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THE TYPOLOGY OF BROILER HOUSE AND THE IMPACT IN THE LOCOMOTION OF BROILERS

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KEYWORDS

broiler houses, gait score, spondylolisthesis, surface temperature.

ABSTRACT

The large majority of broiler houses use two types of systems: dark-house system – DHP, and tunnel with curtain system - ATC. The objective of the present study was to evaluate the association and the prevalence of locomotion issues in the broiler commercial farming systems (DHP and ATC). For assessing the thermal environment and the litter quality, a completely random design was adopted using two factors (broiler houses, DHP and ATC) with 12 repetitions. To study the surface temperature of the broiler breast, and the locomotion ability (gait score) a completely randomized design was adopted in a double factorial scheme 2 x 2 (two houses typology vs. sex) with 24 repetitions. To verify whether the type of house and the sex were associated to broiler locomotion problems due to the lack in walking ability, and the presence of medular compression (spondylolisthesis) the logistic regression was applied to the analysis: odds ratio and relative risk. The chance of the poultry to present inability of walking was 3.80 times higher in the male population. The risk factor associated with the lack of walking ability of the poultry was correlated to the tunnel house with curtains, presenting a relative risk 1.58 times higher when compared to the dark-house with walls. There was not the relative risk of medular compression (spondylolisthesis) neither was found an association between the poultry' sex and the type of house. The reduction in the male broiler locomotion ability might be associated with the rearing in the housing tunnel with curtains.

INTRODUCTION

The production of broiler from aviaries of negative pressure system is essential because in this system the environment can be controlled more efficiently, guaranteeing better performance results. The parameters such as the construction typology, the thermal environment, and litter quality can influence the incidence of locomotive problems which may compromise the locomotion capacity of poultry. Therefore, the dynamics between the type of installation and the management of the animals, to achieve uniformity on the rearing environment without affecting the performance of broilers is essential to ensure maximum control in the production process (Lima et al., 2011).

The way broiler walk may be associated with other types of problem, such as angular deformities *valgus-varus*. With this, the poultry presents overload on the unaffected limb causing pain or discomfort when walking and affects the way of walking (Almeida Paz et al. 2010; Colet et al. 2015; Alves et al. 2016). These pathologies have contributed to the reduction in productivity due to the increase whole carcasses condemnations. Locomotive disturbances affect around 6% of the animals in commercial lots. These diseases are of great importance for world poultry farming (Almeida Paz, 2008). The incidence of locomotor problems is associated with high mortality rates. Pain and discomfort when walking can be predicted using methodologies that evaluate the ability of the poultry to move (Nääs et al. 2010; Fernandes et al. 2012; Colet et al. 2015). These methodologies can quantitatively predict the pain and discomfort of poultry, and their results help decision making in production management and ensure better production rates (Almeida Paz et al. 2010; Caplen et al. 2012).

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New approaches to food quality and safety must be considered to meet the consumer's need for the final product. Among these, we highlight the monitoring of the environmental conditions on the associated facilities with the incidence of locomotive problems in poultry, such as the inability to walk and spondylolisthesis which are considered to be the most prevalent in the commercial breeding system (Dinev, 2014).

The objective of this study was to evaluate the association and the locomotion capacity by gait score and the presence of spondylolisthesis in two systems of commercial breeding: dark-house with wall and tunnel with a curtain.

MATERIAL AND METHODS

The study was carried out in two commercial poultry of broiler chickens located in the region of Itaquiraí - MS, longitude 54° 11'6" W and latitude 23° 28'26" S, with East-West orientation, from May to June of 2015. The experimental procedure was approved by the Ethics Committee of the Federal University of Grande Dourados (protocol number 012/2015).

The aviaries considered in the evaluation were the *dark-house* with wall and tunnel with a curtain. The *dark-house* system with the wall (DHP) had the dimensions of 15 × 150 × 2.20 m (width x length × height), negative ventilation, exhaust fans, high-pressure nebulizers, environment controllers, light intensity controllers, heating system with automatic control and internal masonry walls painted in black. The tunnel-type aviary with curtain (ATC) had dimensions of 15 × 150 × 2.80 m (width × length × height), negative ventilation, exhaust fans, low-pressure nebulizers, environment controllers, heating system with manual firewood heater and with non-laminated polypropylene side curtains with a thickness of 0.17 mm, yellow color.

