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Original Article

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Biosecurity practices on commercial layer farms in Abyek county, Qazvin, Iran: A cross–sectional study

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ABSTRACT

Objective: To investigate the biosecurity measures practiced at commercial layer chicken farms in Abyek country, Qazvin, Iran..

Methods: In this cross-sectional study, all licensed and active commercial layer chicken farms in Abyek county, Qazvin province, Iran in 2019 were recruited. We used a risk-based weighted scoring system (Biocheck.UGent) to assess the level of biosecurity according to internal and external classification. Biosecurity was quantified by converting the answers to 169 questions into score from 0 to 100. The minimum score, "0," represents total absence of any biosecurity measure on the farm, whereas the maximum score, "100," means full application of all investigated biosecurity measures.

Results: The mean score of overall biosecurity in the commercial layer chicken farms in Abyek county, Qazvin province was 72.7. The mean score of internal and external biosecurity measures were 77.1 and 72.2, respectively. The lowest mean score was due to "Disease management" (69.7) among internal biosecurity measures and the lowest mean scores were for "Location of farm" (39.0) and "Removal of manure and dead animals" (42.6) among external biosecurity measures. The highest mean score was for "Transport of the eggs level" (91.0) for external biosecurity measures.

Conclusions: This study showed the biosecurity status of commercial layer chicken farms in Abyek county, Qazvin, Iran and revealed some weaknesses in the implementation of these measures at the internal and external levels. It showed the biosecurity measures of these farms, especially at the external levels need to be improved. This information can aid decision-making on efforts used to improve disease control and prevention strategies in poultry farms.

KEYWORDS: Biosecurity; Poultry; Commercial layer farms; Abyek

1. Introduction

For a long time, poultry farming has a major and special role in food production and family economy in many parts of the world, especially in rural areas. This industry has various sub-sectors, and the commercial layer poultry farming is one of the active and significant sub-sectors among them[1]. As a business activity, the commercial layer poultry farming has a high potential for rapid

Significance

Biosecurity measures are key measures to prevent occurrence and spreading infectious diseases such as avian influenza in poultry farms. Our results regarding status of biosecurity measures in layer poultry farms in Abyek, Qazvin provinces of Iran indicated some weaknesses in the implementation of these measures at internal and external levels. The findings of this study can help policymakers in advanced planning to improve disease control and prevention strategies in poultry farms, through the ranking of farms in each province (especially high-risk provinces) in terms of compliance with biosecurity measures and its application.

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economic growth and has grown faster than other types of livestock and poultry farming in the last 40 years[2]. In adddition, this industry has a high importance and status due to the production of eggs which makes a significant contribution to the supply of animal's protein[1].

Although this industry plays a significant role in food production and the economy of countries, the reduced poultry growth and production and the increased mortality due to the emerging poultry diseases pose health risks and economic losses every year. It significantly affects producers, society and the economy of countries[3–5]. Therefore, it is very important to implement good farm management practices amd biosecurity measures on the commercial farms to prevent the introduction of pathogens.

Biosecurity is a set of various measures to prevent the introduction, establishment and spread of infectious disease, infection and infestation, which has been proposed by the World Organization for Animal Health (WOAH) and the Food and Agriculture Organization of the United Nations (FAO). In other words, biosecurity means the application of preventive measures that are implemented in livestock, poultry, aquatic farms, agricultural farms and other centers for the breeding of living organisms to reduce the risks of introduction and spread of infectious agents. One of the most useful methods for evaluating biosecurity programs is to divide into several internal and external biosecurity subcategories. External biosecurity includes all measures that prevent the entry of pathogens and infectious agents into the breeding unit, and internal biosecurity includes all measures that prevent the spread of infection inside the breeding unit[6, 7].

Iran is one of the most important countries in the Middle East region for commercial layer poultry farming, especially broiler farming. According to the findings of the latest census of commercial layer chicken farming in the country in 2017 by the Iranian Statistics Center, almost 80% of these units are located in just 9 provinces of this country. One of these 9 provinces is Qazvin province, in which the largest numbers of the farms are located in the city of Abyek[8].

In this study, we investigated biosecurity status of the farms using scoring system and classified the farms in different risk groups in terms of the potential of disease entry and spread. The results help provide a suitable platform for establishing a targeted active surveillance program to control the infectious diseases in Iran.

