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Impact of Stocking Density on Productivity of Broiler

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Abstract

Stocking density (SD) is a critical factor influencing broiler performance, carcass quality, and welfare. This review examines current research on the effects of various SDs in broiler production systems. High SDs, although economically attractive, often compromise feed intake, body weight gain, and feed conversion ratio (FCR) due to overcrowding, competition, and elevated stress. In contrast, lower SDs (24–30 kg/m²) consistently support better growth performance, efficient feed utilization, and healthier carcass profiles. Beyond productivity, high SDs are linked to welfare concerns including footpad dermatitis, hock burns, breast blisters, and elevated stress indicators. Carcass and giblet yields are also diminished at higher densities. While mortality rates are not always significantly different, excessively high densities (>40 kg/m²) tend to increase early mortality and injury risk. Overall, the review highlights the importance of optimizing SD to balance productivity and welfare. Adopting low to moderate SDs (30–35 kg/m²) is recommended for sustainable, ethical broiler production. These findings offer practical insights for producers, veterinarians, and policymakers.

Keywords: Stocking density, Growth performance, FCR, Carcass quality, Animal welfare, Poultry management.

Introduction

The global poultry industry continues to expand rapidly to meet the increasing demand for affordable, high-quality animal protein. Broiler chicken production, in particular, has emerged as one of the most efficient and sustainable sources of meat worldwide. According to the United States Department of Agriculture (USDA, 2023), global broiler meat production has surpassed 100 million metric tons, with major contributions from countries such as the United States, Brazil, and China. Within this competitive and fast-growing sector, optimizing production efficiency while ensuring animal welfare remains a central challenge. Among the various management practices, stocking density (SD)—defined as the number of birds or live weight per unit area—is a critical factor influencing broiler productivity, carcass traits, and overall health and welfare.

Stocking density, defined as the number of birds or meat per unit area, directly affects the physical and biological environment of broilers, shaping their productivity and welfare outcomes (Puron *et al*., 2024). Research over the past decade highlights the significant impact of SD on these parameters, highlighting both the opportunities and challenges associated with improving stocking density. High SDs, while economically advantageous in the short term, often compromise the health, growth, and welfare of broilers, particularly when densities exceed 34–40 kg/m² (Council for Agricultural Science and Technology (CAST, 2018). It also reduces space allowance per bird, leading to increased competition for feeders, restricted movement and impaired resting behaviors (Berg & Yngvesson, 2012). This environment not only weakens growth performance but also poses significant challenges to broiler health and welfare (Bergeron *et al*., 2020).

Despite the importance, there are no universal guidelines for stocking density. Recommendations vary globally, reflecting differences in bird size, management practices, and regional regulations. In commercial settings, densities typically range from 30 to 35 kg/m² (CAST, 2018), aiming to optimize both productivity and health outcomes. In Canada, broiler SDs are capped at 31 kg/m² but can rise to 38 kg/m² under specific conditions (NCC, 2022). In the United States, SD recommendations range from 32 to 44 kg/m² depending on market weight, while in the European Union, SDs are limited to 33 kg/m², with allowances for increases to 39 or 42 kg/m² if welfare conditions are met (Council Directive 2007/43/EC). Additionally, certification programs such as the Global Animal Partnership and Certified Humane require adherence to lower stocking densities to promote animal welfare.

The relationship between stocking density and broiler performance is well-documented, particularly in areas such as growth performance, carcass quality, and health. High stocking densities negatively impact growth performance by

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limiting feed and water access, reducing body weight, feed intake, and feed conversion efficiency (FCR). Physiological stress responses, including elevated corticosterone levels, further exacerbate these effects by impairing metabolic processes and energy utilization essential for growth. Intestinal health also suffers under high-density conditions, as evidenced by mucosal damage and gut microflora disruptions that hinder nutrient absorption (Li *et al.*, 2022 and Goo *et al.*, 2024). Studies have consistently shown that lower stocking densities improve these outcomes, facilitating better feed consumption, weight gain, and FCR due to reduced competition and stress (Cengiz *et al.*, 2015 and Astaneh *et al.*, 2018).

Carcass quality parameters, such as dressing percentage, breast meat yield, and fat deposition, are also highly sensitive to stocking density. Overcrowding at higher densities reduces carcass yield and dressing percentages, while promoting fat deposition and mechanical injuries (Bilgili & Hess, 1995 and Zhang *et al.*, 2022). Lower densities, by contrast, are associated with improved carcass traits, including higher breast meat yields and leaner profiles, which align with consumer preferences for healthier meat options (Zhang *et al.*, 2022 and Jiao *et al.*, 2013).

Beyond productivity and carcass quality, stocking density profoundly affects broiler health and welfare. High SDs increase the prevalence of conditions such as footpad dermatitis (FPD), hock burns, breast blisters, and mortality. These conditions arise from prolonged contact with wet or compacted litter, restricted movement, and increased competition for resources. Footpad dermatitis and hock burns, for example, are exacerbated by the poor litter quality often associated with overcrowding, while breast blisters result from mechanical pressure and limited space for comfortable resting (Toghyani *et al.*, 2018 and Guinebretière *et al.*, 2024). Also, breast blister incidence is higher in broilers at high stocking densities due to increased litter moisture, which causes prolonged skin contact with wet litter, leading to irritation (Khosravinia, 2015 and Zabir *et al.*, 2021). Chronic stress, a hallmark of high-density environments, not only compromises bird health but also raises significant ethical concerns, influencing both consumer preferences and regulatory frameworks (Ventura *et al.*, 2012).

Currently, there are no universal guidelines for optimal stocking density, with recommendations varying across regions based on bird genetics, housing systems, and welfare regulations. For example, stocking densities in commercial systems typically range from 30 to 35 kg/m², with allowances to increase under specific conditions in Canada, the United States, and the European Union (CAST, 2018; NCC, 2022). Animal welfare certification programs often recommend even lower densities to ensure better welfare outcomes.

Given the multifaceted impacts of stocking density on broiler performance and welfare, it is crucial to identify a balance that supports both productivity and ethical farming practices. This review aims to evaluate the effects of varying stocking densities on broiler growth, carcass yield, health, and welfare, and to determine suitable density thresholds for sustainable and welfare-friendly broiler production systems.

