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Prevalence data on chicken diseases in low-resource settings

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Summary

The presence of transmissible disease in livestock has a huge impact on welfare and economics in animal and public health. The lack of data enables the spread of diseases due to misinformed decision-making on prevention and control. Low-resource settings face challenges in providing data, turning data availability into a development issue. We collected a large dataset (*n*=997) on prevalence and seroprevalence estimates on viral (*n*=224), bacterial (*n*=83) and parasitic diseases (*n*=690) in backyard chickens in low-income and middle-income countries (LMICs). These originate from 306 studies identified during the screening phase of a systematic literature review. We attempted to classify studies according to the Food and Agriculture Organization of the United Nations classification system of family poultry production systems. Of all the studies, 98.7% (302/306) focused on a single poultry production system while 1.3% (4/306) targeted two different production systems. Within the group of studies that covered one production system, 85.4% (258/302) were classified as 'small extensive scavenging or extensive scavenging', 'small extensive scavenging and extensive scavenging'. In addition to that, 52% (159/306) of the studies did not report information on the chicken breed type. No data was found on any relevant disease from 56.9% (78/137) of LMICs, identifying a potential data gap. Of the estimates on viral and bacterial diseases, 71.0% (218/307) corresponded to diseases notifiable to the World Organisation for Animal Health, highlighting a tendency to measure disease occurrence on diseases relevant to trade. The latter might not necessarily be priority diseases for the producers, however. Also, 72.3% (222/307) of the estimates originate from random samples and they could be used to estimate prevalence in backyard chickens using imputation methods and thus, bridging the data gap.

Keywords

Backyard – Chicken – Data – Disease – Low and middle income – Prevalence.

Introduction

Livestock diseases curtail the level of output in animal production and hence, the profits that society generates through them [1]. Poultry diseases have been associated with an increment of 5% in global hunger in 2019 [2]. In low-income countries, the poultry production level in 2018 was decreased by 22%, probably due to diseases [2].

The World Organisation for Animal Health (WOAH, founded as OIE) provides a global framework of standards according to which Member countries must report specific animal diseases that occur in their territory [3]. These are the so-called 'notifiable or listed diseases' to WOAH. There are 14 listed diseases specifically for poultry, including avian influenza, Newcastle disease, avian infectious bronchitis, infectious bursal disease, avian infectious laryngotracheitis, pullorum disease, fowl typhoid and avian chlamydiosis, among others. Notifiable diseases for poultry only include viral and bacterial diseases. Parasitic diseases as well as reproductive, lameness and animal welfare issues are not included [4].

The procedure for the inclusion and removal of diseases to the WOAH list is standardised [5]. For a disease to be included in the list, an assessment of a pathogenic agent against specific criteria is conducted. The criteria include: *a)* evidence of international spread of the pathogenic agent and, *b)* demonstration that at least one country has proved freedom from that disease and, *c)* an accurate case definition and the existence of reliable means for diagnosis and detection and, *d)* evidence of natural transmission to humans and severe consequence of human infection, or significant impact of the disease on domestic animals health, or significant impact on wildlife animals health.

The establishment of transboundary trade networks of animals and animal products due to globalisation, has increased the risk of spread of animal diseases to new grounds [6]. One of the purposes of notifying diseases to WOAH is to limit the spread through national and international trade by movement restrictions [7]. However, the lack of resources in some regions for collecting data and laboratory diagnosis can hinder capturing and sharing real-time data and thus, enable the spread of animal diseases across the country and beyond [7].

Backyard chickens is usually targeted to address poverty, malnutrition and food security in low resource settings [8]. This production system provides to households meat and eggs, which are a source of high protein quality, especially important for those more vulnerable such as children and pregnant women [9]. Keeping backyard chickens, enable farmers to sell and trade chicken products to generate some income and therefore, mitigate economic vulnerability. In addition to this, backyard chickens are usually managed by women, fostering women's empowerment through the access of some income [10].

The Global Burden of Animal Diseases (GBADs) programme (https://animalhealthmetrics.org) aims to improve societal outcomes through the enhancement of animal health and animal welfare investments. The GBADs programme is committed to fill data gaps on productivity losses, expenditure and disease burden in livestock [11].