2. Methods

2.1. Study design and sampling

The design of this study was cross-sectional and targeted population was all licensed and active commercial layer chicken farms in Abyek county, Qazvin province in 2019. In this study, all 10 licensed and active commercial layer chicken farms in Abyek county, with a total capacity of rearing about 5 300 000 chickens were investigated in fall 2019.

2.2. Data collection

Data collection was done by means of Biocheck.UGentR online biosecurity assessment tool which is available online free of charge[9]. The Biocheck.UGent tool is a questionnaire developed to quantify and describe the status of biosecurity in various poultry farms in two parts: internal and external biosecurity. As some of the questions of this questionnaire were not applicable to poultry farms in Iran, it was modified according to the expert opinion. The validity of the adapted questionnaire was assessed.

The validity of the designed questionnaire was based on the opinions of 10 experts in different fields, including in poultry diseases and epidemiology. Content validity ratio (CVR) was used to quantitatively determine validity. The content validity ratio was calculated and judged separately for each question and also for all questions. At first, this coefficient was obtained for each item (question). Then, according to the standard table for this coefficient, where the minimum acceptable number in the case of the participation of 10 experts is equal to 0.62, the items (questions) with CVR less than 0.62 were removed from the questionnaire[10]. In the qualitative review of the validity, the experts were asked to submit their corrective views in writing after a detailed study of the questionnaire. In the qualitative assessment of validity, experts were asked to check each question in terms of the following: grammar, words correctness, importance of questions, order of the questions, and number of the questions.

Eventually we created a validated questionnaire in which questions related to biosecurity had two parts of internal and external biosecurity. External biosecurity included all the measures that

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prevent the entry of infectious agents into the farm, and consisted of 120 questions divided into 11 subcategories: public health measures & farm characteristics, purchase of one day old chicks, purchase of layers, depopulation and transport of hens, transport of the eggs, feed and water supply, removal of manure and dead animals, visitors and staff, interrelation between farms, infrastructure and vectors, and location of the farm. Internal biosecurity included all measures aimed at preventing the spread of pathogens inside the farm, and consisted of 49 questions and divided into 4 subcategories: disease management, cleaning and disinfection, inter-house management, and egg management.

2.3. Data analysis

In order to analyze the data, the completed questionnaires were entered into the Excel software after checking the quality and completing the possible deficiencies, and all the statistical analyzes were performed in the SPSS version 25 software. After encoding each questionnaire, individual farm results were generated from the system showing the biosecurity score in all categories and subcategories. Means and medians with minimum and maximum indices were obtained for quantitative variables such as the external and internal biosecurity scores, total land area of farm, total capacity of farm, number of sheds, number of workers, farmer age and farmer experience, while frequencies and percentages were computed for qualitative variables such as farm type, veterinarian attendance, farmer sex, farmer education and farmer employment status.

Biosecurity was quantified by converting the answers to 169 questions, mainly dichotomous and trichotomous, into a score from 0 to 100. The minimum score, "0," represents total absence of any biosecurity measures on the farm, whereas the maximum score, "100," means full application of all investigated biosecurity measures. For ease of interpretation of the results, category and subcategory scores were recalculated each time to a score of 100 and presented as a percentage in the reports. The system does not have a cut off score to demarcate between good and poor scores. But generally, each biosecurity measure if complied or not has a corresponding contribution to the general score of that particular farm. A score of 100 means that all the biosecurity measures are all in place and a score of zero means no measure is installed in the farm. Technically, a 50% biosecurity score means that half of the measures are implemented and other half are not. But this depends on the weight given by experts to a particular question. After completion of the risk-based tool, a score becomes available for external, internal, and overall biosecurity on the farm. The risk-based tool was described in more detail by Gelaude *et al*.[9] and can be consulted for free online: http://www.biocheck.ugent.be/v4/about/poultry/.

3. Results

3.1. Farm and farmer characteristics

Of the 10 farms surveyed, 70% were layer breeders and 30% were layer and pullet breeders simultaneously. The mean total land area of the farms was 0.206 km^2 and the mean total capacity of the farms was 534981.90. The farmers were all male with an average age of 58. Completed results for characteristics of the farms and farmers are presented in Table 1.

3.2. Biosecurity status

The mean score of overall biosecurity in commercial layer chicken farms, as well as at the level of external and internal ones, are shown in Table 2.

