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Occurrence of the white striping and wooden breast in broiler chickens: Systematic review and meta-analysis

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Abstract

The accelerated growth of broiler chickens associated with different factors can lead to pectoral myopathy. The objective of the study was to review and analyze all the information related to the incidence and prevalence of White striping (WS) and wooden breast (WB) in broiler chickens through systematic review and meta-analysis based on the current literature. For this purpose, different studies were selected according to inclusion and exclusion criteria for a systematic review and, consequently, meta-analysis to obtain an average occurrence value. The evaluated studies corresponded to in-vivo studies obtaining a population of 125,722 broiler chickens, considering both sexes, a genetic line designed for meat production, complete productive age from 1 to 42 days, and broiler chickens raised under commercial conditions. The Meta Essentials software was used, which allowed the calculations to be made. Heterogeneity was analyzed using Cochrane's Q statistic and Higgins's I^2. The distribution of homogeneity through the funnel plot. The bias of the publications using the Egger statistics with a significance level of 0.005 and the weighting of the articles using the Forest plot. The occurrence for WS was 62%, and for WB was 42%. There is a need to establish a standardized diagnostic test to objectively confirm the presence and/or severity of both diseases and reduce biases.

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Introduction

The recent increase in broiler chicken production is associated with the growing demand for poultry meat, driven by its lower marketing costs than other livestock products and favorable nutritional characteristics. However, a significant proportion of chickens are currently affected by pathological alterations that affect their muscles, a condition known as myopathies. The accelerated growth in broiler chickens resulting from intense genetic selection has shown alterations in the characteristics of the birds' pectoral muscles in recent years. These muscles, which receive the most attention in genetic development for commercial reasons, are also more susceptible to injuries, potentially leading to economic losses (1). This can occur either through carcass seizure or rejection by consumers or processing plants, as carcasses with such pathologies have a negative visual impact on consumers (2). Moreover, carcasses with these issues have lower nutritional quality and may be considered second-rate meat (3,4). Myopathies are considered muscular disorders that can occur in production broiler chickens, where the primary injury affects the muscle bundles symmetrically, particularly in the proximal muscles bearing the most weight, without a defined age of onset (5). Myopathies in chicken breasts typically manifest after processing, as they are not evident during post-mortem visual inspection. However, the presence of these myopathies does not affect public health (6). In the last 30 years, there has been an increase in the incidence of anomalies in breast muscles, such as deep pectoral myopathy (DPM), characterized by ischemic necrosis in deep pectoral muscles commonly referred to as green muscle disease and

the pale, soft, exudative meat (PSE) characterized by meat with lower quality of texture, color, and water-holding capacity than normal breast meat (7). Recently, new muscular abnormalities have been described, such as white striping (WS), characterized by white striations in the muscle, and wooden breast (WB), mostly in the chicken breast. These myopathies are gaining importance in the poultry industry because although they do not pose a risk to public health, they exhibit undesirable characteristics for the end consumer and indicate a product with decreased nutritional, sensory, and technological quality. Additionally, these breasts have lower nutritional values than normal ones (8). The presence of WS and WB has raised concerns among consumers, who associate muscle alterations in birds with changes in meat quality and safety; thus, upon noticing the visual characteristics of WS and WB, they prefer not to purchase them (9). It has been observed that up to 50% of consumers would not buy breasts, with WS showing moderate or severe degrees (2). In many processing centers, breasts with severe degrees of myopathies are either seized or downgraded to a lower-quality product, such as processed chicken or byproducts, leading to significant economic losses for producers (10). Severe degrees of WS and WB, either separately or combined, negatively impact certain aspects of meat quality, particularly water-holding capacity during marination and cooking of breasts. These abnormalities significantly affect the poultry industry, especially in subsequent processes where deboned heavyweight chicken breasts are used (11). The histopathological changes observed in severe or moderate WS include chronic degenerative myopathic lesions such as loss of cross striations, fiber size variability, vacuolar degeneration, fiber lysis, mild mineralization, occasional regeneration, mononuclear cell infiltration, lipidosis, interstitial inflammation, and fibrosis. Multifocal lesions in the same muscle indicate chronic and constant injury causing these lesions (12). The histopathological changes seen in WB are associated with moderate to severe grades of multifocal regenerative myodegeneration and necrosis with a variable amount of accumulated interstitial connective tissue or fibrosis, perivenular infiltration of T lymphocytes, and the presence of other inflammatory processes, such as vacuolar degeneration, lysis, or mild mineralization, which are characteristics also found in this type of myopathy (13). Degenerative changes due to myopathies affect the chemical composition and carcass characteristics. These changes include increased moisture and fat with decreased protein and ash levels in the meat. Additionally, effects on breast weight yield and texture upon cooking can be observed. In the case of WB, aberrant meats in breast yield and water-holding capacity can be appreciated (14). It was reported that approximately 50% of chicken breasts in different countries such as Italy, France, Spain, and Brazil showed white striping, and around 10 to 20% of wooden breasts in the northeast of Brazil (15). The meta-analysis uses objective scientific methods based on statistics to summarize and quantify knowledge gained from previously published research, increasing the number of observations and the statistical power of hypothesis testing to evaluate the possibility of generalizing conclusions to a wide range of studies (16,17). However, meta-analysis studies based on independently conducted experiments are important to eliminate the effects of different experimental conditions, removing each study's effect to increase the inference of scientific systematization to integrate available knowledge (18,17).