Materials and Methods

This study is based on a comprehensive review of secondary literature. All data and information presented were obtained from previously published sources, including peer-reviewed journal articles, academic books, conference proceedings, organizational reports, and relevant online databases. Emphasis was placed on collecting the most recent and relevant findings related to the impact of stocking density on broiler performance, carcass quality, and welfare parameters.

A systematic approach was adopted to identify and evaluate the literature. Search terms such as "stocking density," "broiler performance," "feed conversion ratio," "carcass quality," and "welfare indicators in broilers" were used in databases including Google Scholar, PubMed, Scopus, and ScienceDirect. Studies published between 2005 and 2024 were prioritized to capture both foundational knowledge and recent advancements. Additional information was gathered from guidelines and reports issued by authoritative bodies such as the USDA, the Council for Agricultural Science and Technology (CAST), and the National Chicken Council (NCC).

Data from selected studies were compiled and compared to assess trends in body weight, feed intake, feed conversion ratio (FCR), mortality, and incidence of welfare issues such as footpad dermatitis, hock burns, and breast blisters under varying stocking densities. When applicable, numerical data were extracted and tabulated to illustrate performance outcomes under low, medium, and high stocking densities.

Constructive input from academic supervisors and faculty members was incorporated to refine the scope, structure, and clarity of this review. The final manuscript reflects a critical synthesis of the literature to provide evidence-based recommendations for optimal stocking density in commercial broiler production.

Result and Discussion

Growth Performance

The impact of stocking density (SD) on broiler growth performance is well-documented, with lower SDs (6–15 birds/m² or 24–30 kg/m²) consistently associated with improved body weight (BW), feed intake (FI), and welfare outcomes. Reduced crowding enhances feeder access, minimizes competition, and improves environmental conditions such as litter quality and air composition (Sirri *et al.*, 2007; Cengiz *et al.*, 2015; Goo *et al.*, 2024). High SDs, in contrast, impair growth due to limited movement, stress, and poor housing conditions (Simitzis *et al.*, 2012; Astaneh *et al.*, 2018 ; Yu *et al.*, 2021; Son *et al.*, 2022). Moderate densities may offer a balance between performance and economic efficiency (Dozier *et al.*, 2005; Guinebretière *et al.*, 2024; Kaya & Dereli, 2023). Table 1 from Nasr *et al.* (2021) showed that broilers reared at 14 birds/m² reached an average BW of 1951.07 g, significantly higher than those at 20 birds/m² (1381.50 g), reinforcing the inverse relationship between SD and growth.

Table 1: Growth performance of Broilers reared in different stocking densities

Parameters	Low SD	Medium SD	High SD	SEM
Body weight (g)	1,951.07^a	1,903.61^a	1,381.50^b	40.24
Average daily gain (g/d)	45.30^a	44.17^a	31.74^b	0.96
Feed intake (g)	3,050^a	2,950.92^b	2,300.40^c	91.51
FCR	1.56^b	1.55^b	1.66^a	0.01

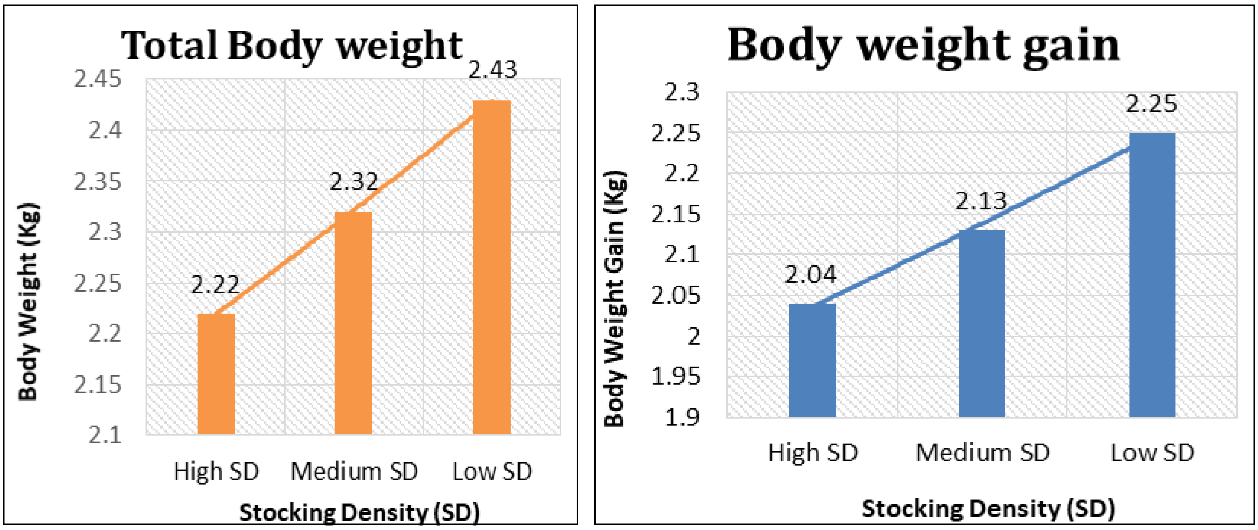
Source: *Nasr et al., 2021*

LSD=14 bird/m², MSD= 18 bird/m², HSD =20 bird/m²

a, b, c : Different Letter within the same row means significantly differ at $p \leq 0.05$ between the groups

Body Weight

Stocking density (SD) has a significant impact on broiler body weight (BW), with most studies indicating that lower densities promote higher final BW due to reduced competition, improved feeder access, and lower stress levels. Shynkaruk *et al.* (2023) reported the highest BW at 31–34.5 kg/m², while densities above 38 kg/m² led to marked reductions. Similarly, Cengiz *et al.* (2015), Sirri *et al.* (2007), and Henrique *et al.* (2017) documented improved BW at lower SDs. Abdelgaber *et al.* (2023) found significantly higher BW at 10 birds/m² compared to 18 birds/m² (Figure 1). Qaid *et al.* (2023) observed a clear inverse relationship between SD and BW from 30 to 120 chicks/m².



