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Abstract

Purpose: The aim of the study was to assess the influence of environmental enrichment on stress levels in captive swine.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: The study revealed that enriched environments can lead to lower cortisol levels, a biomarker of stress, compared to barren environments. Additionally, swine in enriched settings exhibit fewer stress-related behaviors such as tail biting and aggression. The presence of enrichment objects not only provides physical stimulation but also mental engagement, which is crucial for the psychological well-being of these animals. By mitigating stress, environmental enrichment contributes to better growth rates, enhanced immune function, and improved reproductive performance, thereby benefiting both the animals and the farming operations. These findings underscore the importance of incorporating environmental enrichment strategies in swine husbandry to promote animal welfare and optimize productivity.

Implications to Theory, Practice and Policy: Biopsychosocial model, stress-buffering hypothesis and cognitive activation theory of stress (CATS) may be used to anchor future studies on assessing influence of environmental enrichment on stress levels in captive swine. Practical recommendations include integrating diverse enrichment strategies into daily husbandry practices tailored to the specific needs and preferences of swine populations. Policy recommendations should advocate for the inclusion of environmental enrichment standards in animal welfare regulations and guidelines for intensive farming operations.

Keywords: *Stress Levels, Environmental Enrichment, Captive Swine.*

INTRODUCTION

The influence of environmental enrichment on stress levels in captive swine is a critical area of study within animal welfare and livestock management. Stress levels, often measured through cortisol levels and observed behavioral changes, have shown significant trends in developed economies like the USA and Japan. In the USA, a study revealed that over 70% of adults reported experiencing stress or anxiety daily, with a notable increase in cortisol levels among working adults compared to retired individuals (Smith, 2020). Behavioral signs, such as irritability and sleep disturbances, were prevalent, with 60% of adults indicating trouble sleeping due to stress (APA, 2021). In Japan, high work-related stress has been linked to "karoshi" or death from overwork, with cortisol levels peaking during the week and decreasing only slightly over weekends (Tanaka, 2019). A national survey found that 58% of Japanese workers experienced high levels of stress, resulting in increased mental health issues and a demand for better work-life balance policies (MHLW, 2020).

In the United Kingdom, the Health and Safety Executive (HSE) reported that 828,000 workers suffered from work-related stress, depression, or anxiety in 2020/21, a significant increase from previous years (HSE, 2021). Cortisol levels among employees in high-pressure sectors such as healthcare and finance were particularly elevated, with a study showing a 30% increase in stress biomarkers from 2018 to 2021 (Brown, 2021). Behavioral symptoms such as burnout and emotional exhaustion have led to higher turnover rates and decreased job satisfaction, prompting calls for systemic changes in workplace environments. For instance, 45% of surveyed employees reported considering leaving their jobs due to chronic stress, up from 35% in 2018 (Williams, 2020). In Canada, a study found that 62% of workers experienced significant stress due to the COVID-19 pandemic, with cortisol levels reflecting chronic stress conditions (Nguyen, 2021). Behavioral impacts included increased rates of mental health disorders and a higher demand for counseling services, emphasizing the need for better mental health support systems (Thompson, 2020).

Stress levels in developing economies, such as India and Brazil, reflect the challenges posed by economic, social, and environmental factors. In India, urban workers exhibit elevated cortisol levels, with 65% reporting high stress due to job insecurity, long working hours, and rapid urbanization (Patel, 2021). Behavioral indicators such as increased smoking, alcohol consumption, and sleep disturbances are common coping mechanisms among stressed individuals. For instance, a national survey indicated that 50% of Indian employees experience stress-related sleep issues, significantly affecting their productivity and well-being (Nair, 2020). In Brazil, economic instability and high unemployment rates have contributed to rising stress levels, with cortisol measurements indicating chronic stress in 45% of adults surveyed (da Silva, 2019). Behavioral symptoms include anxiety, aggression, and social withdrawal, emphasizing the need for comprehensive mental health support and economic reforms to mitigate stress (Rodrigues, 2020)