Thus, the aim of this study was to determine the percentage of occurrence of WS and WB in broiler chickens. Through the systematic evaluation of white striping and wooden breast studies worldwide, a meta-analysis was conducted to identify specific factors associated with the presence of these myopathies.

Materials and methods

Ethical approval

The study was approved by the Institutional Committee for Ethics in Research with Animals and Biodiversity of Southern Scientific University (23-CIEI-CIENTIFICA-2021).

Data collection

The present analysis included longitudinal, descriptive, prospective studies, cohort studies, controlled randomized trials, undergraduate and doctoral theses, and book chapters in English, Portuguese, and Spanish. The evaluated studies corresponded to *in-vivo* chicken studies, comprising a population of 125,722 chickens, considering both sexes, genetic lines destined for fattening (Cobb and Ross), which had completed the entire productive stage from 1 to 42 days of age, and birds raised under commercial conditions. The following criteria were used for exclusion: studies that did not specify the species or age of the birds, where post-mortem analysis of the bird was not conducted, studies with very high bias, congresses, non-indexed journals, theses that were not defended, and non-randomized trials.

Information related to the topic of interest was gathered in pairs and through the search for keywords white striping, incidence, prevalence, wooden breast, myopathies, and chickens in 3 languages, English, Spanish, and Portuguese, to encompass a greater number of articles. The search was conducted using search engines that included indexed scientific journals such as Scopus, Google Scholar, PubMed, ScienceDirect, Web of Science, and ProQuest. One hundred-one scientific articles published from 2012 to 2022 were used.

Inclusion and exclusion criteria

All research was collected on the Mendeley platform, where it was organized, and the information for each paper was recorded according to the Cochrane manual guidelines

(19), which serve as a guide for conducting proper systematic review and meta-analysis. The studies were then critically analyzed to detect potential errors in the methodological structure, evaluating the objectives of the meta-analysis. Once the information was collected, the checklist was used to assess the risk of bias through the Cochrane tool to determine the risk of bias in the studies, in which studies were identified as low risk of bias, high risk of bias, unclear risk of bias, for the analysis of the information and to limit those studies that helped conduct the systematic review. The checklist provided by the PRISMA platform was also used as a guide to ensure a transparent and complete presentation of the systematic review and meta-analysis. This platform's flowchart was also used to guide the data collection and exclusion process.

Following the systematic review, a meta-analysis of the occurrence variable was conducted, which was considered as the effect size. Articles were critically reviewed based on inclusion and exclusion criteria, and occurrence data and factors associated with presenting these myopathies were extracted and recorded. Relevant topics related to the objectives of the meta-analysis were explored, so 12 articles were selected.

Data analysis and synthesis

The meta-analysis is considered the statistical part of the present project; therefore, initially, the bias of the selected articles and the effect size of the occurrence variable were evaluated. Through the funnel plot, the homogeneity of the chosen articles and the assessment of their bias were identified. The evaluation of the heterogeneity of the selected articles was analyzed using the Cochrane Q statistics and Higgins' I2. By analyzing heterogeneity, the viability of the information was determined, and they were separated into subgroups based on factors that may affect the occurrence in each variable, which were age, region, and weight. The factors were qualitatively identified based on the homogeneity among subgroups of research.

Publication bias assessment

Bias analysis was quantified using Egger's statistic with a significance level of 0.05. The effect size, confidence interval (95%), and weighting of the reviewed articles were conducted using the forest plot. Studies with different effect sizes were transformed using Cohen's d statistic. All calculations were performed using Meta Essentials software (20). Each paper was coded to facilitate its identification in the database. Other codifications were used to incorporate the variability of the experiments into the statistical model.

Results

Studies selection

A total of 1,105,403 papers were found through search engines; 106 papers were selected after reviewing titles and abstracts, and after removing duplicates, the study was left with 91 papers. Following a thorough analysis, 79 papers were excluded. Finally, 12 papers were selected for evaluation according to the inclusion and exclusion criteria. Of these 12 selected papers, 11 papers were chosen for the meta-analysis of white striping and 6 articles for the meta-analysis of wooden breasts. No papers outside the database were selected for the study.

