviour of boars of three breeds were established depending on the age group, season of the year, and type of ventilation, which in the conditions of industrial pig breeding will increase the reserves of ethological strategies to put up performance responses, introduce methods for assessing welfare, and their integration into production.

## Conclusions

Based on the results of the experiment in the conditions of an industrial pork production enterprise, behavioural patterns of boars in the context of breeds depending on the age, season of the year, and type of ventilation were established. Thus, the duration of rest is significant ($P < 0.001$) influenced by: in boars of the Large White breed, 65.7% – age, 15.5% – season of the year, 2.6% – type of ventilation; in boars of the Landrace breed, 49.1% – age, 23.2% – season of the year, 3.0% – type of ventilation; in boars of the Duroc breed, 67.6% – age, 10.9% – season of the year, 0.1% – type of ventilation. Accordingly, the duration of movement was significant ($P < 0.001$) affected by: in Large White boars 68.0% – age, 12.9% – season of the year, 1.4% – type of ventilation; in Landrace boars 44.7% – age, 28.5% – season of the year, 3.2% – type of ventilation; in Duroc boars 64.9% – age, 9.1% – season of the year, 0.5% – type of ventilation. In turn, the duration of feed and water intake was significant ($P < 0.001$) affected by: in Large White boars 49.7% – age, 25.9% – season of the year, 1.8% – type of ventilation; in Landrace boars 55.7% – age, 7.9% – season of the

year, 2.4% – type of ventilation; in Duroc boars 71.9% – age, 12.1% – season of the year, 0.1% – type of ventilation.

Regardless of the breed, season of the year, and type of ventilation, the predominant behavioural act in terms of duration (72.3-76.4%) at $P < 0.001$ and frequency (especially in the summer-autumn period) during the day, was rest, which increased in time with age (6-12-24 months). During rest with the transverse air supply system, the animals showed abnormal apathetic behaviour, which was manifested in lying on their sides or stomach, with their eyes closed, without any reactions to indifferent stimuli in the room for their maintenance, especially in hot periods of the year, which is a manifestation of heat stress in animals. Boars, when kept with transverse air ventilation, spent up to 3% ($P < 0.95$) of their time on stereotypical behaviour, which was manifested in the form of head banging, jumping, and licking the cage grate and the "position of sitting dog" – 2% ($P < 0.95$), especially in the hot periods of summer and autumn.

The conducted study is useful for ethological monitoring of compliance of keeping conditions with the biological needs of boars, and for pig breeders it opens up ways to develop strategies for identifying individuals with behavioural and performance abnormalities as an element of animal welfare assessment and a way to combat heat stress.

Prospects for further studies are to research the relationship of sexual behaviour of boars with qualitative and quantitative signs of their sperm productivity, depending on the breed, age, season of the year, and type of ventilation.

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None.

## Conflict of Interest

None.

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# Поведінкові патерни кнурів у розрізі порід залежно від віку, сезону року і типу вентиляції

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**Анотація.** Важливим інструментом підвищення продуктивних ознак свиней, у тому числі кнурів є ретельне дослідження їх моделей поведінки і реакцій на відповідність умовам утримання, що слугує індикатором протоколу оцінки благополуччя даної статевої групи у комерційних свинофермах. Мета досліду полягала у виявленні впливу віку, сезону року і типу вентиляції на тривалість поведінкових актів кнурів у розрізі порід задля формування їх поведінкових патернів в умовах промислової технології. В експерименті задіяно 18 кнурів великої білої породи, породи ландрас та дюрок. Кнури, відібрані для дослідів, були клінічно здоровими і розділені на дві групи по 9 голів у кожній. Контрольна група кнурів утримувалася в приміщенні з поперечною системою вентиляції, а тварини дослідної групи – в умовах геотермальної подачі повітря протягом року. У процесі візуалізації показників поведінки кнурів різних порід встановлено, що: на тривалість відпочинку вірогідно ($P < 0,001$) впливають 49,1-67,6 % – вік, 10,9-23,2 % – сезон року, 0,1-3,0 % – тип вентиляції; на тривалість руху протягом доби вірогідно ($P < 0,001$) впливають 44,7-68,0 % – вік, 9,1-28,5 % – сезон року, 0,5-3,2 % – тип вентиляції; на тривалість прийому корму і води вірогідно ($P < 0,001$) впливають 49,7-71,9 % – вік, 7,9-25,9 % – сезон року, 0,1-2,4 % – тип вентиляції. Поведінковим актом, що переважав за тривалістю і частотою ($P < 0,001$), особливо у літньо-осінній період у кнурів спостерігався відпочинок, котрий за часом з віком збільшувався від 72,3 % до 76,4 %, незалежно від породи, сезону року і типу вентиляції. Влітку і восени за поперечної системи подачі повітря під час відпочинку у тварин візуалізувалася ненормальна апатична поведінка (лежання на боках, животі, із закритими очима, без жодних реакцій на індиферентні подразники, а час, який кнури витрачали на стереотипну поведінку (биття головою, стрибків і облизування грат решітки клітки) збільшувався на 3 % ($P < 0,95$) і перебували у позі «сидячої собаки» на 2 % ($P < 0,95$). Одержані результати дозволяють в умовах промислового свинарства запровадити використання етологічних факторів з метою підвищення спермопродукції кнурів, виявлення особин з відхиленнями поведінки для розробки способів оцінки благополуччя та інтеграції їх у виробництво

**Ключові слова:** свині; відпочинок; рух; прийом корму і води; благополуччя; трифакторний дисперсійний аналіз