Source: *Abdelgaber et al., 2023*

Fig 1: Effect of stocking density on Total Body weight and Body weight Gain

Further supporting this trend, studies by Goo *et al.* (2024), Gholami *et al.* (2020), and Sugiharto (2022) demonstrated significant BW reductions with increasing SDs. Al-Ajlani *et al.* (2020) and Saini *et al.* (2022) noted that lower SDs also improved muscle development. Nasr *et al.* (2021) reported a 41% decrease in BW at 40 kg/m² compared to 28 kg/m². Other studies (e.g., Zuowei *et al.*, 2011; Zahir *et al.*, 2021; Franco-Rosselló *et al.*, 2022) further confirmed significantly higher BW at lower densities (26–30 kg/m²) compared to >40 kg/m².

However, some studies found no significant differences. Buijs *et al.* (2009), Zhou *et al.* (2024), and McKeith *et al.* (2020) reported similar BW across a wide range of SDs, suggesting that factors such as genetics, climate, and management also play roles. Abo Alqassem *et al.* (2018) and Li *et al.* (2022) noted optimal BW at moderate densities, implying that an intermediate SD may offer a practical balance between growth and resource use.

Feed Intake

Feed intake (FI) in broilers is strongly influenced by stocking density (SD), with lower densities generally promoting higher consumption. This is attributed to better feeder access, reduced competition, and lower stress levels. Numerous studies have reported increased FI under low SD conditions. Thema *et al.* (2022) observed a 12% higher FI at 9 birds/m² compared to 16 birds/m². Similarly, Nasr *et al.* (2021) and Goo *et al.* (2024) demonstrated significantly greater FI at densities of 14 birds/m² and 15.2 birds/m², respectively, with intake declining as SD increased.

Several researchers found consistent trends. Qaid *et al.* (2023), Kim *et al.* (2024), and Tong *et al.* (2020) reported reduced FI at higher SDs, ranging from 22 to 120 chicks/m². Al-Ajlani *et al.* (2020), Moussa *et al.* (2021), and Patel *et al.* (2023) observed 10–20% higher intake at lower densities (8–10 birds/m²), underscoring the adverse effects of crowding on feeding behavior. Jeon *et al.* (2022) and Li *et al.* (2022) also reported improved intake at lower SDs, while Dozier *et al.* (2005) and Astaneh *et al.* (2018) found that both low and moderate densities enhanced FI compared to high SDs.

However, some studies found no significant effects. Zhou *et al.* (2024), McKeith *et al.* (2020), and Franco-Rosselló *et al.* (2022) observed minimal differences in FI across a range of SDs. Notably, Pekel *et al.* (2020) and Abo Alqassem *et al.* (2018) reported higher FI at moderate to high SDs, particularly during early growth stages, suggesting that feed consumption may also be influenced by bird age, behavior, and management factors.

Feed Conversion Ratio (FCR)

Feed conversion ratio (FCR) is a critical measure of broiler production efficiency and is notably influenced by stocking density (SD). Generally, lower SDs are associated with improved FCR due to reduced stress, better feeder access, and enhanced gut health. Several studies, including Qaid *et al.* (2023), Nasr *et al.* (2021), and Rambau *et al.* (2016), reported significantly poorer FCR at high SDs (≥40 kg/m²), while Franco-Rosselló *et al.* (2022) and Bai *et al.* (2023) found superior FCR at lower densities (10 birds/m² or ~27 kg/m²).

Some findings, however, revealed mixed or non-significant effects. Abdelgaber *et al.* (2023), Pinheiro *et al.* (2024), and Zhou *et al.* (2024) observed no statistically significant differences across densities, though trends favored lower SDs. Interestingly, Asaniyan and Akinduro (2021) reported better FCR at higher densities (15 birds/m²), possibly due to more efficient feed utilization under controlled conditions. Li *et al.* (2017) and Siaga *et al.* (2017) reported marginally improved FCR at moderate SDs.

Physiological mechanisms may also explain these outcomes. Goo *et al.* (2024) linked enhanced FCR at lower SDs to improved intestinal integrity and nutrient absorption. Sirri *et al.* (2011) similarly emphasized better digestive efficiency under low-density conditions.

Carcass Quality

Carcass Yield and Giblet Traits

Stocking density (SD) significantly influences carcass yield, a key economic trait in broiler production. Lower SDs are generally associated with improved carcass characteristics due to better growth rates and reduced physiological stress. Abo Alqassem *et al*. (2018) reported higher dressing weights and organ yields at lower densities (12 birds/m²) compared to higher densities (20 birds/m²), with statistically significant differences in dressing weight, liver, gizzard, spleen, and heart weights (Table 2). Similarly, Franco-Rosselló *et al*. (2022) and Nasr *et al*. (2021) found higher carcass weights and dressing percentages at lower SDs (27–28 kg/m²), while van der Eijk *et al*. (2023) observed the highest carcass yield at 24 kg/m².

Table 2: Dressing yield and giblet yield of broiler in different stocking densities

Parameters	Low SD	Medium SD	High SD
Dressing wt (g)	1426.7 ± 14.10^{b}	1498.3 ± 7.21^{a}	1375.3 ± 17.03^{b}
Dressing %	75.0 ± 1.58^{a}	76.7 ± 0.30^{a}	75.7 ± 0.31^{a}
Liver wt (g)	48.9 ± 0.40^{a}	48.1 ± 1.09^{a}	44.1 ± 0.98^{b}
Gizzard wt (g)	46.7 ± 0.75^{a}	44.3 ± 1.09^{b}	38.6 ± 0.0^{c}
Spleen wt (g)	3.4 ± 0.23^{a}	2 ± 0.0^{b}	1.6 ± 0.11^{b}
Heart wt (g)	9.7 ± 0.28^{a}	9 ± 0.11^{a}	7.1 ± 0.28^{b}

Source: *Abo. Alqassem et al., 2018*

LSD=12 bird/m^2, MSD= 15 bird/m^2, HSD =20 bird/m^2
Result expressed as Mean ±Stander error
a, b, c: Different Letter within the column means significantly differ at $p\leq$ 0.05 between the groups

Siaga *et al*. (2017) also reported higher dressing percentages and giblet yields at lower densities (30 kg/m²), though most differences were not statistically significant (Table 3). Olanrewaju *et al*. (2024) and Kumar and Singh (2022) noted marked reductions in carcass traits beyond 20 birds/m². Conversely, studies by Pinheiro *et al*. (2024), Simsek*et al*. (2011), and Simitzis *et al*. (2012) reported no significant differences across SDs, while Dozier *et al*. (2005) and Cengiz *et al*. (2015) observed slightly higher yields at higher SDs without statistical significance.

