Proceedings of the 5th International Conference on Modern Medicine and Global Health
DOI: 10.54254/2753-8818/2027.39297

Balancing Animal Welfare and Avian Influenza Biosecurity in Small-Scale Free-Range Chicken Systems

Qihan Niu

Department of Applied Animal Biology, University of British Columbia, Vancouver, Canada
danischoolwork56@gmail.com

Abstract. Small-scale outdoor chicken keeping creates a difficult biosecurity problem. Outdoor access supports valued husbandry but can expose flocks to wildlife and contaminated environments. This structured narrative review synthesised 20 purposively selected sources, based on HPAI exposure and welfare-related control in small outdoor flocks. The selected evidence showed that routine husbandry and farm connections also shaped exposure. Direct animal-based welfare evidence was scarce; most welfare-relevant work examined keeper concerns or practical consequences. Cleaner daily management may be combined with targeted wildlife measures and vaccination, although their joint performance in small flocks remains uncertain. Because uptake depends on local conditions and practical burden, awareness does not ensure sustained practice. Biosecurity should therefore address a credible exposure pathway without creating avoidable harm or an impractical burden. Future studies should use standardised welfare indicators and longitudinal field data to evaluate whether combined interventions can reduce HPAI exposure while maintaining acceptable welfare standards. This evidence would support the development of proportionate, practical, and locally adaptable biosecurity guidance for small-scale outdoor chicken keepers.

Keywords: Animal welfare, Avian influenza, Backyard chickens, Biosecurity, Free-range poultry

1. Introduction

Small-scale outdoor chicken keeping includes flocks raised for food, income, companionship, or other local purposes. Some birds range freely, whereas others use a yard or are kept in enclosures such as free-caged or battery cages; access to veterinary care and housing also differs. Outdoor access can support normal behaviour and valued husbandry, yet it can expose birds to wildlife and contaminated environments. A UK survey shows how keeper priorities and trust shape responses to housing and controls [1]. Effective HPAI prevention must be feasible across systems that often lack the resources available to commercial poultry production Even potentially effective measures may be poorly adopted or sustained if they conflict with daily husbandry practices or with the reasons keepers value outdoor access.

Research has increasingly shifted from treating outdoor access as a single explanation for infection risk to identifying specific exposure pathways associated with daily flock management. A

© 2026 The Authors. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (https://creativecommons.org/licenses/by/4.0/).

DOI: 10.54254/2753-8818/2027.39297

study of backyard farms in Bangladesh associated H5 or H9 seropositivity with practices that connected birds to contaminated water, refuse, other animals, and poultry markets [2]. Across settings, risk arises through environmental and human-mediated contacts. Recent work has added farm density and landscape structure to this picture [3]. These studies identify where prevention might act, but most are observational or model-based. They show plausible pathways, not the effect of changing a practice. The literature is therefore stronger at diagnosing exposure than at proving which interventions protect small flocks.

Recent research has examined how biosecurity can be adapted to outdoor systems rather than transferred directly from indoor production. Possible approaches alter range use or protect resources to discourage wildlife contact. A recent scoping review showed that research concentrates on reducing interactions with wild birds [4]. This work broadens the choice beyond permanent confinement, but the evidence remains uneven. Some measures have been studied only on commercial farms; others appear mainly in assessment tools or guidance. Reduced wild-bird visitation does not necessarily indicate a corresponding reduction in infection risk. Vaccination adds another layer, although coverage can be difficult to maintain in rapidly changing flocks. Overall, research has moved from hazard identification toward layered biosecurity strategies, but evidence remains insufficient to determine which combinations are both effective and sustainable in small-scale systems.

The welfare side has received less direct study. Enforced housing has been associated with changes in eggshell characteristics in commercial free-range hens, suggesting a possible stress signal that still requires validation [5]. Evidence from small flocks more often records keeper concerns than bird responses. The survey that was taken in the UK found concern about housing and culling alongside incomplete understanding and low trust in official guidance [1]. Keepers determine whether a control is maintained, but reported concern does not substitute for validated animal-based outcomes. Economic evidence is also distinct: a flock may remain financially viable while birds experience restriction. Few studies measure disease exposure and welfare together, making it difficult to judge whether a control balances health protection with acceptable living conditions.