The results showed that the mean score of overall biosecurity in Abyek commercial layer chicken farms was 72.7. The mean overall biosecurity ranged from 62.6 to 79.3. The average biosecurity score for external biosecurity was 72.2 with a range between 39.0 and 91.0 and for internal biosecurity it is equal to 77.1 with a range between 69.7 and 87.8.

Among the measures related to external biosecurity, the subcategory with a mean score of 39.0 for farm location had the lowest scores, while the subcategory with a mean score of 91.0 for transport of the eggs had the highest scores. Among measures related to internal biosecurity, cleaning and disinfection subcategory had the highest mean score of 87.8 and disease management subcategory had the lowest mean score of 69.7.

Overall biosecurity scores in Layer chicken farms in Abyek country are shown in Figure 1.

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Table 1. Farm and farmer characteristics in commercial layer chicken farms in Abyek country, Qazvin, Iran.

Variables	*N* (%)
Sex	
Male	10(100)
Female	0(0)
Education	
In-completed high school	0(0)
Completed high school	3(30)
Bachelor degree	0(0)
Master degree and above	7(70)
Employment status	
Full time	6(60)
Part time	4(40)
Veterinarian attendance	
Yes	10100)
No	0(0)
Age (years)	
Mean ± SD	58.0 ± 9.5
Range	45.0-75.0
Experience (years)	
Mean ± SD	22.5 ± 7.6
Range	12.0-35.0
Total land area (km^2)	
Mean ± SD	0.20 ± 0.20
Range	0.02-0.70
Total capacity	
Mean ± SD	534 981.9 ± 515 164.4
Range	70 000.0-1 604 184.0
Sheds	
Mean ± SD	15.6 ± 15.1
Range	2.0-45.0
Workers	
Mean ± SD	20.7 ± 13.5
Range	8.0-50.0

Note: data are expressed as *N* (%) unless otherwise specified.

Table 2. Overall external and internal biosecurity scores in Commercial Layer chicken farms in Abyek country, Qazvin, Iran.

Subcategory	Weight factor	Mean score ± SD	Range
External Biosecurity			
Public health measures & farm characteristics	7	64.2 ± 10.1	44.2-78.8
Purchase of one day old chicks	5	88.0 ± 14.0	65.7-100
Purchase of layers	5	89.7 ± 10.8	75.6-100
Depopulation and transport of hens	4	82.5 ± 11.2	53.7-93.5
Transport of the eggs	5	91.0 ± 13.5	63.2-100
Feed and water supply	6	59.2 ± 12.5	47.1-83.0
Removal of manure and dead animals	6	42.6 ± 14.7	22.8-69.3
Visitors and staff	12	76.0 ± 8.8	63.7-91.1
Interrelation between farms	3	90.6 ± 20.6	40.0-100
Infrastructure and vectors	10	71.3 ± 9.6	56.1-81.1
Location of the farm	7	39.0 ± 18.5	14.2-63.4
Internal Biosecurity			
Disease management	9	69.7 ± 12.9	56.2-92.8
Cleaning and disinfection	13	89.8 ± 8.7	74.5-97.0
Inter-house management	4	77.1 ± 26.3	30.7-100
Egg management	4	73.7 ± 15.1	48.2-93.8
Overall biosecurity	100	72.7 ± 5.3	62.6-79.3

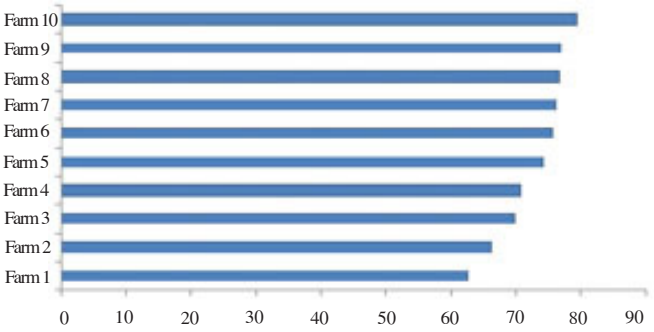

Figure 1. Overall biosecurity scores in Layer chicken farms in Abyek country, Qazvin, Iran.