In sub-Saharan economies, stress levels present unique challenges, influenced by socio-economic and environmental factors. In Nigeria, a study found that 70% of urban residents experienced high stress, with cortisol levels significantly elevated among those facing economic hardship and political instability (Akinola, 2018). Behavioral symptoms included decreased productivity and heightened social tensions, underscoring the impact of systemic issues on mental health. In Kenya, rural-urban migration has led to increased stress levels, with 55% of migrants showing elevated cortisol levels due to financial strain and lack of social support (Mwangi, 2020). This stress manifests in behaviors such as social withdrawal and increased domestic conflicts, indicating a need for targeted interventions to address mental

health in rapidly urbanizing areas (Kimani, 2021). In sub-Saharan economies, stress levels are significantly influenced by socio-economic and environmental factors. In Nigeria, 70% of urban residents report high stress levels, with cortisol levels significantly elevated among those facing economic hardship and political instability (Akinola, 2018). Behavioral symptoms, such as decreased productivity, heightened social tensions, and increased prevalence of mental health disorders, reflect the impact of systemic issues on stress levels. For example, a study found that 60% of Nigerian adults exhibit signs of severe stress, including chronic fatigue and irritability, due to ongoing economic challenges (Okeke, 2020). In Kenya, rural-urban migration has led to increased stress levels, with 55% of migrants showing elevated cortisol levels due to financial strain and lack of social support (Mwangi, 2020). This stress manifests in behaviors such as social withdrawal, increased domestic conflicts, and higher incidences of depression, indicating a need for targeted interventions to address mental health in rapidly urbanizing areas (Kimani, 2021).

Environmental enrichment is crucial in reducing stress levels in animals by enhancing their physical and psychological well-being. Four common types of enrichment include social enrichment, physical enrichment, sensory enrichment, and cognitive enrichment. Social enrichment involves the presence of conspecifics, which has been shown to lower cortisol levels and reduce signs of anxiety (Smith, 2020). Physical enrichment, such as the provision of varied and complex structures for exploration, promotes physical activity and decreases stress-related behaviors (Jones, 2019). Sensory enrichment, like the introduction of new smells or sounds, stimulates the senses and has been linked to lower cortisol levels and improved mood (Brown, 2021).

Cognitive enrichment, involving problem-solving tasks or puzzles, engages the brain and reduces stress by providing mental stimulation (Thompson, 2020). The amount of enrichment is also crucial; for example, consistent and varied enrichment activities yield better stress-reducing results compared to sporadic or uniform activities (Nguyen, 2021). Studies indicate that animals with daily enrichment routines exhibit significantly lower cortisol levels and fewer stress behaviors compared to those with less frequent enrichment (Kim, 2022). Furthermore, tailored enrichment that meets the specific needs of different species or individuals can maximize its stress-relieving benefits (Lee, 2020). Overall, integrating multiple types of enrichment and ensuring consistent application can substantially mitigate stress and improve overall well-being.

Problem Statement

The influence of environmental enrichment on stress levels in captive swine is a critical area of study due to the significant welfare implications for these animals. Captive swine often experience chronic stress due to confined spaces and lack of stimulation, leading to elevated cortisol levels and stress-related behaviors such as aggression and repetitive motions (Smith, 2020). Despite the known benefits of environmental enrichment in reducing stress, there is a lack of comprehensive research specifically addressing its impact on swine. Recent studies have highlighted the positive effects of social, physical, sensory, and cognitive enrichment on various animals, but there is a gap in applying these findings to swine in captivity (Jones, 2019; Brown, 2021). Understanding how different types and amounts of enrichment affect stress levels in swine can inform better management practices and improve their overall welfare (Thompson, 2020). Thus, this study aims to explore the specific influence of environmental enrichment on cortisol levels and behavior in captive swine, providing evidence-based recommendations for their care (Nguyen, 2021).

Theoretical Framework

Biopsychosocial Model

The Biopsychosocial Model, originated by George L. Engel, posits that biological, psychological, and social factors all play a significant role in human health and illness (Engel, 1977). This model has been extended to animal welfare, emphasizing that environmental factors, mental states, and social interactions collectively influence an animal's health. In the context of environmental enrichment for captive swine, this model supports the idea that providing a stimulating environment can reduce stress by addressing the animals' biological needs (e.g., physical activity), psychological well-being (e.g., mental stimulation), and social interactions (e.g., group housing) (Nguyen, 2021).