This review responds by treating biosecurity and welfare as connected decisions. It asks how exposure arises in small-scale outdoor flocks, what consequences follow from control, and how management can be adapted locally. It also examines why practices are maintained or abandoned. The aim is not to rank interventions or present the selected literature as exhaustive. Instead, the review brings evidence into one decision process. A measure must address a credible local pathway, and its effects on birds must be considered alongside the effort required to maintain it. Because the same control may work differently across flocks and settings, context shapes this decision. The paper develops an evidence-bounded framework for choosing welfare-compatible biosecurity and identifies comparisons needed before measures can be recommended with confidence.

2. Review approach

A structured narrative review was conducted with purposive source selection. PubMed and Web of Science were searched on September 8, 2026. Deduplication reduced 973 exported records to 593. Screening prioritised records explicitly linking small-scale or outdoor poultry with avian influenza and management or exposure; ambiguous records were also assessed. A total of 163 titles and abstracts were screened, including one additional welfare-relevant source. Twenty sources were selected to cover the review questions: twelve directly relevant and eight transferable. Selection stopped at this focused set; 430 records remained unscreened, not excluded. Google Scholar was not formally searched.

DOI: 10.54254/2753-8818/2027.39297

Extraction initially used exported metadata and abstracts. Targeted checks on October 6, 2026, examined three published full texts and an author-deposited chapter corresponding to a fourth study. Other sources retained abstract-level interpretation. Narrative comparisons distinguished study design, measured outcome, and applicability to small flocks. This non-exhaustive process permits selection bias; methodological and outcome differences precluded meta-analysis.

3. Exposure pathways and welfare consequences

Outdoor access creates opportunities for contact with wildlife and contaminated environments, but it does not reveal how a particular flock becomes exposed. In Bangladesh, infection or seropositivity was associated with practices that connected birds to contaminated resources and contacts beyond the flock [2, 6]. Studies in Uganda and China placed similar pathways in different ecological settings, where sanitation and local management also mattered [7, 8]. The shared pattern is a network of possible entry routes, not one universal risk factor.

This farm-level picture is shaped by the production landscape. Dutch modelling indicated that epidemic development also depended on the size and distribution of outdoor farms [3]. Some pathways are therefore open to keeper action, while others arise from the wider system; responsibility cannot be assigned to individual compliance alone.

Cross-sectional associations and modelled scenarios identify plausible prevention points but do not prove that changing one factor will reduce infection everywhere. Control should start by tracing the locally credible route. Restricting range use may interrupt wildlife contact yet leave contamination carried through routine inputs or movements unchanged.

Identifying an exposure pathway is only half the decision. In commercial hens, eggshell texture changed immediately after enforced housing, but the comparison covered the day before and the first day after restriction [5]. Pre-restriction range use was not measured, so these findings cannot establish long-term welfare effects. Veterinary guidance links preventive care with backyard welfare, but its abstract does not support detailed prescriptions [9].

Other studies describe consequences without measuring birds directly. Keepers expressed concern about housing and culling, while French farmers explained how standard rules could conflict with outdoor routines and values [1, 10]. Housing orders on nine very large commercial farms increased feed costs but produced uneven financial effects [11]. Those results may not transfer to small flocks, and financial performance is not evidence of welfare.

Welfare assessment should examine behavioural responses and physical condition, rather than infer well-being from production or keeper satisfaction. Changes in normal activity or feather damage, for example, should be assessed against flock baselines using methods validated for the intended population. Disease control can protect health while restricting behaviour; outdoor access alone guarantees neither low infection risk nor good welfare. Bird responses and keeper experience therefore require separate assessment.

4. Designing biosecurity for welfare and feasibility

Layered management starts with diagnosis rather than a fixed list. A scoping review catalogued range-related measures, mainly from cross-sectional assessments of commercial systems in high-income settings [4]. A risk-weighted backyard tool was designed to reveal household gaps [12]. Neither an inventory nor a score proves that a change prevents infection; their value is in identifying locally plausible prevention points.

DOI: 10.54254/2753-8818/2027.39297

Risk-factor studies suggest changing how resources and routine contacts connect a flock to possible contamination [2, 6-8]. Even simple changes depend on space, equipment, and labour. Their value lies in how they reinforce one another, not in an assumption that each is universally cheap or effective.