Characteristics of the studies

All selected white striping (WS) and wooden breast (WB) studies were written in English. Of these, 4 studies were conducted in Europe, 3 in Asia, and 5 in the Americas. The papers were selected from 2012, as this was the first description year of WS myopathy. Ten years of information was considered. Eight of the 12 papers analyzed occurrence by age, weight, and genetic line, so each was considered a separate study. The program showed that for 2022, no articles met the inclusion criteria. Detailed information on the studies is presented in Tables 1 and 2. The study about pectoral myopathies showed the highest occurrence of WS at 100%, while the studies' occurrence was 11%. Additionally, some studies, which are considered different from bodies, are divided. The study with the highest occurrence of WB was 96.1%, while the reported lowest occurrence was 4% (Tables 1 and 2).

Table 3 shows the evaluation of bias in the analyzed studies. Most studies have a relatively high risk of bias due to certain methodological deficiencies. Therefore, the results presented below have a high potential for bias; however, excluding the high-risk studies and using only those with a low risk of bias could provide unbiased but imprecise results. In the case of studies that evaluated WB, the assessment of this condition is quite subjective (the evaluator categorizes it according to their criteria), resulting in a high detection bias. There is a probable risk of bias for the studies on white striping because many studies do not mention randomization in their methodology and do not mention blinding of the evaluators. It is worth noting that two studies did not present complete results due to lack of time.

The occurrence data for WS was extracted from 9 studies, comprising 124,467 individuals from whom the data was obtained in the Forest Plot of WS occurrence (Figure 1). The pooled analysis found that the occurrence rate of WS myopathy was 62% (I^2 = 99.97%, confidence interval = 95%, P = 0.001).

The empty circles represent the white striping occurrence reported in each study, with whiskers representing their confidence intervals. The circle's diameter corresponds to the sample size, with larger circles indicating larger samples. The solid diamond shape represents the pooled occurrence, with its confidence marked at the diamond's endpoints. Dotted lines with arrowheads crossing the rhombus represent the prediction interval of the random-effects model. Individual study occurrences are displayed alongside the

pooled WS occurrence, with confidence intervals in square brackets. The occurrence data in the forest plot for WB were extracted from 6 studies (Figure 2) comprising 14,042 individuals from whom the data was obtained. In the pooled analysis, the occurrence rate was 42% (I^2 = 99.87%, Confidence interval = 95%, P = 0.001).

Table 1: Characteristics of the studies included for the occurrence analysis of white striping in broiler chickens

Title of paper	Autor	Year	Journal	Sample size	Nº of cases, WS	% WS
Occurrence of white striping under commercial conditions and its impact on breast meat quality in broiler chickens.	21	2013	Poultry Science	28000	3360	12%
An investigation of a reported case of white striping in broilers.	22	2014	Journal of Applied Poultry Research	25520	2512	9.84%
Incidence of white striping under commercial conditions in medium and heavy broiler chickens in Italy.	10	2014	Journal of Applied Poultry Research	7500 11000 8500 8000 35000	2550 2640 4845 4800 5415	34% 24% 57% 60% 44%
Evaluation of white striping prevalence and predisposing factors in broilers at slaughter.	23	2015	Poultry Science	7600 15200	5336 12542	70.20% 82.51%
Meat quality of broiler breast fillets with white striping and woody breast muscle myopathies.	11	2016	Poultry Science	285	274	96.10%
Incidence of broiler breast myopathies at 2 different ages and its impact on selected raw meat quality parameters.	24	2017	Poultry Science	960 960	888 949	92.4% 98.85%
Monitoring of white striping and wooden breast cases and impacts on breast meat quality collected from commercial broilers (*Gallus gallus*).	14	2018	Asian-Australasian journal of animal sciences	41 59 83	39 57 83	95% 97% 100%
White striping prevalence and its effect on meat quality of broiler breast fillets under commercial conditions.	25	2018	Journal of Animal Physiology and Animal Nutrition	60 60 60 60	26 30 37 42	44.00% 49.33% 61.53% 71.88%
Occurrence of breast meat abnormalities and foot pad dermatitis in light-size broiler chicken hybrids.	26	2019	Animals	780 780	476 242	61.00% 31.00%
Occurrence of wooden breast and white striping in Brazilian slaughtering plants and use of near-infrared spectroscopy and multivariate analysis to identify affected chicken breasts	9	2020	Journal of Food Science	1200 6919 600 240	132 3169 474 228	11.00% 45.80% 79.00% 95.00%
Research Note: Evaluation of the incidence of white striping and underlying myopathic abnormalities affected by fast weight gain in commercially fed broiler chickens	27	2021	Poultry Science	120	108	90.00%

White striping: WS.