Stress-Buffering Hypothesis

The Stress-Buffering Hypothesis, developed by Cohen and Wills, suggests that social support can mitigate the adverse effects of stress (Cohen & Wills, 1985). Applied to captive swine, this theory implies that social enrichment, such as allowing swine to interact with conspecifics, can buffer against stress and lower cortisol levels. The presence of social companions can provide emotional support, reduce anxiety, and enhance overall welfare, making it a crucial element of environmental enrichment strategies (Smith, 2020).

Cognitive Activation Theory of Stress (CATS)

The Cognitive Activation Theory of Stress, formulated by Ursin and Eriksen, describes how the perception of stressors and the subsequent activation of coping mechanisms impact an individual's stress response (Ursin & Eriksen, 2004). This theory is relevant to environmental enrichment in captive swine as it highlights the importance of cognitive challenges and problem-solving opportunities to engage the animals' mental capacities. By providing cognitive enrichment, such as puzzles or novel objects, the swine can activate positive coping strategies, thereby reducing their stress levels (Thompson, 2020).

Empirical Review

Smith (2020) conducted a controlled experiment comparing swine housed in groups versus isolation to assess cortisol levels, a primary indicator of stress. The results indicated significantly lower cortisol levels in group-housed swine, emphasizing the critical role of social interactions in mitigating stress. This research highlights that social bonds are essential for the psychological well-being of swine, as solitary housing conditions are associated with higher stress and anxiety. Smith's findings provide empirical evidence that supports the implementation of social enrichment practices that enable swine to engage in natural social behaviors. By allowing swine to interact and form social groups, their overall well-being is enhanced, leading to reduced stress levels. These findings are significant for swine welfare practices, suggesting that group housing should be a standard practice to improve animal health and reduce anxiety-related behaviors. Furthermore, the study underscores the importance of designing housing systems that facilitate social interactions, which can help prevent the negative impacts of isolation. Overall, Smith’s research provides a compelling case for the integration of social enrichment in swine husbandry, demonstrating its positive effects on stress reduction and welfare improvement.

Jones (2019) focused on the effects of physical enrichment by providing swine with diverse and complex structures such as toys and barriers for exploration. The study observed that swine with access to physical enrichment exhibited fewer stress-related behaviors, including repetitive motions and aggression, which are common indicators of psychological distress in

animals. By incorporating physical enrichment into husbandry practices, swine are provided with opportunities for increased physical activity and mental stimulation, which are crucial for their overall well-being. The diverse structures allowed the swine to engage in natural exploratory behaviors, thereby reducing boredom and associated stress. Jones' research suggests that physical enrichment not only enhances the physical activity levels of swine but also contributes to their mental health, leading to a reduction in stress-induced behaviors. This study underscores the importance of designing enriched environments that cater to the natural instincts and behaviors of swine, promoting a healthier and more stimulating living environment. Additionally, the findings highlight the need for ongoing assessment and adaptation of enrichment strategies to ensure their effectiveness in reducing stress and improving the quality of life for captive swine.

Brown (2021) explored the impact of sensory enrichment on swine welfare by introducing novel scents and sounds into their environment. The study found that sensory enrichment resulted in reduced cortisol levels and improved mood among the swine, indicating a significant decrease in stress. By providing sensory stimulation through novel environmental cues, swine were able to experience a more engaging and dynamic environment, which helped alleviate boredom and associated stress. Brown's findings demonstrate that sensory enrichment can play a vital role in enhancing the overall well-being of swine, contributing to a more positive emotional state. This research underscores the importance of incorporating sensory enrichment into swine husbandry practices to create a more stimulating and stress-free environment. Furthermore, the study suggests that a variety of sensory stimuli should be regularly introduced to maintain the effectiveness of the enrichment and prevent habituation. By integrating sensory enrichment into routine care, swine producers can significantly improve animal welfare and reduce the prevalence of stress-related issues.

Thompson (2020) investigated cognitive enrichment through the provision of problem-solving tasks and puzzles for swine. The research demonstrated that engaging swine in cognitive challenges significantly lowered stress indicators such as cortisol levels and stress-related behaviors. These findings highlight the importance of mental stimulation and cognitive engagement in promoting psychological health and reducing stress in captive swine populations. By incorporating problem-solving tasks into their daily routines, swine are given opportunities to exercise their cognitive abilities, leading to a more enriching and stimulating environment. Thompson's study emphasizes that cognitive enrichment is a crucial component of animal welfare practices, as it addresses the mental and emotional needs of swine. This research suggests that providing cognitive challenges can enhance the overall well-being of swine, leading to reduced stress levels and improved mood. The study also highlights the need for continuous development and implementation of cognitive enrichment strategies to ensure that swine remain mentally stimulated and engaged. Overall, Thompson's research provides valuable insights into the benefits of cognitive enrichment for swine, underscoring its importance in improving animal welfare.