The poultry of the *Cobb* lineage was raised for 42 days, according to the management of the integrating company. The poultry was housed in the same period in mixed lots (male and female), with a mean density of 14 poultry m^{-2} with 31,200 poultry in both aviaries, on wood shavings litter on seventh use with 10 cm thickness.

The facilities were divided into four quadrants, front, half near the front, half near the rear and rear to perform the data collection at equidistant points from the following variables: thermal environment, litter quality and poultry sampling for analysis of incidence on locomotor problems (Figure 1).

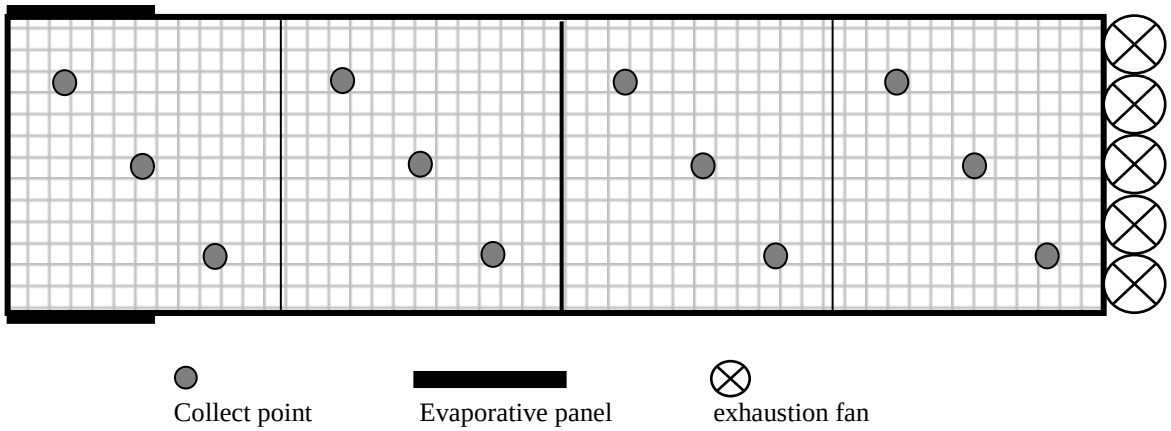


FIGURE 1. Points of data collection inside the aviaries.

Data on the thermal environment (temperature and relative air humidity) were collected in the morning (08:00 - 9:00h). The data were registered in 12 points per house, three points per quadrant (Figure 1) with the aid of a portable hygrometer (HT-7020 with ICEL Manaus sensor, accuracy ± 3.5%). The period after the growth phase is the one with the highest incidence of locomotive problems (Jacob et al., 2015), since poultry present, more considerable weight in this phase, occupy more space, and are more active in the morning. This justifies the data collection strategy adopted to sample the environment at 42 days of age and in the morning.

A thermometer with an external sensor (AK05, Akso Ltda., São Paulo, Brazil) with an accuracy of ± 0.5 °C and within the range of - 10 to 100 °C) was used to record the litter temperature, it was used an at a depth of 5 cm.

For the humidity analysis and pH of the litter, samples were collected at 12 points per aviary, being three points per quadrant, avoiding areas near or below the feeders and drinking fountains. The litter was collected and then packed in plastic bags in a refrigerated environment for later analysis in the laboratory. The pH of the litter samples homogenized from 25 g of the sample to 70 ml of distilled water was measured with a pH-meter (Hanna, HI-2210, Hanna Inst., São Paulo, Brazil) with an accuracy of ± 0.01 pH and range from - 2.0 to 16.0.

In the measurement of litter humidity, 100 grams of litter samples were used, and after homogenates, they were placed in a forced ventilation oven for 12 hours at 105 ºC, according to the methodology by AOAC (1984). For the calculation of humidity the following equation was used: % water = (initial weight - final weight) / initial weight.

For the evaluation of *gait score* of the poultry at the 42 days of growing, 48 poultry per plant was selected, 12 poultry per quadrant where the methodology consisted of subjective observations that made it possible to assign a score to the way the poultry walked. The standardized methodology of the *gait score* system consists in six conditions, being: 0 - considered normal; 1 - the poultry moves fast, but a small deficiency when walking can be observed; 2 - the poultry moves fast, but with debility when walking; 3 - the poultry moves with great difficulty, presenting severe lameness; 4 - the poultry almost does not move and when it can move uses the wings like support; and 5 - the poultry does not walk, when it stands, soon sits (Almeida Paz et al. 2010).