As part of the GBADs, this study releases a large dataset of prevalence estimates on backyard chicken disease in low-income and middle-income countries (LMICs) to support researchers in secondary analysis and thus, to improve public benefit from increased data use. This study describes the geographic distribution of the data, type of diseases, sampling used and attempts to classify the studies selected according to the Food and Agriculture Organization of the United Nations (FAO) classification system of family poultry production systems [12].

Materials and methods

Data collection

Studies reporting prevalence and seroprevalence data were collected in the screening step of a systematic literature review (SLR) whose goal was to identify and evaluate studies that provide data to estimate the impact of diseases and other causes of morbidity or mortality in backyard chickens in LMIC. We targeted countries classified as LMIC by the World Bank (WB) [13]. Only prevalence and seroprevalence data from chickens that had gone through diagnoses by an animal health professional and/or laboratory diagnosis were collected. The ten most spoken languages were covered in the review and the search was restricted 1981–2021 [14]. Backyard farms (including free-roaming chicken farms) were understood as the definition by FAO (sectors 3 and 4) [15]. An essential inclusion criterium was that farms had to have a low biosecurity level and chickens in contact with other wild birds. Information on the search strategy, including search strings in the different languages and databases consulted, can be found in Muñoz-Gómez *et al.* [14]. In total 344 studies gathering prevalence and seroprevalence data were identified out of which, 35 studies were excluded because the countries were not classified by the WB as LMICs and 3 studies were also excluded because they were redundant (double-published). As a result, 306 studies were finally selected.

Data extraction and data management

Data extracted from selected studies included pathogen name, sample type (random *versus* non-random), breed type, breed name, prevalence, seroprevalence, sample size, testing level, continent, country, production system according to the FAO classification system of family poultry, publication year, first author surname and uniform resource locator, commonly known as URL. All data were extracted in an excel file. The dataset contains 1,012 prevalence and seroprevalence estimates. However, data on comorbidities (*n*=15), were excluded for this analysis, for simplicity.

We attempted to classify the studies according to the FAO classification system of family poultry [12] (small extensive scavenging, extensive scavenging, semi-intensified, small-scale intensified). In addition to that, we extracted information on the breed type (local breed, commercial breed, mixed breed, local and commercial breeds, local and mixed breeds, local and commercial and mixed breeds). Local breed refers to indigenous or native breeds from the region as mentioned in the study. Commercial breed refers to specialised broiler/layer production breeds, also named as 'exotic breeds', according to the study. Mixed breed refers to a breed that descends from different breeds.

A random sample was defined as a sample randomly selected from all possible chickens of the entire flock. Random samples were considered representative samples from the target population. A non-random sample was understood as a sample that is normally used for confirmatory diagnosis in which individuals are not randomly selected.

The complete dataset on prevalence and seroprevalence of diseases from backyard chickens in LMICs can be accessed through the following link: https://gbads-repro-pods.s3.ca-central-1.amazonaws.com/gbads-20231220-0001/DataPod/2023-Supplementary+material-dataset_RV_2d.xlsx

A companion document of the dataset is also available online: https://gbads-repro-pods.s3.ca-central-1.amazonaws.com/gbads-20231220-0001/DataPod/2023-Supplementary+material-readme_RV_2d.docx

Descriptive analysis

A descriptive analysis was conducted using the stats package in R [16]. Maps were reproduced using *ggplot2* package in R [17]. All the analysis and visualisation were performed using RStudio 4.2.4 [18].

Results

We found prevalence and seroprevalence data on backyard chickens from 43.1% (59/137) of LMICs. A total of 997 prevalence and seroprevalence estimates from backyard chicken diseases in LMICs were extracted from 306 studies. Out of those 997 estimates, 83 corresponded to bacteria diseases, 224 to viral diseases and 690 to estimates parasitic diseases (Figure 1).

Table I shows the classification of prevalence and seroprevalence estimates of viral and bacterial disease conforming to whether the diseases are or not notifiable to WOAH. According to our data, 71.0% of the prevalence and seroprevalence estimates of viral and bacteria diseases corresponded to notifiable diseases and 29.0% to non-notifiable diseases (Table I).

Table II displays information on the classification of prevalence and seroprevalence estimates on viral and bacterial diseases according to the sampling type. Results show that 72.3% of the prevalence and seroprevalence estimates were randomly sampled (Table II). Of the total prevalence and seroprevalence estimates that corresponded to notifiable diseases, 76.1% were randomly selected and in the case of non-notifiable diseases, 62.9% (Table II).