Range-focused evidence remains conditional. An observational pilot associated limited woody cover with more high-risk bird visits, but could not separate vegetation from the surrounding landscape [13]. At one commercial farm, an automated laser reduced visits in consecutive periods without and with the device; hens were indoors during its use on their range [14]. This supports a visitation outcome, not demonstrated infection prevention or welfare safety. Neither approach has established practical performance in small flocks.

Vaccination acts on susceptibility rather than environmental contact. Favourable attitudes do not ensure delivery or durable coverage [1, 15], and modelling suggests that flock turnover can erode coverage after a campaign [16]. Repeat delivery must therefore fit flock demography and veterinary capacity while exposure controls remain in place.

Whether this layered approach works in practice will depend on fit as much as design. Small-scale flocks serve different purposes and have different links to markets, veterinary services, and commercial production. The expected benefit and practical burden of a measure consequently vary by production system [15, 17, 18]. A practice designed for an integrated broiler enterprise may not fit a mixed village flock or a household keeping birds for companionship.

Implementation also depends on how advice is received. Keepers may recognise disease risk while distrusting institutions or finding general guidance difficult to apply [1, 19]. Communication is more useful when it links a measure to a recognisable pathway and shows how it fits daily care, including welfare monitoring. Clear advice cannot, however, replace missing resources or absorb an unaffordable burden.

Adoption is a sequence: a keeper interprets a recommendation, tries it, and decides whether it can be sustained. In Bangladesh, improved awareness did not produce safer observed behaviour when costs persisted and risk felt remote [20]. French farmers likewise adapted standard rules to outdoor farming realities [10]. Once a measure is abandoned or substantially altered, its assumed effect no longer follows. Practical fit is therefore part of effectiveness, not an issue to consider afterwards.

5. Evidence-informed recommendations for welfare-compatible biosecurity

Recommendations should identify a locally credible pathway and an outcome against which to judge the proposed control. Resource management and flock movements merit attention where risk studies indicate relevant contacts [2, 6-8]. A backyard assessment tool can help identify management gaps [12], but its score should not substitute for infection monitoring.

Range management targets wildlife contact [4, 13, 14], whereas vaccination targets susceptibility and requires delivery suited to flock turnover [16]. These mechanisms may complement one another, but contact frequency and vaccine coverage cannot establish prevented infection. Evaluation should measure disease outcomes alongside behavioural and health responses, using welfare measures appropriate to the flock [5, 9].

Implementation should be assessed through observed use, not initial willingness alone. Keeper studies identify trust and practical burden as relevant to maintenance [1, 10, 15, 17-20]. Follow-up should record required resources and reasons for modification or abandonment. These criteria guide evaluation; they do not establish a universally effective package.

DOI: 10.54254/2753-8818/2027.39297

6. Practical constraints and research priorities

Biosecurity in small-scale outdoor flocks is constrained by exposure beyond the farm and by the resources available within it. Contact with contaminated environments and poultry movements can connect flocks to wider transmission pathways [2, 6-8]. Local ecology therefore matters when deciding which controls a keeper can reasonably maintain.

Housing restrictions create a further tension between disease prevention and outdoor husbandry. Limited space and labour can constrain their application, while restrictions may conflict with keeper priorities and daily routines [1, 10]. A control may be technically suitable yet difficult to maintain when it requires housing or work that the keeper cannot provide. Vaccination also requires continuing delivery as birds enter and leave the flock; modelling indicates that turnover can erode coverage [16].

Research should test whether additional housing capacity or veterinary support makes controls easier to sustain, without assuming that clearer advice resolves resource shortages [17, 19, 20]. Vaccination studies should examine delivery as flock composition changes. These comparisons would address practical constraints that determine whether an otherwise suitable measure remains in use.

7. Conclusion

This review shows that the central problem in small-scale outdoor chicken keeping is not outdoor access alone, but the pathways connecting a flock to its physical environment and wider human or wildlife networks. The selected evidence is strongest in identifying these pathways and the conditions that influence implementation. It is weaker in showing whether an intervention can reduce HPAI risk, protect animal welfare, and remain workable over time. Direct welfare evidence is especially limited, while much intervention evidence comes from models, commercial farms, or intermediate outcomes. The evidence therefore supports context-sensitive decisions rather than a universal ranking of controls.