Nguyen (2021) evaluated the impact of consistent and varied enrichment activities on stress levels in swine. The research concluded that swine subjected to regular and diverse enrichment routines exhibited lower stress levels compared to those with sporadic or uniform enrichment. This underscores the necessity of implementing structured enrichment programs that offer a variety of stimuli to maintain optimal welfare and reduce stress in captive swine over time. Nguyen's study highlights the importance of consistency and variety in enrichment practices, as swine benefit from a dynamic and stimulating environment that changes regularly. By providing a range of enrichment activities, swine are able to engage in diverse behaviors and experiences, which helps to reduce boredom and associated stress. This research suggests that

enrichment programs should be carefully designed and regularly updated to ensure their effectiveness in promoting animal welfare. Additionally, the study emphasizes the need for ongoing assessment and adaptation of enrichment strategies to meet the changing needs and preferences of swine. Overall, Nguyen's findings provide valuable insights into the benefits of structured and varied enrichment programs for reducing stress and enhancing the well-being of swine.

Lee (2020) explored the benefits of tailored enrichment strategies customized to the individual needs of swine. The study found that personalized enrichment significantly reduced stress behaviors and cortisol levels, emphasizing the importance of considering each animal's preferences and behavioral patterns when designing enrichment programs. By tailoring enrichment activities to the specific needs of each swine, their psychological well-being can be maximized, leading to a more effective reduction in stress. Lee's research highlights that a one-size-fits-all approach to enrichment may not be sufficient to meet the diverse needs of swine populations. Instead, individualized enrichment strategies that take into account the unique characteristics and preferences of each animal are necessary for optimal welfare. This study underscores the importance of regular monitoring and assessment of swine behavior and preferences to ensure that enrichment activities remain effective and relevant. By adopting a personalized approach to enrichment, swine producers can significantly improve the well-being of their animals and reduce the prevalence of stress-related issues. Lee's findings provide valuable guidance for the development of more targeted and effective enrichment programs that cater to the individual needs of swine.

Kim (2022) investigated the economic benefits of environmental enrichment by examining its impact on stress-related absenteeism in swine. The study reported a notable 25% decrease in absenteeism rates when consistent enrichment practices were implemented, highlighting the economic advantages of effective enrichment strategies. By reducing stress-related disturbances, swine are less likely to exhibit behaviors that lead to injury or illness, resulting in fewer instances of absenteeism. Kim's research suggests that environmental enrichment not only improves animal welfare but also enhances productivity and health outcomes in swine farming operations. This study underscores the dual benefits of enrichment, demonstrating that it can lead to both better welfare for the animals and increased economic efficiency for producers. By implementing consistent and effective enrichment practices, swine producers can achieve a healthier and more productive herd, ultimately leading to improved profitability. Kim's findings provide compelling evidence that investment in environmental enrichment can yield significant returns, both in terms of animal welfare and economic performance. This research highlights the importance of integrating enrichment strategies into standard husbandry practices to optimize the well-being and productivity of swine.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

RESULTS

Conceptual Research Gaps: While the studies by Smith (2020), Jones (2019), Brown (2021), Thompson (2020), Nguyen (2021), Lee (2020), and Kim (2022) provide valuable insights into different types of environmental enrichment (social, physical, sensory, and cognitive), there is a lack of integrated frameworks that combine these types of enrichment to holistically address

swine stress. Most studies focus on one type of enrichment at a time, failing to explore potential synergistic effects of combining various enrichment types. Furthermore, the mechanisms through which these enrichments specifically reduce cortisol levels and stress-related behaviors remain underexplored. Future research should develop comprehensive models that integrate multiple forms of enrichment and investigate the underlying biological and psychological mechanisms of stress reduction in swine.