Interestingly, Abo Alqassem *et al*. (2018) and Ahmed and Khan (2021) reported optimal dressing percentages at moderate densities (15–18 birds/m²), suggesting that under controlled conditions, moderate SDs can support favorable outcomes. Variability among findings may reflect differences in genetics, nutrition, and environmental management.

Table 3: Dressing yield and giblet yield of broiler in different stocking densities

Parameters	Low SD	Medium SD	High SD	SEM
Dressing %	82.70	80.60	78.40	1.39
Liver wt (g)	3.13	3.02	2.71	1.14
Gizzard wt (g)	1.59	1.55	1.69	1.20
Heart wt (g)	0.58	0.52	0.51	0.00
Abdominal fat (g)	1.74	1.81	1.77	0.10
Significance	NS	NS	NS	

Source: *Siaga et al., 2017*

LSD=30kg/m^2, MSD= 35 kg/m^2, HSD =40 kg/m^2
Result expressed as Mean ±Stander error
a, b, c: Different Letter within the column means significantly differ at $p\leq$ 0.05 between the groups

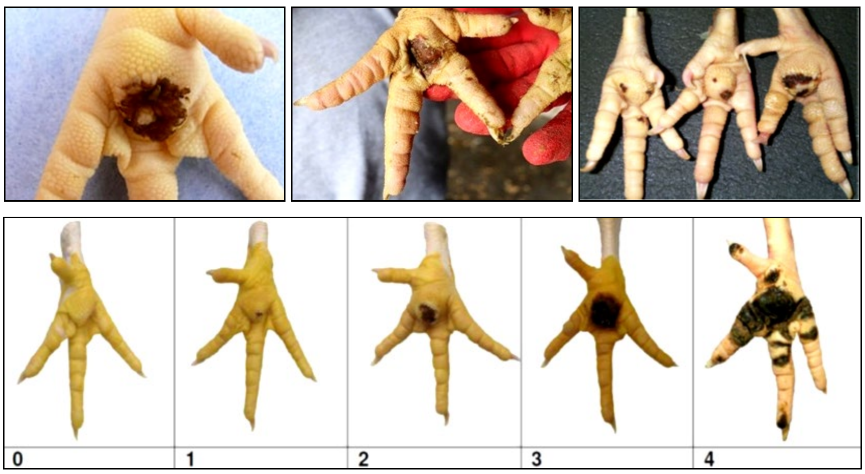
Abdominal Fat Deposition

The relationship between stocking density (SD) and abdominal fat yield is complex. Several studies, including Pinheiro *et al*. (2024), Siaga *et al*. (2017), and Zuowei *et al*. (2011), reported no significant differences across SDs, though lower fat percentages were often observed at higher densities. In contrast, studies by Lee and Jones (2020), Wang *et al*. (2021), and Tong *et al*. (2020) linked high SDs to increased fat deposition due to stress-induced metabolic imbalances. While Patel and Singh (2020) reported the lowest fat at 15 birds/m², Khosravinia (2015) found higher fat percentages at moderate densities, suggesting variable responses based on environmental and genetic factors.

Health and Welfare:

Footpad Dermatitis (FPD)

Footpad dermatitis (FPD) is a major welfare concern in broilers, strongly influenced by stocking density (SD). High SDs increase litter moisture due to excessive manure and water spillage, leading to greater prevalence and severity of FPD. Lesions are typically scored from 0 (no lesion) to 3 (severe; >1.5 cm) (Figure 2; Gadzama, 2024).



Score: *0= no abnormalities; 1= moderate lesion measuring less than 0.75 cm (diameter); 2= large lesions measuring more than 1.5 cm; and 3= severe lesions measuring more than 1.5 cm.*

Fig 2: Different scores of Foot Pad DermatitisSource: Gadzama, 2024

Multiple studies have shown a direct correlation between SD and FPD. Škrbić *et al.* (2012) reported a 25% increase in lesions above 30 kg/m². Zhou *et al.* (2024), Mocz *et al.* (2022), and Shynkaruk *et al.* (2023) observed more severe FPD at SDs >40 kg/m², while Erensoy *et al.* (2024) and Khosravinia (2015) found higher scores at 36 and 14 birds/m², respectively. Abdelgaber *et al.* (2023) showed significantly increased FPD scores at 18 birds/m² compared to 10 birds/m², especially by day 33 (Table 4).

Table 4: Effect of stocking density on Foot pad dermatitis (FPD) scoring of broiler chickens

Age	Score	Low SD	Medium SD	High SD
At 21 days	0	100.00^{a}	92.75^{b}	83.64^{c}
	1	0^{b}	7.25^{a}	12.96^{a}
	2	0	0	0
	3	0	0	0
At 33 days	0	63.25^{ab}	73.59^{a}	50.09^{ab}
	1	15.87	12.30	10.27
	2	18.01	11.50	20.01
	3	2.78^{b}	2.54^{b}	13.63^{a}

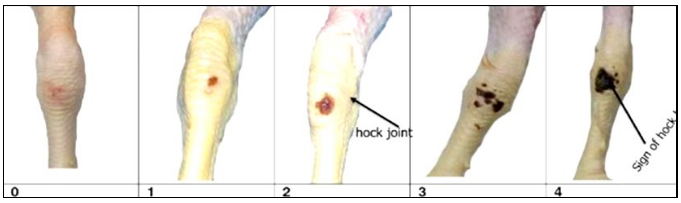
Source: *Abdelgaber et al., 2023*

LSD=10 bird/m^2, MSD= 15 bird/m^2, HSD =18 bird/m^2
Result expressed as Mean ±Stander error
a, b, c: Different Letter within the column means significantly differ at $p\leq$ 0.05 between the groups

Conversely, moderate densities (24–30 kg/m²) were associated with improved leg health and reduced FPD (Guinebretière *et al.*, 2024; van der Eijk *et al.*, 2023). Although litter quality can mitigate FPD (Alabi *et al.*, 2023), high SDs remain a dominant risk factor, reinforcing the need to balance bird density with proper litter management for optimal welfare (Shepherd & Fairchild, 2010).