Table 2: Characteristics of the studies included for the occurrence analysis of woody breast in broiler chickens

Title of paper	Autor	Year	Journal	Sample size	Nº of cases, WB	% WB
Meat quality of broiler breast fillets with white striping and woody breast muscle myopathies	11	2016	Poultry Science	285	274	96.10%
Incidence of broiler breast myopathies at 2 different ages and its impact on selected raw meat quality parameters	24	2017	Poultry Science	960	408	42.4%
				960	814	84.79%
Monitoring of white striping and wooden breast cases and impacts on quality of breast meat collected from commercial broilers (*Gallus gallus*)	14	2018	Asian-Australasian journal of animal sciences	57	5	7%
				83	7	8%
Characteristics and incidence of broiler chicken wooden breast meat under commercial conditions in China	28	2019	Poultry Science	1135	706	61.90%
Occurrence of Breast Meat Abnormalities and Foot Pad Dermatitis in Light-Size Broiler Chicken Hybrids	26	2019	Animals	780	461	59.00%
				780	195	25.00%
Occurrence of wooden breast and white striping in Brazilian slaughtering plants and use of near-infrared spectroscopy and multivariate analysis to identify affected chicken breasts	9	2020	Journal of Food Science	1200	48	4.00%
				6919	1986	28.70%
				600	196	32.70%
				240	228	95.00%

Woody breast: WB.

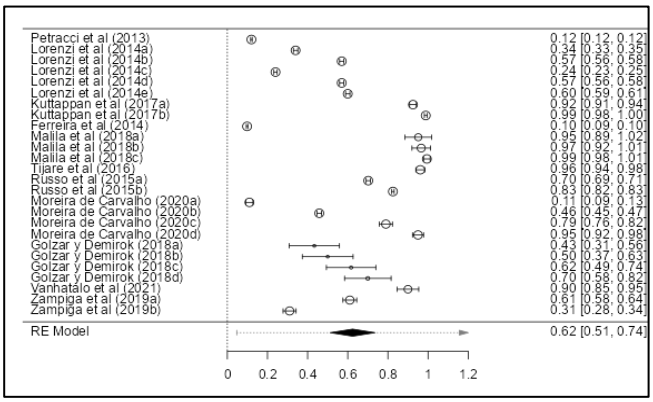

Figure 1: Forest plot of white striping occurrence.

The empty circles represent the occurrence reported in each wooden breast study, with whiskers representing their confidence intervals. The circle's diameter corresponds to the sample size, with larger circles indicating larger samples. The solid diamond shape represents the pooled occurrence, with its confidence marked at the diamond's endpoints. Dotted lines with arrowheads crossing the rhombus represent the prediction interval of the random-effects model. Individual study occurrences are displayed alongside the pooled WB occurrence, with confidence intervals shown in square brackets. A high percentage of heterogeneity was observed for the occurrence of both diseases. To explore this heterogeneity, a Funnel plot diagram was created (Figures 3 and 4) and shows evidence of the high variability. Four studies provided data on the European continent, with an aggregate occurrence of 44% (95% CI; 0.14-0.75) for WS, while insufficient data existed for wooden breasts. However, it showed a heterogeneity of 99.99%. Four studies were used to measure the occurrences of WS for chicken weight, which ranged from 2.50 to 3.00 kg. The occurrence was 51% (95% CI; 0.25-0.77), with a heterogeneity of 99.98%. Measurement for wooden breasts could not be performed due to an insufficient number of studies. Seven studies were included to evaluate the occurrence between 42 and 49 days of age for both diseases. The occurrence for WS was 54% (95% CI; 0.33-0.75), with a heterogeneity of 99.99%. For WB, the occurrence was 25% (95% CI; 0.08-0.43), with a heterogeneity of 99.54%.

Table 3: Quality measures of the selected articles/bias analysis of white striping and woody breast in broiler chickens