In the record of surface temperature data, thermographic images of the chest on 48 poultry/facility were recorded being 12 poultry per quadrant, in the morning at 08:00 with the aid of Testo® infrared thermographic camera with an accuracy of ± 0.1 °C and in the 7.5 - 13 µm spectrum. For the evaluation of the thermographic images, six random points were taken from the collected images on the poultry pectoral area (Figure 2). For the image processing, it was used the Testo IRSoft® software, to extract the temperature values. The emissivity adopted from the poultry surface was 0.95 as proposed by Montanholi et al. (2008).

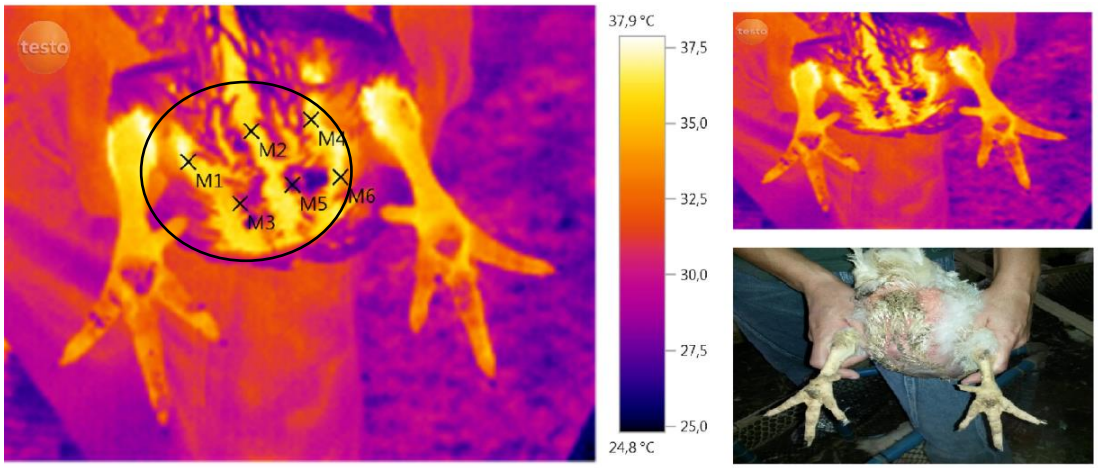
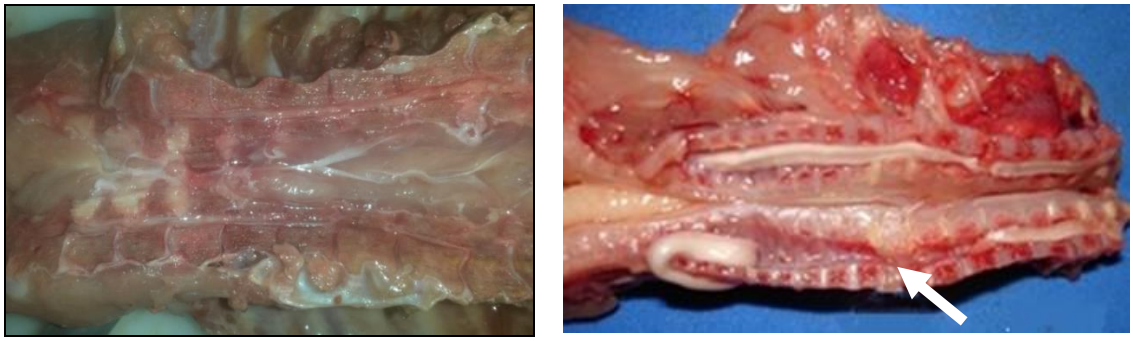


FIGURE 2. Thermographic image and real image from the collection points on the surface temperature took from the poultry.

After the commercial slaughter, twenty carcasses were selected per facility for evaluation of spondylolisthesis using the integrity analysis of the vertebrae (Figure 3). For this, the spine was sectioned longitudinally in the middle region with electric tape saw (Metvisa Inox 1.78m model SFP8). The poultry was classified as having or not the deformity as described by Paixão et al. (2007).



A B

FIGURE 3. Macroscopic view of the spinal cord (spondylolisthesis): without lesion (A) and with lesion (B).