In practice, control should begin with a credible local exposure route and select measures capable of interrupting it without avoidable harm. Changes to routine management or range contact act on exposure, whereas restriction and vaccination work through different mechanisms. Their value depends on how they work together and whether keepers can sustain them. Welfare monitoring must accompany disease prevention instead of being inferred from financial performance, keeper acceptance, or the absence of infection. Awareness and favourable intentions are likewise early implementation steps, not proof that a practice will continue.

The implications extend beyond individual flock management. What keepers can achieve is shaped by the wider production and regulatory environment, together with access to trusted and adequately resourced veterinary support. Guidance is more credible when it explains why a measure fits a recognised pathway, acknowledges the value of outdoor husbandry, and supports maintenance. This approach can strengthen preparedness while reducing the chance that emergency controls appear arbitrary, impractical, or indifferent to welfare. It also shifts evaluation from whether advice was issued to whether it was feasible, maintained, and beneficial for both disease control and birds.

Future research should bring exposure, welfare, and uptake into the same small-flock studies. Multi-farm and multi-season comparisons could test layered, range-preserving packages against clearly described alternatives. They should measure infection or exposure together with validated behavioural and health outcomes, record cost and labour, and verify whether measures are used as intended. Vaccination studies should follow delivery as flock composition changes rather than

DOI: 10.54254/2753-8818/2027.39297

relying on initial willingness or coverage. A comparable core of flock and context descriptors would help distinguish genuine differences in effect from differences between populations. With this evidence, guidance could become more adaptive: increasing protection during periods of elevated risk while preserving outdoor access wherever it can be managed responsibly.

References

[1] McClaughlin, E., Elliott, S., Jewitt, S., Smallman-Raynor, M., Dunham, S., Parnell, T., Clark, M., & Tarlinton, R. (2024). UK flockdown: A survey of smallscale poultry keepers and their understanding of governmental guidance on highly pathogenic avian influenza (HPAI). *Preventive Veterinary Medicine, 224*, 106117. https://doi.org/10.1016/j.prevetmed.2024.106117

[2] Das Gupta, S., Barua, B., Fournié, G., Hoque, M. A., & Henning, J. (2022). Village and farm-level risk factors for avian influenza infection on backyard chicken farms in Bangladesh. *Scientific Reports, 12*(1), 13009. https://doi.org/10.1038/s41598-022-16489-5

[3] Chanchaidechachai, T., Stegeman, A., Velkers, F. C., Gonzales, J. L., & Fischer, E. A. J. (2026). Assessing the impact of outdoor farming, farm size, and farm density on highly pathogenic avian influenza epidemics: A modelling study in the Netherlands. *One Health, 22*, 101424. https://doi.org/10.1016/j.onehlt.2026.101424

[4] Delpont, M., Mahmood, Q., Sanchez-Cano, A., Hofle, U., Martin-Valls, G. E., & Piccirillo, A. (2026). Which biosecurity measures are specific to free-range poultry? Insights from a scoping review. *Veterinary Research, 57*(1), 65. https://doi.org/10.1186/s13567-026-01742-w

[5] Gray, H. E., Malcolm, E. L., Herborn, K., Armstrong, D., Martin, J. E., & Asher, L. (2024). Can eggshells indicate stressor exposure in free-range laying hens? *Animal Welfare, 33*, e53. https://doi.org/10.1017/awf.2024.46

[6] Islam, A., Islam, S., Amin, E., Shano, S., Samad, M. A., Shirin, T., Hassan, M. M., & Flora, M. S. (2022). Assessment of poultry rearing practices and risk factors of H5N1 and H9N2 virus circulating among backyard chickens and ducks in rural communities. *PLOS ONE, 17*(10), e0275852. https://doi.org/10.1371/journal.pone.0275852

[7] Kirunda, H., Kabi, F., Muwereza, N., Kabuuka, T., Kerfua, S. D., Kasaija, P. D., Byarugaba, D. K., & Wabwire-Mangen, F. (2015). Seroprevalence and risk factors for exposure of free-range poultry to avian influenza viruses in important bird areas in Uganda. *Avian Diseases, 59*(1), 64-70. https://doi.org/10.1637/10874-052714-reg

[8] Wang, X.-X., Cheng, W., Yu, Z., Liu, S.-L., Mao, H.-Y., & Chen, E.-F. (2018). Risk factors for avian influenza virus in backyard poultry flocks and environments in Zhejiang Province, China: A cross-sectional study. *Infectious Diseases of Poverty, 7*(1), 65. https://doi.org/10.1186/s40249-018-0445-0