Out of the 306 studies that contains the dataset, only three studies referred to the FAO classification system on family poultry production systems to define the chicken production system under study. None of the studies (*n*=306) provided information on each of the criteria used by FAO to define family poultry production systems [12]. We only used some of those criteria (‘production/farming type’, ‘other livestock raised’, ‘flock size’, ‘poultry breeds’, ‘source of new chicks’, ‘feed source’, ‘drinking water’, ‘poultry housing’, ‘access to veterinary services and veterinary pharmaceuticals’ and ‘access to urban markets’) to classify the production systems described in the studies. These criteria were the ones regularly covered by most of the studies. To maximise our attempt to classify studies, we created additional categories of production systems that covered two close production systems of the FAO classification (e.g. ‘small extensive scavenging or extensive scavenging’) as it was difficult to discriminate between them due to a lack of information in the selected studies. The information extracted from each study is available in the dataset.

Of the total number of studies, 98.7% (302/306) focused on a single production system while 1.3% (4/306) targeted two different production systems. Within the group of studies that focused on a single production system, 65.6% (198/302) were classified as ‘small extensive scavenging or extensive scavenging’, 11.6% (35/302) as ‘small extensive scavenging’, 8.3% (25/302) as ‘extensive scavenging’, 8.9% (27/302) as ‘extensive scavenging or semi-intensified’, 4.3% (13/302) as ‘semi-intensified’, 0.3% (1/302) as ‘small-scale intensified’ and 1.0% (3/302) of the studies were not classified due to lack of information on the production system under study. Within the group of studies that targeted two different production systems, two studies covered a ‘small extensive scavenging’ production system and a ‘extensive scavenging’ production system, other study focused on a ‘extensive scavenging’ production system and a ‘small-extensive scavenging or extensive scavenging’ production system and another study focused on two production systems that were classified as a ‘small extensive scavenging’ production system and a ‘small-extensive scavenging or extensive scavenging’ production system.

Regarding the breed type, 52.0% (159/306) of the studies did not report information on the type of breed, 35.3% (108/306) of the studies were based on local breeds, 4.6% (14/306) on local and commercial breeds, 3.6% (11/306) of the studies focused only on commercial breeds, 2.9% (9/306) on local and mixed breeds, 1.3% (4/306) of the studies reporting findings on mixed breeds and 0.3% (1/306) of the studies covered three different type of breeds (local, mixed and commercial breeds).

Discussion

Around 60–90% of the poultry population in LMICs are raised in backyard systems [19]. We only found prevalence and seroprevalence data on backyard chicken diseases in 43.1% (59/137) of LMICs. This means that, according to our data, there is a potential data gap in the remaining 56.9% of LMICs. In our search strategy, we did not include the WOAH database and national surveillance reports. Also, the search was restricted until 2021. Therefore, it is possible that these data exist in sources that were not considered in the search strategy or published in the last two years and, that were not captured in the screening phase. However, we should also consider that although this could be the case for some countries, it is plausible that for many LMICs, no data on disease prevalence in backyard chickens are regularly generated and thus, there is a knowledge gap on the health status of the predominant production system in LMICs.

The absence of disease data on backyard chickens is not only an animal health issue but becomes a public health one. Backyard chickens can spread zoonotic diseases to humans such as salmonellosis, avian influenza virus and campylobacteriosis, which can heavily impact the health of vulnerable people [20]. Without data, there is no context to assess this risk and to reduce or prevent it. The lack of data on backyard chicken diseases can also create misconceptions on the current animal/public health system, lead to misinformed decision-making and incorrect conclusions.