In the evaluations of the thermal environment and litter quality was used a completely randomized design considering two negative pressure facilities: *dark-house* with wall and tunnel type aviary with curtain, with 12 replicates, totaling 24 experimental units. A completely randomized design with two factors was considered in the evaluation of poultry chest surface temperature and inability to move by *gait score*, considering two negative pressure facilities: *dark-house* with wall and aviary with curtain *vs.* sex: (male and female) and 24 replicates totaling 96 experimental units. After normality verification, the analysis of variance was calculated and was performed the means comparison between the factors by Tukey's test with 95% assurance. To verify if the type of facility and sex are associated with the presence of locomotive problems in the poultry (inability to move through the presence of spondylolisthesis) were analyzed by logistic regression: odds ratio and relative risk (n = 20), with 95 % assurance. Calculations were performed using the Vassar Stats online program (VassarStats, 2016).

RESULTS AND DISCUSSION

The mean air temperature and relative humidity differed between the facilities at 26.70 °C and 81.94% in the ATC and for DHP at 25.48 °C and 54.85% respectively (Table 1). The significant result for the ATC facility can be explained by oscillation in the internal microclimate of the aviary and lack of maintenance in the equipment reducing the air flow since it is coated with lateral polyethylene curtains that could present faults in the seal.

TABLE 1. Average air temperature (ºC) and relative humidity (%) in different facilities.

Facilities	Air temperature (°C)	Relative humidity (%)
DHP	25.48 b	54.85 b
ATC	26.70 a	81.94 a
Average	26.09	68.40
Standard deviation	1.25	5.05
CV%	4.23	14.24
P- Value	0.0131	< .0001

The averages followed by the same letter do not differ statistically from each other by the Tukey test at 5% probability level.

The litter quality parameters did not present different temperature and humidity averages for the two aviaries. However, the DHP had pH 8.59 differing from the ATC at pH 7.93 (Table 2). The excreta accumulation during the growing period increases the litter pH (Lima et al., 2015). Litter quality is considered an essential aspect of the incidence of locomotive problems in broilers. One of the litter quality parameters, pH, is influenced by poultry age, temperature and poultry density (Menegali et al., 2012). High humidity in the litter can worsen the incidence of calluses in the chest and feet, skin burns, crusting, bruising, havoc and elimination. Also, the wet litter is also the cause of one of the most severe environmental problems of modern broiler production, the ammonia. However, very dry litter produce dust that can also cause problems, such as dehydration of young poultry and respiratory diseases (Carvalho et al., 2011; Mendes & Komiyama, 2011). The litter presents great impact on the quality and productivity of the broiler, constituting an item of fundamental importance in the management of aviaries in poultry production systems (Almeida Paz et al., 2010;

High temperature and litter pH provide increased microbial activity and formation of harmful gases. Thus, litter quality directly affects the performance and well-being of poultry, as they also influence their comfort (Toghyani et al. 2010; Calvet et al. 2011). Lima et al. (2015) evaluated negative ventilation systems dark house with wall and curtain tunnel and observed higher pH and humidity for the litter in *dark-house*. This issue might occur due to improper litter and environment management and may contribute to increased ammonia volatilization, which is maximized at pH above 7.0.

TABLE 2. Average Temperature (°C), Humidity (%) and pH in litter from different facilities.

	Litter Quality Parameters		
Facilities	Temperature (°C)	Humidity (%)	pH
DHP	27.67 a	24.91 a	8.59 a
ATC	27.89 a	26.95 a	7.93 b
Average	27.78	25.93	8.26
Standard deviation	0.85	2.86	0.39
CV%	3.09	10.53	2.44
P- Value	0.5508	0.0809	<.0001

Averages followed by the same letter do not differ statistically from each other by the Tukey test at 5% probability level.

An effect on the chance and risk of poultry being incapable of locomotion at 42 days when considering the sex factor alone was observed. The odds ratio for incapable of locomotion with *gait score* in the range of 1 to 5 for males was 1.41 times higher, and the relative risk was 1.15 times higher for males than for females at 42 days of age (Table 3). Comparing male *vs.* female in the aviary tunnel type female, we found a significant effect of locomotion inability for poultry associated with the facilities type in which the poultry was grown. The odds ratio of the poultry presenting inability to move, or *scores* between 1 and 5, was 3.8 times higher for males and the relative risk of 1.58 higher, that means that there is a strong association between the sex of the poultry and the locomotive incapacity in the tunnel-type system in the last stage of grow.