4. Discussion

The present study investigated the level of implementation of biosecurity practices in the commercial layer chicken farms in Abyek. Various studies conducted and published worldwide on the status of biosecurity in poultryfarms have used different classifications, different number of measures and different scoring criteria[7, 11–15]. This study classified the biosecurity measures into internal and external levels to score and assess the measures according to a modified Biocheck.UGent tool.

Based on the findings obtained from this study, the mean score of overall biosecurity in commercial layer chicken farms in Abyek was 72.7, which were 72.2 and 77.1 for external and internal biosecurity, respectively. This results were in agreement with one study in Philippines which reported that the mean score of overall biosecurity score was 65.9, internal biosecurity score was 63.3 while the external biosecurity score was 71.9 on 124 layer farms[15]. So far, various studies in different parts of the world have investigated the biosecurity of layer poultry farms using a scoring system, but some of them used scoring system other than Biocheck.UGent tool. A study used Australian Centre for International Agriculture Research (ACIAR) biosecurity ranking system to obtain the overall biosecurity score of 63.4 for commercial layer poultry farms in Sulawesi province of Indonesia in 2010[13]. In addition to this, a study conducted in 2009 stated the overall biosecurity score of 64.5 and 71.7, respectively, using ACIAR biosecurity ranking system for commercial layer farms in Bali and West Java, Indonesia[16]. Studies concerning biosecurity situation in layer poultry farm in other parts of the world such as Sudan, Nigeria, Australia and France have also been conducted, but their results were presented without a similar scoring system. So we cannot make comparison those results with our results. The results obtained from this study showed that the overall biosecurity score in Abyek, Iran was somewhat better than some East Asian countries. However,

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there is still a need for fostering biosecurity awareness and expertise among the breeders, especially external biosecurity that scores lower than internal biosecurity on commercial layer chicken farms should be seriously considered.

In this study, the subcategory that scored the lowest in external category is "Location of the farm" (39.0), followed by "Removal of dead animals and manure from the halls" with a mean score 42.6. In any case, compliance with standard distance to the important sources of contamination is the first barrier against the entry of disease into a farm. Therefore, it is very important to identify the possible disease transmission route before establishing a farm and to build the farm in an appropriate location, away from other breeding centers, roads and other sources of pollution. The result of the subcategory related to "Removal of animals and manure" in this study is consistent with findings reported by Manuja *et al*. who recommended composting and anaerobic storage of manure before it is spread in the fields or used as organic fertilizer[17]. The findings indicated that manure and carcasses can also be a source of agents unless disposed of properly. Therefore, training and awareness of breeders is necessary for proper implementation of biosecurity practices.

As for internal category, the lowest mean score was "Disease management" subcategory with a mean score 69.7, mainly due to the density of birds per unit and the single-age of the flock status. Similar findings were also obtained by Scott *et al*.[18] who reported that the existence of birds with several ages in the flock leads to poor disinfection of the sheds, allowing the continuation and circulation of pathogens and the spread of diseases. Therefore, it is very important to modify the behaviors related to disease management in these units to improve the internal biosecurity status in this city. In other words, having a proper disease management strategy including proper handling of patients, proper diagnosis and treatment for patients, isolation and health records, as well as improving the immune system of susceptible birds, especially through vaccination, is very important and deserves more attention.

5. Conclusions

This study showed the biosecurity status of the participating farms and revealed some weak points in the implementation of these measures at internal and external levels. These results showed that the biosecurity measures of these farms need to be improved and upgraded, especially at the external level. To achieve the desired state of biosecurity implementation, continuous training of breeders and monitoring of its implementation is necessary. The findings of this study can help policymakers in advanced planning to improve disease control and prevention strategies in poultry farms, through the ranking of farms in each province (especially high-risk provinces) in terms of compliance with biosecurity measures and its application.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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This study was approved by the ethics committee of Razi Vaccine and Serum Research Institute, Karaj, Iran (No. 34-18-1852-051-990400).

Data availability statement

The data supporting the findings of this study are available from the corresponding authors upon request.

Authors' contributions

Mehrabadi MHF, Mirzaie K and Rabiee MH designed the study. Both Mirzaie K and Parsai A collected the data. Mehrabadi MHF, Mirzaie K and Rabiee MH performed the analytic calculations and interpreted the results, and drafted the article and conducted critical revision of the article. Mehrabadi MHF, Ghalyanchi A, Rabiee MH, Bashashati M, and Shoushtari A contributed to the final version of the manuscript.

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