Author	Selection bias	Performance bias	Attrition bias	Reporting bias	Other biases
21 (2013)	No	Unclear risk of bias	No	No	No
22 (2014)	High risk of bias	No	Unclear risk of bias (no information on birds not diagnosed with RB)	No	No
10 (2014)	High risk of bias (birds were divided according to characteristics)	No	No	No	No
23 (2015)	No	Unclear risk of bias (The paper does not mention whether the staff was biased or the selection was random when rating the breasts)	No	No	No
11 (2016)	High risk of bias (Bird characteristics were chosen)	No	High risk of bias (Due to time, there was no categorization for some WS and WB categories)	Unclear risk of bias, as WB assessment is quite subjective.	High risk of bias (No mention of randomization in procedures)
24 (2017)	High risk of bias (Trial characteristics were chosen)	Unclear risk of bias (Tactile assessment not specified)	No	Unclear risk of bias, as WB assessment is quite subjective.	No
14 (2018)	Yes (Bird characteristics were chosen, male sex)	No	No	Unclear risk of bias, as WB assessment is quite subjective.	No
25 (2019)	High risk of bias (Birds to be evaluated were selected and not by randomization (healthy birds))	Unclear risk of bias (The paper does not mention whether the staff was biased or the selection was random when rating the breasts).	No	No	No
28 (2019)	Unclear risk of bias and the criteria for selecting birds are not mentioned.	No	No	Unclear, risk of bias, WB assessment is quite subjective.	No
26 (2019)	No	Unclear risk of bias (No mention whether the staff was biased when rating the breasts)	No	Unclear risk of bias, as WB assessment is quite subjective.	No
9 (2020)	No	Unclear risk of bias (No mention of whether the staff was biased or the selection was random when rating the breasts).	No	Unclear risk of bias, as WB assessment is quite subjective.	No
27 (2021)	No	Unclear risk of bias (No mention of whether the staff was biased when rating the breasts).	No	No	No

White striping: WS; Woody breast: WB.

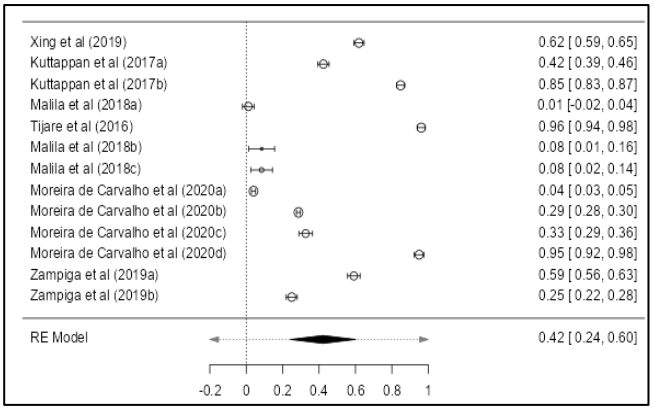

Figure 2: Forest plot of wooden breast occurrence.

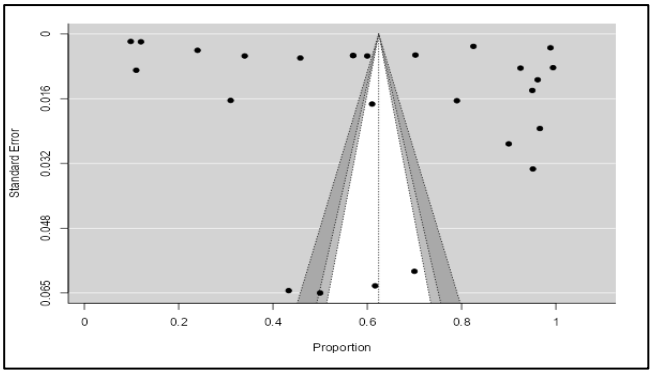

Figure 3: Funnel plot diagram for white stripe.

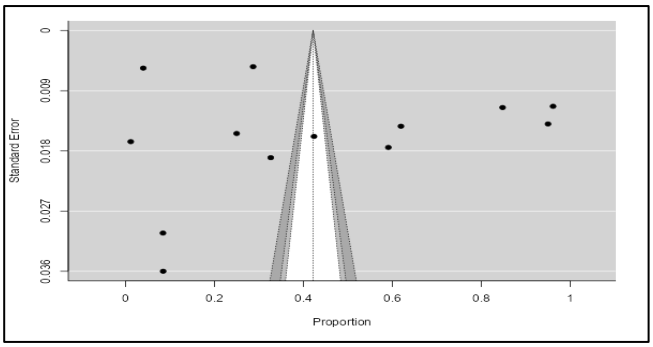

Figure 4: Funnel plot diagram for wooden breast.

Discussion

The accelerated growth rate experienced by broiler chickens can affect muscle metabolism, leading to myopathies. This is because the space between the connective tissue of the endomysium and perimysium is small, reducing the space for capillaries. This, in turn, limits the proper removal of CO^2 and lactic acid from tissue metabolism, consequently causing myodegeneration of muscle fibers and resulting in myopathies (28-30).

In the case of WS occurrences, based on the studies included in this research, it is not possible to assert an occurrence of 62% in broiler chickens due to the high heterogeneity. The incidence in studies with a large population (25,26) was less than 10%. In contrast, the studies (10,23) on broiler chickens found different percentages of WS, 43% and 78.4%, respectively. Therefore, various factors associated with the disease during commercial processes can alter the occurrences of myopathies.