TABLE 3. The incidence of alteration in the locomotion of broilers at 42 days of age.

		Disability of locomotion		
Facilities	Sex	Absent	Present	Total
DHP	Male	13	11	24
	Female	10	14	24
	Total	23	25	48
Broiler house Tunnel with curtain (ATC)	Male	5	19	24
	Female	12	12	24
	Total	17	31	48

	Association Measures	
Factors	Odds Ratio	Relative Risk
Male *vs.* Female	1.41 (- 0.62; + 3.18)	1.15 (- 0.82; + 1.62)
Male *vs.* Female (DHP)	0.60 (- 0.19; + 1.89)	0.79 (- 0.45; + 1.36)
Male *vs.* Female (ATC)	3.80 (- 1.07 – 13.52)	1.58 (- 1.01; + 2.48)
DHP *vs.* ATC	0.60 (- 0.26; + 1.35)	0.81 (- 0.57; + 1.14)
DHP *vs.* ATC (Male)	0.22 (- 0.06; + 0.79)	0.58 (- 0.36; + 0.94)
DHP *vs.* ATC (Female)	1.40 (- 0.45; + 4.38)	1.17 (- 0.69; + 1.97)

Confidence Interval 95%: Lower limit = -; Upper limit = +.

It is possible to raise the possibility of this poultry inability to move with gait score categorized within the range of 1 to 5 in 1.4 times higher for females, and the risk factor was 1.7 higher for DHP about ATC. These results indicate a significant association between the facilities typology and the incidence of the inability of the poultry move caused by pain and discomfort when walking (Figure 4).

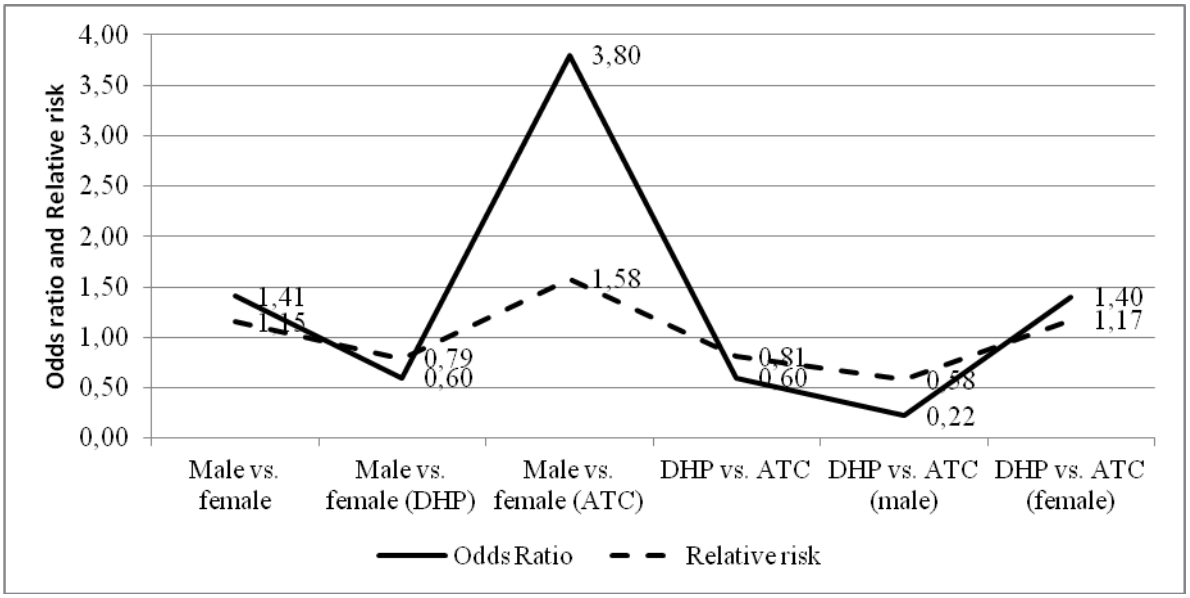


FIGURE 4. Results of the logistic regression model adjusted for male vs. female, male vs. female (DHP), male vs. female (ATC), DHP vs. ATC, DHP vs. ATC (male) and DHP vs. ATC (female).