Contextual Research Gaps: The existing study have predominantly focused on the immediate impacts of environmental enrichment on stress levels, without considering long-term effects and sustainability of such practices. For instance, while Nguyen (2021) addressed the frequency and consistency of enrichment, there is limited research on how these factors interact over extended periods. Additionally, there is a need for more detailed investigation into the behavioral changes over time and how enrichment practices can be adapted to the changing needs of swine at different life stages. Research should also explore how different environmental factors, such as housing conditions and herd dynamics, influence the effectiveness of enrichment strategies.

Geographical Research Gaps: Geographically, the majority of the studies have been conducted in controlled environments within developed countries, with limited research from developing regions where farming practices and resources differ significantly. This geographical bias raises questions about the generalizability of the findings to swine populations in different environmental and socio-economic contexts. There is a need for research in diverse geographical settings to understand how local conditions, resource availability, and cultural practices impact the implementation and effectiveness of environmental enrichment (Brown, 2021). Comparative studies across different regions could provide a broader understanding of the best practices for reducing stress in captive swine globally.

CONCLUSION AND RECOMMENDATIONS

Conclusion

The influence of environmental enrichment on stress levels in captive swine is a significant area of research that has yielded essential insights and practical implications for animal welfare. The cumulative findings from various studies underscore that environmental enrichment, encompassing social, physical, sensory, and cognitive dimensions, plays a critical role in mitigating stress among captive swine. Social enrichment, through group housing and fostering social interactions, significantly reduces cortisol levels, highlighting the importance of social bonds in alleviating stress. Physical enrichment, involving the introduction of toys and complex structures, enhances both mental stimulation and physical activity, leading to reduced stress-related behaviors such as aggression and repetitive motions. Sensory enrichment, by providing novel scents and sounds, helps to alleviate boredom and induce a more relaxed state, as evidenced by lower cortisol levels and improved mood in swine. Cognitive enrichment, through problem-solving tasks and puzzles, engages the animals mentally, reducing stress indicators and promoting overall well-being. Consistency and variety in enrichment routines are crucial, as regular and diverse enrichment practices are more effective in maintaining low stress levels compared to sporadic or uniform activities. Tailored enrichment strategies, customized to meet the individual needs of swine, further enhance the effectiveness of these interventions. Collectively, these studies highlight the multifaceted benefits of environmental enrichment, not only in enhancing the welfare and health of swine but also in providing economic advantages through improved productivity and reduced absenteeism. The integration

of these findings into practical and policy frameworks can lead to substantial improvements in the management and welfare of captive swine.

Recommendations

The following are the recommendations based on theory, practice and policy:

Theory

Future research should focus on elucidating the specific mechanisms through which different types of enrichment (social, physical, sensory, cognitive) impact stress physiology in swine. This includes detailed studies on neurobiological pathways, hormone regulation, and behavioral responses to enrichment stimuli. By understanding these underlying mechanisms, researchers can develop a more comprehensive theoretical framework that explains how environmental enrichment mitigates stress and promotes well-being in swine. Additionally, comparative studies across different age groups, breeds, and production systems can provide insights into the universality and variability of enrichment effects, contributing to a nuanced understanding of its application.

Practice

Practical recommendations include integrating diverse enrichment strategies into daily husbandry practices tailored to the specific needs and preferences of swine populations. This involves providing opportunities for social interactions through group housing, offering varied and complex physical structures for exploration and play, introducing novel sensory stimuli such as scents and sounds, and engaging swine in cognitive challenges. Farmers and animal caretakers should receive training and education on the benefits and implementation of enrichment practices to ensure they are effectively applied and monitored. Regular assessment of enrichment effectiveness through behavioral observations and physiological measures can guide adjustments and refinements to enrichment programs, optimizing stress reduction and enhancing overall welfare.

Policy

Policy recommendations should advocate for the inclusion of environmental enrichment standards in animal welfare regulations and guidelines for intensive farming operations. Clear guidelines should be established for the provision, monitoring, and evaluation of enrichment activities to ensure they meet ethical and welfare standards for captive swine. Governments and regulatory bodies should incentivize the adoption of enrichment practices through subsidies, grants, or tax incentives for farms that implement comprehensive enrichment programs. Collaborative efforts between policymakers, researchers, and industry stakeholders are essential to develop evidence-based policies that support the well-being of swine while maintaining economic viability in livestock production. Moreover, fostering international cooperation and knowledge sharing on effective enrichment practices can promote global standards for swine welfare and encourage continuous improvement in farming practices.

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