The global presence of mobile phones has made possible to undertake innovative initiatives in the field of animal health in LMICs. These include, for example, smartphone-based applications in Ethiopia that provide veterinarians with a differential diagnostic list based on selected signs and steps for diagnosis and treatment [21] and an e-veterinary diagnostic system in Tanzania in which diagnostic results are provided in a timely manner via SMS to livestock field officers [22]. Other initiatives have also targeted livestock owners or just community neighbours. This is the case, for example, of a phone-based surveillance system in Kenya in which farmers and community members directly report disease events to veterinarians [23]. However, although the use of mobile phones can facilitate the report of animal health events, this information should be cautiously interpreted and validated by animal health experts. Building capacity on training in animal disease recognition by phone users becomes indispensable to prevent the saturation of veterinary services [24]. Also, the need to conduct field evaluation with diagnostic support is necessary and inherent for the evaluation of phone-based surveillance systems [25,26] and therefore, to strengthen its performance and cost-effectiveness. Field evaluation allows, for example, to determine the diagnosis of diseases that share similar signs or symptoms such as fowl cholera, Newcastle disease and aspergillosis [27] and therefore, to discriminate when immediate response from the veterinary services is required.

Although these initiatives are still at a premature stage, the interest in using phones to report livestock diseases is increasing. Taking a long-term view, these approaches could offer significant benefits in terms of collecting data on backyard chicken diseases using cheap and fast technologies in low-resource settings and thus, fill the data gap. However, the limiting factors that could hamper this progress should be also acknowledged. These include for example, the limited Internet connectivity in some areas [21], the consequence of having mobile phones on income and expenditure in the household [28], the possession of feature phones *versus* smartphones [22] and reporting incentives [23]. Therefore, although the digital transformation is here and can contribute to meaningful progress in animal health, it highlights inequality and reminds us that data availability is a development issue.

In our study, 71.0% of the prevalence and seroprevalence estimates on viral and bacterial diseases corresponded to notifiable diseases to WOAH. This shows that, according to our data, there is a tendency to measure (or publish) disease occurrence of notifiable diseases in backyard chickens in LMICs. We lack knowledge on whether notifiable diseases are the economically most pressing issues in this livestock production system in LMICs. However, one of the reasons for this could be that member countries are required to report occurrence of these diseases to WOAH and as a consequence, more data are published [3]. Also, the fact that more data are published on notifiable diseases is an indicator that international standards could be considered a national priority. However, this might not necessarily be aligned with priority diseases in this production system in LMICs.

In the absence of information on livestock disease impacts, WOAH has commissioned surveys to delegates in different continents with the aim to establish a disease priority list in livestock species. There are several factors that can play a role in deciding which are the most important diseases such as the impact on food security, impacts on export sector, impact on public opinion, impact on wildlife and the environment [29]. The reason for establishing a disease priority list focusing on individual countries is to ensure that scarce resources target the most pressing issues to obtain the greatest benefits in animal and human health [30]. As far as we know, this type of survey has not been conducted in chickens yet.

Our results also showed that the sampling type most used in both notifiable and non-notifiable disease was random sampling. This means that 72.3% of the prevalence and seroprevalence estimates for viral and bacterial diseases can be used to draw inferences about the target population and therefore, they can be used, for example, to estimate disease burden when the estimates are pooled together. Random sampling is used, for example, as part of sentinel surveillance [31] and monitoring control programmes [32]. Results also showed that 27.7% of the estimates were not randomly selected, 61.2% (52/85) of them being from notifiable diseases. Non-probability-based samples can produce useful information for example, to detect disease and to identify changes in temporal and geographical patterns of disease. However, they should not be applied to estimate disease prevalence in a population as the samples are biased [33].

Prevalence is a measure of disease occurrence and it is useful to identify disease problems, to establish priorities on research, defining control strategies that operate in the long term and to evaluate diagnostic tests [34]. It is particularly valid if disease indicators are used that are present for a considerable period of time, such as antibodies.

As part of the GBADs' endeavour, we collected a large dataset on prevalence and seroprevalence estimates on viral, bacteria and parasitic diseases on backyard chickens based in LMICs. The release of this dataset intends to be used for new research and bring value to the economy and to society, as a whole and particularly in poor resource settings.

Our aim is now to estimate disease prevalence for relevant diseases through imputation methods to bridge the data gap on backyard chicken diseases in low-resource settings. To estimate the total economic burden attributable to diseases, in addition to prevalence data, data on productivity losses due to diseases and health conditions (e.g. mortality rate, yield reduction in egg production, yield reduction in body weight) and data on expenditure on health care and preventive measures (e.g. expenditure in vaccination, expenditure in veterinary medicines) are required. By identifying the major causes of economic burden, the allocation of resources can be optimised in preventive and control measures [35].