Hock Burn

Hock burn, a key welfare indicator in broiler production, is closely associated with high stocking densities (SD) and increased litter moisture. Similar to footpad dermatitis, overcrowding exacerbates lesion severity due to limited space and prolonged contact with damp litter (Figure 3; Ishaya Gadzama *et al.*, 2024).



Source: *IshayaGadzama et al., 2024*

Fig 3: Different scores of Hock Burn

Numerous studies have confirmed that higher SDs lead to increased hock burn prevalence. Van der Eijk *et al.* (2023) and Guinebretière *et al.* (2024) observed significantly more severe lesions at densities of 37–42 kg/m² compared to 24–30 kg/m². Abdelgaber *et al.* (2023) demonstrated higher hock burn scores at 18 birds/m², particularly by day 33, with significantly more birds showing severe lesions at higher SDs (Table 5). Hepworth *et al.* (2010) reported a 15% increase in hock burn when SD increased from 30 to 38 kg/m².

Table 5: Effect of stocking density on Hock Burn (HB) scores of broiler chickens

Age	Score	Low SD	Medium SD	High SD
At 21 days	0	78.33	67.75^{ab}	54.63^{b}
	1	21.67	26.09	33.02
	2	0.00^{b}	6.16^{b}	12.35^{c}
	3	0	0	0
At 33 days	0	43.73	50.03	33.78
	1	26.87	24.47	15.55
	2	26.63^{a}	18.74^{b}	26.81^{a}
	3	2.78^{b}	6.76^{b}	23.80^{a}

Source: *Abdelgaber et al., 2023*

LSD=10 bird/m^2, MSD= 15 bird/m^2, HSD =18 bird/m^2
Result expressed as Mean ±Stander error
a, b, c: Different Letter within the column means significantly differ at $p\leq$ 0.05 between the groups

Bailie *et al.* (2018) found that while moderate SDs (30–36 kg/m²) did not significantly affect litter moisture or incidence rates, dermatitis severity increased with higher SDs (Table 6). Supporting evidence from Wang *et al.* (2021), Son *et al.* (2013), and Erensoy *et al.* (2024) also highlights the link between high SDs and elevated hock burn risk, reinforcing the need for proper litter and space management to safeguard leg health.

Table 6: Effects of stocking density on measures of dermatitis severity and litter moisture

Parameters	Stocking density (SD)				P-value
	30 kg/m^2	32 kg/m^2	34 kg/m^2	36 kg/m^2	
Litter moisture (%)	32.3	30.0	31.1	31.4	0.87
Incidence of hock burn (%)	15.1	14.7	16.7	16.0	0.75
Incidence of podo dermatitis (%)	59.3	57.0	48.1	54.7	0.14
Severity of dermatitis lesions	4.0^{a}	4.2^{a,b}	4.3^{b}	4.4^{b}	<0.05

Source: *Bailie et al., 2018*

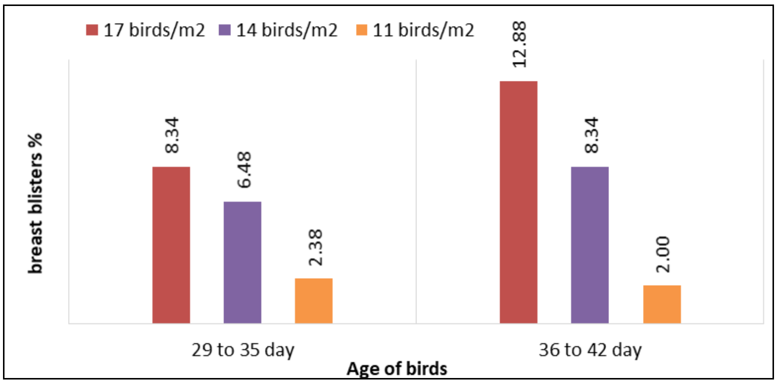
Breast Blister

Breast blisters, resulting from prolonged contact with wet litter, are significantly influenced by stocking density (SD). Interestingly, Erensoy *et al.* (2024) found more breast blisters at lower SDs (18 birds/m²), potentially due to behavioral factors. However, most evidence, including from Kaukonen *et al.* (2016) and Arnould & Leterrier (2021), supports that lower densities (24–30 kg/m²) reduce blister formation by improving movement and litter conditions. Poor ventilation in high-density systems further exacerbates the issue (Li *et al.*, 2016). Visual depiction of blister severity is shown in Figure 4.

Source: *www.backyardchickens.com*

Fig 4: Breast Blister

High SDs reduce resting space and elevate stress, increasing the risk of blisters. Khosravinia (2015) and Zahir *et al*. (2021) reported significantly higher blister prevalence at densities exceeding 14 birds/m². Brown *et al*. (2019) observed a 25% increase in cases above 20 birds/m², while Zhao *et al*. (2009) demonstrated greater incidence above 30 kg/m² (Figure 5).



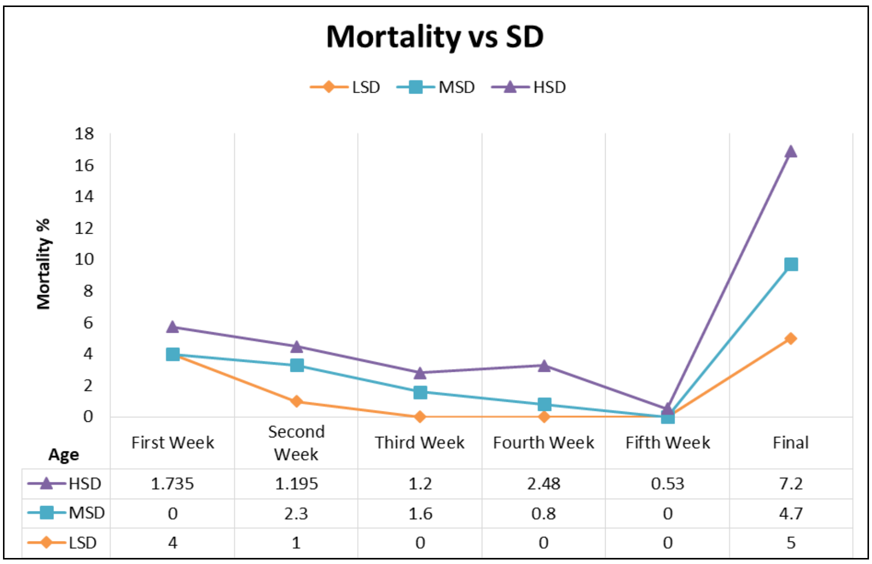
Source: *Zhao, 2009*

Fig 5: Effects of stocking density on the incidence of Breast Blisters (BB)