According to Almeida Paz et al. (2008) and Colet et al. (2015), age is the factor that most influences the lesion degree in poultry and may also be affected by other locomotor problems such as femoral degeneration and tibial dyschondroplasia which aggravate the *gait score* due to overload in the unaffected limb.

In the present study, male broilers presented a high incidence of locomotion incapacity with *gait score* higher than 1. Nääs et al. (2012) and Colet et al. (2015) observed that *gait score* in males tended to be higher than females, confirming the results of the present study. This occurs due to higher growth velocity of males when compared to females. According to Rose et al. (1996), female broilers have a lighter skeleton when compared to males, being less susceptible to bone deformities or musculoskeletal abnormalities. The *gait score* measure was widely adopted by importers, mainly European, in the evaluation of the broiler welfare. Specific importing markets have established that, in the *gait score* evaluation, lots that present 30% or more of broilers with a score equal to or greater than 1 are not able for the export/import market (Almeida Paz, 2008; Cordeiro et al., 2012).

For the sex factor, there was no difference in the abdominal surface temperature of the broilers (Table 4). However, the facility factor presented statistical difference for the surface temperature of the broiler. The ATC had a mean surface temperature of 36.61 °C and the DHP of 35.80 °C. The evaluation on the surface temperature in poultry serves as parameters for physiological response to the environment indicating if the conditions are adequate or not, since the heat loss is related to the surface temperature of the poultry (Nääs et al. 2010; Nascimento et al. 2011).

TABLE 4. Mean abdominal temperature of poultry at 42 days of age.

	Broiler Sex		
Facilities	Male	Female	Average
DHP	35.75	35.84	35.80 b
ATC	36.69	36.53	36.61 a
Average	36.22 a	36.19 a	36.21
Standard deviation		1.08	
CV %		2.81	

The averages followed by the same letter do not differ statistically from each other by the Tukey test at 5% probability level.

At the ATC housing, the chest surface temperature was higher, considering that the pH of the litter in this house was 7.93, a lower value than in the DHP. This higher temperature may be associated with ammonia volatilization which occurs with ammonia detachment and alkaline pH reduction. The increasing of ammonia volatilization may be a consequence of inadequate litter management conditions which may increase the incidence of locomotor problems, foot, and chest calluses, and contact pododermatitis (Hashimoto et al., 2013; Gopinger et al. 2015; Cristo et al. 2017).

The results of the odds ratio (0.23) and relative risk (0.46) of the spondylolisthesis evaluation using vertebral integrity analysis were not significant indicating that there is no association with the facilities type (Table 5).

TABLE 5. The incidence of spondylolisthesis in poultry at 42 days of growth from different facilities.

	Incidence of Spondylolisthesis		
Facilities	Absent	Present	Total Poultry
Dark-house with the wall *(DHP)*	14	06	20
Broiler house tunnel with curtain (ATC)	07	13	20
Total Poultry	21	19	40
	Association Measures		
Factor	Odds Ratio	Relative Risk	
DHP *vs.* ATC	0.23 (- 0.06; + 0.87)	0.46 (- 0.22; + 0.97)	

Confidence Interval: 95%. Inferior limit: -; Upper limit: +.

In the present study, there was no association between the facilities and the incidence of spondylolisthesis; this means that the facilities typology is not associated with the occurrence of a lesion in the vertebrae. The possibility of this lesion occurring (0.23) and the risk factor (0.46) is low in DHP compared to the ATC. However, it can be observed that in the evaluated broilers, the risk factor was 46% higher in DHP for the presence of spondylolisthesis. Such finding indicates that the poultry with this condition could present a progression of the deformity in the vertebrae resulting in paralysis and consequently death by hunger and thirst. Paixão et al. (2007) observed spondylolisthesis in poultry at the fourth week of age, and the most severe manifestation of this condition was paraplegia. However, this result may also be associated with other pathomorphological conditions (Dinev, 2013; Dinev, 2014). Considering also to calculate the relative risk reduction about ATC system using the following formula: RRR = (1-0.46) x 100, we obtain a 54% reduction in the incidence of spondylolisthesis under the conditions of changes for the type of facilities.

CONCLUSIONS

The incidence of locomotive problems may be related to the typology of the aviaries used in broilers' production. These problems may be even more significant for males grown in tunnel system with a curtain.

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