Higher occurrence in older birds (65 days), with 98.95% and 95%, were observed respectively (24,9). Meanwhile, at 6 or 7 weeks old, they found 92.4% and 45.8% occurrence. This latter percentage matches the one obtained from the meta-analysis of the age subgroup. The authors assert that the older the bird, the higher the percentage of these myopathies.

The occurrences obtained for weight (51%) can be supported by studies that have reported a higher occurrence of WS as the bird's body weight increases, showing quite high occurrences in birds of 2.75, 3.30, and 3.50 kg, respectively (27,23,10). However, Petracci *et al.* (21) found an occurrence e of 12% in birds with an average weight of 2.75 kg. The variability of these results may be due to factors other than weight that can influence the occurrence of myopathies, such as genetic parameters or environmental factors, including diet density, management, and age of the birds (31). On the other hand, we have a lower occurrences percentage for WB; however, the results cannot be taken as a reference due to the high heterogeneity, which is explained in the same way as for WS. However, based on the reviewed papers, the occurrence of WS is higher than that of WB, as determined by the studies.

The WB disease requires better standardization compared to WS, as the measurement scale is based on a tactile score. The studies analyzed for this disease are mostly evaluated by qualified personnel (11); however, it would be ideal to have an evaluation instrument that provides faster and more accurate data, as the risk of personnel bias is quite high. The high heterogeneity may be due to the poor standardization of myopathies through visual and histological criteria. Studies in broiler chickens (32,33) provide quantitative analyses to better categorize these myopathies, which could provide less biased data for future studies. Occurrences of both myopathies occur more frequently in broiler chickens with a high growth rate (1,31). However, the factors associated with the occurrence of this disease are not entirely clear. They also mention that environmental factors such as management, nutritional density in the diet, age of the birds, and weight of the birds are more closely related to these conditions.

The heterogeneity of the papers can be explained by the lack of an effective measurement scale for both diseases, as both WS and WB are based on subjective scoring systems. This flaw in a review included more factors that make the measurement scale less effective, such as moisture, ash,

temperature, light, and other processing conditions (1). Despite finding high heterogeneity in the meta-analysis of the age subgroup, the analyzed papers show that as the weeks or days of production increase, the occurrence percentage of both diseases increases considerably. The reported WS occurrence was 92.4% and 42.4% for WB at 42 days, while the incidence at 62 days of age was 98.85 and 84.79%, respectively (24). In the bias analysis, it was evident that no study was categorized as 'low risk of bias' due to these diseases' subjective and non-standardized rating system. Kuttapan *et al.* (2) proposed a scale of 0 to 3 for WS, which has been used in various studies; however, some studies (11), such as Tijare *et al.* (11), have added the category extreme.

Conclusions

The meta-analysis and systematic review revealed a high occurrence of WS and WB in broiler chickens. However, the meta-analysis was not significant due to high heterogeneity. The risk factors highlighted in the review were weight, genetic lineage, growing time, and type of diet. Birds with higher weight, genetic lineage with a better growing time ratio, and older age presented a higher occurrence of these diseases. There is a need to establish a standardized diagnostic test to objectively confirm the presence and/or severity of both diseases to reduce biases, which would help group them in a meta-analysis.

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Conflict of interest

The authors declare no conflicts of interest regarding this manuscript's publication and/or funding.