3.3.4 Mortality

The relationship between stocking density (SD) and broiler mortality is variable, with many studies reporting no statistically significant differences. Research by Thomas *et al*. (2004), Buijs *et al*. (2009), López-López *et al*. (2022), and van der Eijk *et al*. (2023) found mortality rates unaffected across a range of SDs. However, certain trends emerge under specific conditions. Buijs *et al*. (2009) noted a peak in mortality at 35 kg/m², while Dozier *et al*. (2005) reported increased mortality at medium density (35 kg/m²) by 49 days.

Some studies identified age-specific effects. Madilindi *et al*. (2018) observed higher mortality at high SDs during early growth (≤21 days), which diminished over time. Qaid *et al*. (2023) and Abo Alqassem *et al*. (2018) reported significantly higher mortality at extreme SDs (120 birds/m² and 20 birds/m², respectively), with the lowest rates at moderate densities (15 birds/m²). Conversely, Khosravinia (2015) reported slightly higher mortality at lower densities, though not statistically significant. Mortality trends across densities and age are depicted in Figure 6. These findings suggest that while SD may not always significantly influence mortality, overcrowding and age-specific stressors can elevate risk.



Source: *Abo. Alqassem et al., 2018*

Fig 6: Mortality in different stocking density and age

Conclusion

Stocking density is a critical management factor that directly influences broiler growth performance, carcass traits, and welfare indicators. Evidence from numerous studies demonstrates that lower to moderate stocking densities (24–30 kg/m²) support optimal body weight gain, feed intake, and feed conversion efficiency. High densities, particularly those exceeding 35–40 kg/m², are consistently associated with reduced growth performance, poorer carcass yield, and compromised welfare, including increased incidences of footpad dermatitis, hock burns, breast blisters, and in some cases, elevated mortality. While some variability exists depending on bird genetics, environmental conditions, and management practices, the overall trend favors adopting lower densities to enhance both productivity and animal welfare. Moderate densities may offer a practical balance between economic efficiency and welfare if accompanied by stringent management of litter quality, ventilation, and space allocation. Future research should focus on region-specific recommendations and integrating advanced housing technologies to optimize density thresholds. Ultimately, responsible density management is essential for sustainable, ethical, and economically viable broiler production systems.

References

1. Abdelgaber AA, Mohammed AAA, Mahmoud UT and Darwish MHA. Effect of stocking density on broilers behaviour and welfare indices. *Assiut Veterinary Medical Journal*. 2023; 69(179):1–13.
2. Abo. Alqassem ZM, Ahmed SA, Ahmed EA and El Iraqi KG. Effect of different stocking densities as an environmental stressing factor on broiler behavior and performance. *Benha Veterinary Medical Journal*. 2018; 34(2):51–65.
3. Alabi OM, Olagunju SO, Aderemi FA, Lawal TE, Oguntunji AO, Ayoola MO, Oladejo OA, Adeleye BE, Adewumi AA, Alabi BD and Tarta A. Effect of litter management systems on incidence and severity of footpad dermatitis among broilers at finisher stage. *Translational Animal Science*, 8:txad145, 2023.
4. Asaniyan EK and Akinduro VO. Impact of stocking density on the rearing environment and growth performance of broiler chicken. *Nigerian Journal of Animal Production*. 2021; 47(6):65–81.
5. Astaneh IY, Chamani M, Mousavi SN, Sadeghi AA and Afshar MA. Effects of stocking density on performance and immunity in Ross 308 broiler chickens. *Kafkas University Veterinary Faculty Journal*. 2018; 24(4):483-489.
6. Bai K, Huang Q, Zhang J, He J, Zhang L and Wang T. Supplemental effects of probiotic *Bacillus subtilis* on growth performance, antioxidant capacity, and meat quality of broiler chickens. *Poultry Science*. 2017; 96(1):74–82.
7. Berg C and Yngvesson J. The impact of stocking density on broiler welfare and performance. *Journal of Poultry Science*. 2012; 49(3):1-10.
8. Bergeron S, Pouliot E and Doyon M. Commercial poultry production stocking density influence on bird health and performance indicators. *Animals*. 2020; 10(8):1253.
9. Bilgili SF and Hess JB. The effects of stocking density on broiler performance and carcass quality. *Poultry Science.* 1995; 74(12):1-6.
10. Buijs S, Keeling L, Rettenbacher S, Van Poucke E and Tuyttens FAM. Stocking density effects on broiler welfare: Identifying sensitive ranges for different indicators. *Animal Welfare*. 2009; 18(1):1-8.
11. Cengiz Ö, Köksal BH, Tatlı O, Sevim Ö, Ahsan U, Üner AG, Ulutaş PA, Beyaz D, Büyükyörük S, Yakan A and Önol AG. Effect of dietary probiotic and high stocking density on the performance, carcass yield, gut microflora, and stress indicators of broilers. *Poultry Science*. 2015; 94(10):2395–2403.
12. Council Directive 2007/43/EC. Laying down minimum rules for the protection of chickens kept for meat production. *Official Journal of the European Union,* 2007.
13. Council for Agricultural Science and Technology (CAST). The role of stocking density in poultry production. *CAST Issue Paper* 62, 2018.
14. Dozier WA, III, Thaxton JP, Branton SL, Morgan GW, Miles DM, Roush WB, Lott BD and Vizzier-Thaxton Y. Stocking density effects on growth performance and processing yields of heavy broilers. *Poultry Science*. 2005; 84(6):1352–1359.
15. Dozier WA, III, Thaxton JP. Purswell JL, Olanrewaju HA, Branton SL.and Roush WB. Stocking density effects on male broilers grown to 1.8 kilograms of body weight. *Poultry Science*. 2006; 85(2):344–351.
16. Erensoy K, Sarıca M, Noubandiguim M and Karaçay N. The effects of varying stocking densities during the first 10 days on the performance, welfare, slaughter, and meat quality characteristics of broiler chickens in the subsequent period. *Tropical Animal Health and Production*. 2024; 56(8):286.
17. Franco-Rosselló R, Navarro-Villa A, Polo J, Solà-Oriol D and García-Ruiz AI. Improving broiler performance at market age regardless of stocking density by using a pre-starter diet. *Poultry Science*. 2024; 103(2):1-8.
18. Gholami M, Chamani M, Seidavi A, Sadeghi AA and Aminafschar M. Effects of stocking density and climate region on performance, immunity, carcass characteristics, blood constituents, and economical parameters of broiler chickens. *RevistaBrasileira de Zootecnia*. 2020; 49:e20190049.
19. Goo D, Kim JH, Choi HS, Park GH, Han GP and Kil DY. Effect of stocking density and sex on growth performance, meat quality, and intestinal barrier function in broiler chickens. *Poultry Science*. 2024; 103(3):1-10.
20. Guinebretière M, Warin L, Moysan JP, Méda B, Mocz F, Bihan-Duval EL, Thomas R, Keita A and Mignon-Grasteau S. Effects of strain and stocking density on leg health, activity, and use of enrichments in conventional broiler chicken production. *Poultry Science.* 2024; 103(9):103993.
21. Henrique CDS, Oliveira AFG, Ferreira TS, Giusti Bruno LD and others. Effect of stocking density on performance, carcass yield, productivity, and bone development in broiler chickens Cobb 500®. *SEMINA: CiênciasAgrárias*. 2017; 38(4 Supl 1):2705–2714.
22. Hepworth PJ, Nefedov AV. Muchnik IB and Morgan KL. Early warning indicators for hock burn in broiler flocks. *Avian Pathology: Journal of the W.V.P.A.* 2010; 39(5):405–409.
23. Jeon JJ, Kim HJ, Kim HJ, Kang HK, Kim CH, Kim HS, Kang BS, Kim SH and Jang A. Effects of animal welfare-certified rearing systems on the blood parameters and meat quality characteristics of broilers at the farm level in Korea. *Food Science of Animal Resources.* 2022; 42(1):128–141.