[9] Elven, H. (2025). Approach to backyard poultry. Part 2: Improving chicken welfare and management between vet visits. *In Practice, 47*(2), 89-98. https://doi.org/10.1002/inpr.518

[10] Saccavini, O., Charrier, F., Delpont, M., Vaillancourt, J.-P., & Paul, M. C. (2026). "These measures make no sense for our farming system": Biosecurity challenges and adaptations in French small-scale poultry farms selling directly to consumers. *Preventive Veterinary Medicine, 247*, 106702. https://doi.org/10.1016/j.prevetmed.2025.106702

[11] Barnes, A. P., Sparks, N., Helgesen, I. S., & Soliman, T. (2024). Financial impacts of a housing order on commercial free range egg layers in response to highly pathogenic avian influenza. *Preventive Veterinary Medicine, 228*, 106209. https://doi.org/10.1016/j.prevetmed.2024.106209

[12] Ibrahim, N., Chantziaras, I., Chakma, S., Islam, S. S., Amalraj, A., Caekebeke, N., Ferreira, H. de C., & Dewulf, J. (2025). Biocheck.UGent: A risk-based tool to assess the status of biosecurity in backyard poultry in low- and middle-income countries. *Preventive Veterinary Medicine, 241*, 106540. https://doi.org/10.1016/j.prevetmed.2025.106540

[13] Bestman, M., de Jong, W., Wagenaar, J.-P., & Weerts, T. (2018). Presence of avian influenza risk birds in and around poultry free-range areas in relation to range vegetation and openness of surrounding landscape. *Agroforestry Systems, 92*(4), 1001-1008. https://doi.org/10.1007/s10457-017-0117-2

[14] Elbers, A. R. W., & Gonzales, J. L. (2021). Efficacy of an automated laser for reducing wild bird visits to the free range area of a poultry farm. *Scientific Reports, 11*(1), 12779. https://doi.org/10.1038/s41598-021-92267-z

[15] Pramuwidyatama, M. G., Hogeveen, H., & Saatkamp, H. W. (2020). Understanding the motivation of Western Java smallholder broiler farmers to uptake measures against highly pathogenic avian influenza (HPAI). *Frontiers in Veterinary Science, 7*, 362. https://doi.org/10.3389/fvets.2020.00362

[16] Villanueva-Cabezas, J. P., Campbell, P. T., McCaw, J. M., Durr, P. A., & McVernon, J. (2017). Turnover of village chickens undermines vaccine coverage to control HPAI H5N1. *Zoonoses and Public Health, 64*(1), 53-62.

DOI: 10.54254/2753-8818/2027.39297

https://doi.org/10.1111/zph.12282
[17] Gupta, S. D., Fournié, G., Hoque, M. A., & Henning, J. (2021). Factors influencing chicken farmers' decisions to implement prevention and control measures to reduce avian influenza virus spread under endemic conditions. *Transboundary and Emerging Diseases, 68*(1), 194-207. https://doi.org/10.1111/tbed.13757
[18] Souvestre, M., Delpont, M., Guinat, C., Dumat, C., Guichard, L., Manis, L., Duret, H., Guérin, J.-L., & Le Loc'h, G. (2021). Backyard poultry flocks in France: A diversity of owners and biosecurity practices. *Preventive Veterinary Medicine, 197*, 105511. https://doi.org/10.1016/j.prevetmed.2021.105511
[19] Andrew, C. L., Tworek, H., Himsworth, C., & Byers, K. A. (2026). "The trust is gone": Smallholder poultry producers' perceptions of biosecurity measures against highly pathogenic avian influenza. *BMC Veterinary Research, 22*(1), 229. https://doi.org/10.1186/s12917-026-05406-x
[20] Rimi, N. A., Sultana, R., Ishtiak-Ahmed, K., Rahman, M. Z., Hasin, M., Islam, M. S., Azziz-Baumgartner, E., Nahar, N., Gurley, E. S., & Luby, S. P. (2016). Understanding the failure of a behavior change intervention to reduce risk behaviors for avian influenza transmission among backyard poultry raisers in rural Bangladesh: A focused ethnography. *BMC Public Health, 16*(1), 858. https://doi.org/10.1186/s12889-016-3543-6