References

1. Kuttappan VA, Hargis BM, Owens CM. White striping and woody breast myopathies in the modern poultry industry: A review. Poult Sci. 2016;95(11):2724-2733. DOI: 10.3382/ps/pew216
2. Kuttappan VA. Characterization and Consumer Acceptance of White Striping in Broiler Breast Fillets [Ph.D. Dissertations]. Fayetteville: University of Arkansas; 2012. 38 p. [available at]
3. Kuttappan VA, Lee YS, Erf GF, Meullenet JFC, McKee SR, Owens CM. Consumer acceptance of visual appearance of broiler breast meat with varying degrees of white striping. Poult Sci. 2012;91(5):1240-1247. DOI: 10.3382/ps.2011-01947
4. Petracci M, Sirri F, Mazzoni M, Meluzzi A. Comparison of breast muscle traits and meat quality characteristics in 2 commercial chicken hybrids. Poult Sci. 2013;92(9):2438-2447. DOI: 10.3382/ps.2013-03087
5. Mahon M. Poultry Science Symposium Series Vol.25. In: Richardson RI, Mead GC, editors. Muscle abnormalities: Morphological aspects. CABI publishing; 1999. 19-64 p. [available at]
6. Barbut S. Recent myopathies in broiler breast meat fillets. Worlds Poult Sci J. 2019;75(4):559-582. DOI: 10.1093/ICB/20.2.437
7. Maiorano G. Meat defects and emergent muscle myopathies in broiler chickens: Implications for the modern poultry industry. Rocz Nauk Pol Tow Zootech. 2017;13(3). DOI: 10.5604/01.3001.0010.5454
8. Petracci M, Mudalal S, Soglia F, Cavani C. Meat quality in fast-growing broiler chickens. Worlds Poult Sci J. 2015;71(2):363-374. DOI: 10.1017/s0043933915000367
9. De-Carvalho LM, Ventanas S, Olegario LS, Madruga MS, Estévez M. Consumers awareness of white-striping as a chicken breast myopathy affects their purchasing decision and emotional responses. LWT. 2020;131:109809. DOI: 10.1016/j.lwt.2020.109809
10. Lorenzi M, Mudalal S, Cavani C, Petracci M. Incidence of white striping under commercial conditions in medium and heavy broiler chickens in Italy. J Appl Poult Res. 2014;23(4):754-758. DOI: 10.3382/japr.2014-00968
11. Tijare VV, Yang FL, Kuttappan VA, Alvarado CZ, Coon CN, Owens CM. Meat quality of broiler breast fillets with white striping and woody breast muscle myopathies. Poult Sci. 2016;95(9):2167-2173. DOI: 10.3382/ps/pew129
12. Kuttappan VA, Shivaprasad HL, Shaw DP, Valentine BA, Hargis BM, Clark FD, McKee SR, Owens CM. Pathological changes associated with white striping in broiler breast muscles. Poult Sci. 2013;92(2):331-338. DOI: 10.3382/ps.2012-02646
13. Sihvo HK, Immonen K, Puolanne E. Myodegeneration with fibrosis and regeneration in the pectoralis major muscle of broilers. Vet Pathol. 2014;51(3):619-623. DOI: 10.1177/0300985813497488
14. Malila Y, Juthawut U, Srimarut Y, Chaiwiwattrakul P, Uengwetwanit T, Arayamethakorn S, Punyapornwithaya V, Sansamur C, Kirschke CP, Huang L, Tepaamorndech S. Monitoring of white striping and wooden breast cases and impacts on quality of breast meat collected from commercial broilers (*Gallus gallus*). Asian-Aust J Anim Sci. 2018;31(11):1807-1817. DOI: 10.5713/ajas.18.0355
15. Petracci M, Soglia F, Madruga M, Carvalho L, Ida E, Estévez M. Wooden-Breast, White Striping, and Spaghetti Meat: Causes, Consequences and Consumer Perception of Emerging Broiler Meat Abnormalities. Compr Rev Food Sci Food Saf. 2019;18(2):565-583. DOI: 10.1111/1541-4337.12431
16. Riley RD, Lambert PC, Abo-Zaid G. Meta-analysis of individual participant data: rationale, conduct, and reporting. BMJ. 2010;340(7745):521-525. DOI: 10.1136/bmj.c221
17. Stewart LA, Clarke M, Rovers M, Riley RD, Simmonds M, Stewart G, Tierney JF. Preferred reporting items for systematic review and meta-analyses of individual participant data: the PRISMA-IPD statement. J Am Med Assoc. 2015;313(16):1657-1665. DOI: 10.1001/jama.2015.3656
18. Sauvant D, Schmidely P, Daudin JJ, St-Pierre NR. Meta-analyses of experimental data in animal nutrition. Animal. 2008;2(8):1203-1214. DOI: 10.1017/s1751731108002280
19. Higgins JT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, Welch VA. Cochrane Handbook for Systematic Reviews of Interventions. 2nd ed. UK: John Wiley & Sons; 2019. [available at]
20. Suurmond R, van Rhee H, Hak T. Introduction, comparison, and validation of Meta-Essentials: A free and simple tool for meta-analysis. Res Synth Methods. 2017;8(4):537-553. DOI: 10.1002/jrsm.1260
21. Petracci M, Mudalal S, Bonfiglio A, Cavani C. Occurrence of white striping under commercial conditions and its impact on breast meat quality in broiler chickens. Poult Sci. 2013;92(6):1670-1675. DOI: 10.3382/ps.2012-03001
22. Ferreira TZ, Casagrande RA, Vieira SL, Driemeier D, Kindlein L. An investigation of a reported case of white striping in broilers. J Appl Poult Res. 2014;23(4):748-753. DOI: 10.3382/japr.2013-00847
23. Russo E, Drigo M, Longoni C, Pezzotti R, Fasoli P, Recordati C. Evaluation of white striping prevalence and predisposing factors in broilers at slaughter. Poult Sci. 2015;94(8):1843-1848. DOI: 10.3382/ps/pev172
24. Kuttappan VA, Owens CM, Coon C, Hargis BM, Vazquez-A Non M. Incidence of broiler breast myopathies at 2 different ages and its impact