24. Jiao H, Jiang Y, Song Z, Lin H and Song Z. Effect of perch type and stocking density on the behaviour and growth of broilers. *Animal Production Science.* 2013; 54(7):973-980.
25. Kaukonen E, Norring M and Valros A. Effect of litter quality on foot pad dermatitis, hock burns, and breast blisters in broiler breeders during the production period. *Avian Pathology: Journal of the W.V.P.A.* 2016; 45(6):667–673.
26. Kaya M and DereliFidan E. The effect of drinking water temperature and stocking density on broiler performance, meat quality, and some behavioral traits at high ambient temperature. *Journal of the Hellenic Veterinary Medical Society.* 2023; 74(1):5315–5324.
27. Khosravinia H. The effects of stocking density on carcass quality and feed conversion ratio in broilers: A review of recent findings. *Journal of Animal Production Science.* 2015; 55(3):1-7.
28. Kim CH, Kim KH, Chun JL, Lim SJ and Jeon JH. Animal welfare indicators and stress response of broiler chickens raised at low and high stocking density. *Journal of Animal Science and Technology*. 2024; 66:e64.
29. Li J, Miao Z, Tian W, Yang Y, Wang J and Yang Y. Effects of different rearing systems on growth, small intestinal morphology, and selected indices of fermentation status in broilers. *Asian-Australasian Journal of Animal Sciences.* 2016; 29(10):1510–1517.
30. Li J, Miao Z, Tian W, Yang Y, Wang J and Yang Y. Effects of different rearing systems on growth, small intestinal morphology and selected indices of fermentation status in broilers. *Animal Science Journal.* 2017; 88(6):900-908.
31. Li Y, Xing S, Wang X, Li X, Zhang M and Feng J. Effects of increasing stocking density on the performance and ileal microbiota of broilers. *The Journal of Poultry Science.* 2022; 59(3):291–296.
32. López-López P, Sarmiento-Franco LA and Santos-Ricalde R. Effect of stocking density on performance, infection by *Eimeria* spp., intestinal lesions, and foot pad injuries in broilers with outdoor access under tropical conditions. *British Poultry Science.* 2022; 63(2):108–114.
33. McKeith A, Loper M and Tarrant KJ. Stocking density effects on production qualities of broilers raised without the use of antibiotics. *Poultry Science.* 2020; 99(2):698–701.
34. Mocz F, Michel V, Janvrot M, Moysan JP, Keita A, Riber AB and Guinebretière M. Positive effects of elevated platforms and straw bales on the welfare of fast-growing broiler chickens reared at two different stocking densities. *Journal of Animal Science and Technology.* 2024; 12(5):542.
35. Nasr MAF, Abouelezz KFM and El-Husseiny OM. Impact of stocking density on growth performance and welfare in broiler chickens. *Animal Production Science.* 2021; 61(12):1-9.
36. National Chicken Council (NCC). Guidelines for broiler stocking density. *NCC Report,* 2022.
37. Olanrewaju HA, Magee CL, Collier SD and Purswell JL. Effect of stocking density on selected blood physiological, biochemical, and enzymatical variables of broilers grown to 3 kg under antibiotic-free conditions. *Indian Journal of Animal Research.* 2024; 58(1):1-7. https://doi.org/10.18805/IJAR.BF-1848
38. Pekel E, Yilmazer-Musaoglu H and Yilmazer-Musaoglu, H. Effects of reducing dietary amino acid density and stocking density on growth performance, carcass characteristics, meat quality, and occurrence of white striping in broiler chickens. *Journal of Poultry Science.* 2020; 99(12):7178–7191
39. Pinheiro AL, Mascarenhas AG, Café MB, Mello HHC, Lopes JCB and Rezende DML. Welfare and production performance of broilers reared at different stocking densities. *RevistaBrasileira de CiênciaAvícola*. 2024; 26(3):001-010.
40. Puron E, Silva J and Oliveira A. Physiological stress and oxidative stress markers in broilers subjected to high stocking densities. *Poultry Science.* 2024; 103(1):1-12.
41. Qaid MM, El-Kassas HA and El-Bahr SM. The impact of stocking density on growth performance, carcass characteristics, and some blood parameters of broiler chickens. *Poultry Science.* 2023; 102(5):1-10.
42. Rambau MD, Mudau ML, Makhanya SD and Benyi K. Effects of stocking density and daily feed withdrawal periods on the performance of broiler chickens in a semi-arid environment. *Tropical Animal Health and Production.* 2016; 48(8):1547–1554.
43. Saini A, Sharma S, Singh N, Saini R and Chandra V. Effect of different stocking density on broiler performance with and without Ashwagandha (*Withaniasomnifera*) supplementation. *Indian Journal of Animal Nutrition.* 2022; 39(1):104-112.
44. Shepherd EM and Fairchild BD. Footpad dermatitis in poultry. *Poultry Science.* 2010; 89(10):2043–2051.
45. Shynkaruk T, Long K, LeBlanc C and Schwean-Lardner K. Impact of stocking density on the welfare and productivity of broiler chickens reared to 34 d of age. *Journal of Applied Poultry Research.* 2023; 32(2):100344.
46. Siaga R, Baloyi JJ, Rambau MD and Benyi K. Effects of stocking density and genotype on the growth performance of male and female broiler chickens. *Asian Journal of Poultry Science.* 2017; 11(3):96-104.
47. Simitzis PE, Kalogeraki E, Goliomytis M, Charismiadou MA, Triantaphyllopoulos K, Ayoutanti A, Niforou K, Hager-Theodorides AL and Deligeorgis SG. Impact of stocking density on broiler growth performance, meat characteristics, behavioural components and indicators of physiological and oxidative stress. *British Poultry Science.* 2012; 53(6):721–730.
48. Simsek UG, Ciftci M, Cerci IH, Bayraktar M, Dalkilic B, Arslan O and Balci TA. Impact of stocking density and feeding regimen on broilers: Performance, carcass traits and bone mineralization. *Journal of Applied Animal Research.* 2011; 39(2):230-233.
49. Sirri G, Minelli E, Folegatti S and Meluzzi A. Footpad dermatitis and productive traits in broiler chickens kept with different stocking densities, litter types and light regimen. *Italian Journal of Animal Science.* 2007; 6(4):734-736.
50. Škrbić Z, Pavlovski Z, Lukić M, Petričević V, Miljković B and Marinkov G. The effect of the diet on incidence of foot-pad lesions and productivity of broilers. *Biotechnology in Animal Husbandry.* 2012; 28:353-360.
51. Son J, Kim HJ, Hong EC and Kang HK. Effects of stocking density on growth performance, antioxidant status, and meat quality of finisher broiler chickens under high temperature. *Antioxidants (Basel, Switzerland).* 2022; 11(5):871.
52. Son SW, Lee HJ and Kim JH. The effects of different stocking densities on growth performance and meat quality in broilers. *Asian-Australasian Journal of Animal Sciences.* 2013; 26(12):1670-1677.
53. Sugiharto S. Dietary strategies to alleviate high-stocking-density-induced stress in broiler chickens-a comprehensive review. *Archives Animal Breeding.* 2022; 65(1): 21–36.
54. Thema KK, Mnisi CM and Mlambo V. Stocking density-