Conclusions

This study provides access to a large global dataset on prevalence and seroprevalence data on bacterial, viral and parasite diseases in backyard chickens in LMICs. We did not find data from 56.9% of the LMICs, identifying a potential data gap. Modern communication technologies such as mobile phones can be used to supplement data on backyard chicken diseases. The FAO classification on family poultry production system is not generally used in the selected studies to define chicken production systems in LMICs. Our attempt to classify studies showed that 85.4% of the studies were based on small extensive scavenging or extensive scavenging farms. More than half of the studies (52.0%) did not report information on the chicken breed type. In total, 71.0% of the prevalence and seroprevalence on viral and bacterial diseases correspond to notifiable diseases to WOAH, highlighting a tendency to measure disease occurrence on these diseases. Overall, 72.3% of the prevalence and seroprevalence estimates on viral and bacterial diseases were drawn from random samplings and can used to estimate disease occurrence in low-resource settings using, for example, imputation methods and thus, bridging the data gap.

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Table I

Classification of prevalence and seroprevalence estimates on viral and bacterial diseases according to whether diseases are notifiable or non-notifiable

	Notifiable disease (n, %)	Non-notifiable disease (n, %)	Total
Viral disease	172 (76.8%)	52 (23.2%)	224 (100.0%)
Bacterial disease	46 (55.4%)	37 (44.6%)	83 (100.0%)
Total	218 (71.0%)	89 (29.0%)	307 (100.0%)

Table II

Classification of prevalence and seroprevalence estimates on viral and bacterial diseases according to the sampling type

	Non-random sampling (n, %)	Random sampling (n, %)	Total
Notifiable diseases	52 (23.9%)	166 (76.1%)	218 (100.0%)
Non-notifiable diseases	33 (37.1%)	56 (62.9%)	89 (100.0%)
Total	85 (27.7%)	222 (72.3%)	307 (100.0%)

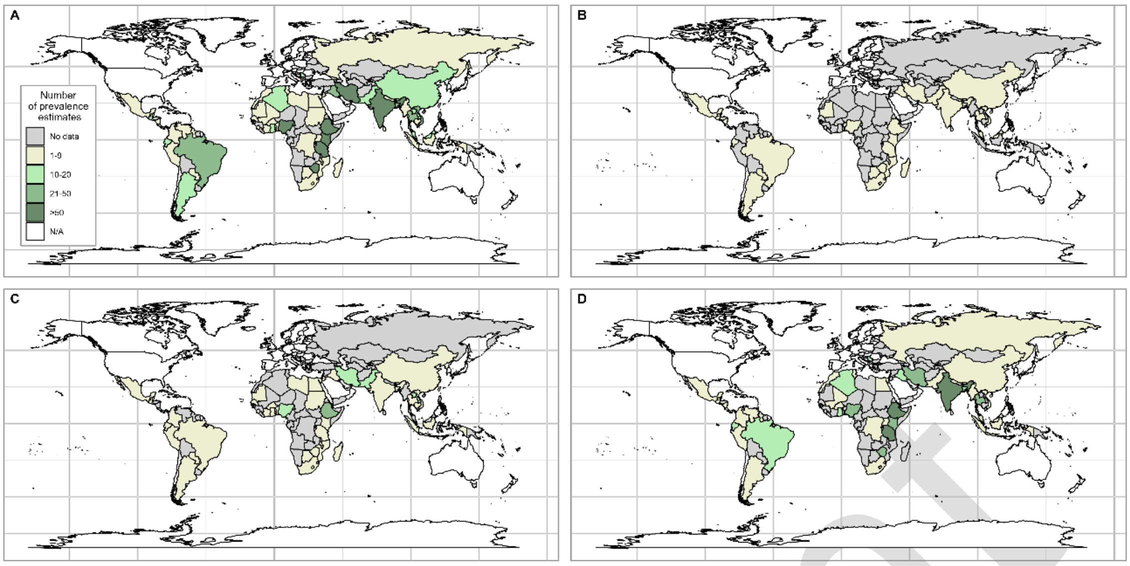

Figure 1

World map showing the geographic location where prevalence and seroprevalence data were collected

A: Geographic location of all prevalence data (*n*=997)
B: Geographic location of bacteria prevalence data (*n*=83)
C: Geographic location of viral prevalence data (*n*=224)
D: Geographic location of parasite prevalence data (*n*=690)