on selected raw meat quality parameters. Poult Sci. 2017;96(8):3005-3009. DOI: 10.3382/ps/pex072
25. Golzar AS, Demirok SE. White striping prevalence and its effect on meat quality of broiler breast fillets under commercial conditions. J Anim Physiol Anim Nutr. 2019;103(4):1060-1069. DOI: 10.1111/jpn.13092
26. Zampiga M, Meluzzi A, Pignata S, Sirri F. Occurrence of breast meat abnormalities and foot pad dermatitis in light-size broiler chicken hybrids. Animals. 2019;9(10):706. DOI: 10.3390/ani9100706
27. Vanhatalo OE, Henderson JD, De La Torre U, Garrity CR, Pechanec MY, Mienaltowski A, King AJ, Mienaltowski MJ. Research Note: Evaluation of the incidence of white striping and underlying myopathic abnormalities affected by fast weight gain in commercially fed broiler chickens. Poult Sci. 2021;100(4). DOI: 10.1016/j.psj.2021.101020
28. Xing T, Zhao X, Zhang L, Li JL, Zhou GH, Xu XL, Gao F. Characteristics and incidence of broiler chicken wooden breast meat under commercial conditions in China. Poult Sci. 2020;99(1): 620-628. DOI: 10.3382/ps/pez560
29. Petracci M, Soglia F, Berri C. Muscle metabolism and meat quality abnormalities. In: Petracci M, and Berri C, editors. Poultry Quality Evaluation: Quality Attributes and Consumer Values. 1st ed. UK: Elsevier; 2017. 51-75 p. DOI: 10.1016/b978-0-08-100763-1.00003-9
30. Kawasaki T, Iwasaki T, Yamada M, Yoshida T, Watanabe T. Rapid growth rate results in remarkably hardened breast in broilers during the middle stage of rearing: A biochemical and histopathological study. PloS One. 2018;13(2). DOI: 10.1371/journal.pone.0193307
31. Huang X, Ahn DU. The incidence of muscle abnormalities in broiler breast meat - A review. Korean J Food Sci Anim Resour. 2018;38(5):835-850. DOI: 10.5851/kosfa.2018.e2
32. Pampouille E, Hennequet-Antier C, Praud C, Juanchich A, Brionne A, Godet E, Bordeau T, Fagnoul F, Le Bihan-Duval E, Berri C. Differential expression and co-expression gene network analyses reveal molecular mechanisms and candidate biomarkers involved in breast muscle myopathies in chicken. Sci Rep. 2019;9(1). DOI: 10.1038/s41598-019-51521-1
33. Praud C, Jimenez J, Pampouille E, Couroussé N, Godet E, Le Bihan-Duval E, Berri C. Molecular phenotyping of white striping and wooden breast myopathies in chicken. Front Physiol. 2020;11. DOI: 10.3389/fphys.2020.00633/full

ظهور مرض الخطوط البيضاء وتخشب عضلة الصدر في دجاج اللحم: مراجعة منهجية وتحليل تلوي

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الخلاصة

يمكن أن يؤدي النمو المتسارع للدجاج اللاحم المرتبط بعوامل مختلفة إلى اعتلال عضلي صدري. كان الهدف من الدراسة هو مراجعة وتحليل جميع المعلومات المتعلقة بحدوث وانتشار مرض الخطوط البيضاء (WS) والصدر الخشبي (WB) في الدجاج اللاحم من خلال المراجعة المنهجية والتحليل التلوي بناء على المصادر الحالية. لهذا الغرض، تم اختيار دراسات مختلفة وفقا لمعايير الاشتمال والاستبعاد لمراجعة منهجية، وبالتالي التحليل التلوي للحصول على متوسط قيمة الحدوث. تتوافق الدراسات التي تم تقييمها مع الدراسات في الجسم الحي التي حصلت على ١٢٥،٧٢٢ دجاجة لاحم ، مع الأخذ في الاعتبار كلا الجنسين، وهو خط وراثي مصمم لإنتاج اللحوم، والعمر الإنتاجي الكامل من ١ إلى ٤٢ يوما، والدجاج اللاحم الذي يتم تربيته في ظل ظروف تجارية. تم استخدام برنامج Meta Essentials، مما سمح بإجراء العمليات الحسابية. تم تحليل عدم التجانس باستخدام إحصائية كوكرين Q و I^2 Higgins's. توزيع التجانس من خلال المخطط القمعي. تحيز المنشورات باستخدام إحصائيات Egger بمستوى دلالة ٠،٠٠٥ وترجيح المقالات باستخدام مخطط الغابة. كان نسبة حدوث مرض الخطوط البيضاء ٦٢٪، والصدر الخشبي ٤٢٪. هناك حاجة إلى إنشاء اختبار تشخيصي موحد لتأكيد وجود و/أو شدة كلا المرضين بشكل موضوعي وتقليل التحيزات.