induced changes in growth performance, blood parameters, meat quality traits, and welfare of broiler chickens reared under semi-arid subtropical conditions. *PloS One.* 2022; 17(10):e0275811.
55. Thomas P, Wilson JH and Havenstein GB. Effects of stocking density on performance, behavior, and carcass characteristics of broiler chickens. *Poultry Science.* 2004; 83(1):1-7.
56. Toghyani M, Tabeidian SA and Gheisari HR. Mechanical injuries caused by overcrowding in broilers: Implications for management practices and welfare outcomes. *Veterinary Research Forum.* 2018; 9(3):251-258.
57. USDA. *World Agricultural Supply and Demand Estimates*. United States Department of Agriculture, 2023.
58. Van der Eijk JAJ, van Harn J, Gunnink H, Melis S, van Riel JW and de Jong IC. Fast- and slower-growing broilers respond similarly to a reduction in stocking density with regard to gait, hock burn, skin lesions, cleanliness, and performance. *Poultry Science.* 2023; 102(5):102603.
59. Ventura BA Siewerdt F and Estevez I. Access to barrier perches improves behavior repertoire in broilers. *PLoS One.* 2012; 7(12):e29826.
60. Wang L, Kong L, Hu X, Bai H, Wang Z, Jiang Y, Bi Y, Chang G and Chen G. Effect of stocking density on performance, meat quality and cecal bacterial communities of yellow feather broilers. *Animal Biotechnology.* 2021; 33(1):1-11.
61. Yu DG, Namgung N, Kim JH, Won SY, Choi WJ and Kil DY. Effects of stocking density and dietary vitamin C on performance, meat quality, intestinal permeability, and stress indicators in broiler chickens. *Journal of Animal Science and Technology.* 2021; 63(1):815-826.
62. Zabir M, Miah MA, Alam M, Bhuiyan MEJ, Haque MI, Sujan KM and Mustari A. Impacts of stocking density rates on welfare, growth, and hemato-biochemical profile in broiler chickens. *Journal of Advanced Veterinary and Animal Research.* 2021; 8(4):642–649.
63. Zhang Y, Li X and Wang Z. Effects of high stocking densities on breast meat quality in broilers: Implications for production practices. *Animal Production Science.* 2022; 62(4):345–352.
64. Zhao FR, Geng L, Li B and Zhao YJ. Effects of environmental factors on breast blister incidence, growth performance, and some biochemical indexes in broilers. *The Journal of Applied Poultry Research.* 2009; 18(4):699–706.
65. Zhou S, Watcharaanantapong P, Yang X, Thornton T, Gan H, Tabler T, Prado M and Zhao Y. Evaluating broiler welfare and behavior as affected by growth rate and stocking density. *Poultry Science.* 2024; 103(4):103459.
66. Zuowei S, Yan L, Yuan L, Jiao H, Song Z, Guo Y and Lin H. Stocking density affects the growth performance of broilers in a sex-dependent fashion. *Poultry Science.* 2011; 90(7):1406–1415.