One Health 2 (2016) 55–64

Contents lists available at ScienceDirect

One Health

journal homepage: www.elsevier.com/locate/onehlt

Interventions in live poultry markets for the control of avian influenza: A systematic review

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A R T I C L E I N F O

Article history:
Received 12 October 2015
Received in revised form 17 February 2016
Accepted 14 March 2016
Available online 22 March 2016

Keywords:
Influenza A virus
Live poultry market
A/H7N9
A/H9N2
Closure
Rest day

A B S T R A C T

Background: Live poultry markets (LPMs) pose a threat to public health by promoting the amplification and dissemination of avian influenza viruses (AIVs) and by providing the ideal setting for zoonotic influenza transmission.
Objective: This review assessed the impact of different interventions implemented in LPMs to control the emergence of zoonotic influenza.
Methods: Publications were identified through a systematic literature search in the PubMed, MEDLINE and Web of Science databases. Eligible studies assessed the impact of different interventions, such as temporary market closure or a ban on holding poultry overnight, in reducing i) AIV-detection rates in birds and the market environment or ii) influenza incidence in humans. Unpublished literature, reviews, editorials, cross-sectional studies, theoretical models and publications in languages other than English were excluded. Relevant findings were extracted and critically evaluated. For the comparative analysis of findings across studies, standardized outcome measures were computed as i) the relative risk reduction (RRR) of AIV-detection in LPMs and ii) incidence rate ratios (IRRs) of H7N9-incidence in humans.
Results: A total of 16 publications were identified and reviewed. Collectively, the data suggest that AIV-circulation can be significantly reduced in the LPM-environment and among market-birds through (i) temporary LPM closure, (ii) periodic rest days (iii) market depopulation overnight and (iv) improved hygiene and disinfection. Overall, the findings indicate that the length of stay of poultry in the market is a critical control point to interrupt the AIV-replication cycle within LPMs. In addition, temporary LPM closure was associated with a significant reduction of the incidence of zoonotic influenza. The interpretation of these findings is limited by variations in the implementation of interventions. In addition, some of the included studies were of ecologic nature or lacked an inferential framework, which might have lead to cosiderable confounding and bias.
Conclusions: The evidence collected in this review endorses permanent LPM-closure as a long-term objective to reduce the zoonotic risk of avian influenza, although its economic and socio-political implications favour less drastic interventions, e.g. weekly rest days, for implementation in the short-term.

Contents

Abbreviations: C/D, cleansing and disinfection; GLM, general linear model; IRR, incidence rate ratio; LBM, live bird market; LPM, live poultry market; NDV, Newcastle Disease Virus; OR, odds ratio; PUE, Pneumonia of Unknown Etiology; rLPM, retail live poultry market; RR, relative risk; RRR, relative risk reduction; RT-PCR, reverse transcription polymerase chain reaction; wLPM, wholesale live poultry market.

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http://dx.doi.org/10.1016/j.onehlt.2016.03.002
2352-7714/

1. Introduction

Human influenza viruses cause seasonal influenza, a globally widespread respiratory illness giving rise to ~3–5 million cases of severe illness every year [1]. Influenza viruses can also be found in other mammals and birds, and the greatest diversity of influenza viruses occurs in aquatic birds [2]. Most strains of avian influenza viruses (AIVs) do not pose a risk to human health. Some strains however, e.g. subtypes H7N9 [3] and H5N1 [4], have acquired the ability to cross the species-barrier and infect humans who come into close contact with infected birds or contaminated environments [5]. Occasionally, animal influenza viruses cause global pandemics in humans, as happened three times in the 20th century and most recently in 2009 [6,7]. Surveillance of avian influenza viruses is important to identify new strains that may pose a pandemic threat [8].

Because of the high density and variety of avian hosts, live poultry markets (LPMs) support the maintenance, amplification and dissemination of AIVs [8–11]. In addition, LPMs provide frequent opportunities for inter-species transmission events [8–12]. In fact, the emergence of zoonotic influenza outbreaks has often been preceded by long-lasting AIV-circulation in market poultry [13,14].

Considering the unpredictability of the subtype or strain causing the next zoonotic or pandemic influenza threat [15], generic measures to control the endemicity of AIVs at the source, e.g. in market poultry, remain key elements of pandemic preparedness [8,15,16]. Permanent LPM closure encounters strong public resistance [17]. Nonetheless, Chinese LPMs were temporarily closed during both H7N9-waves [18]. Hong Kong's LPMs implemented monthly [19] or bimonthly [20] rest days and an overnight poultry storage ban [21]. Similarly, LPM-systems in the North-Eastern USA have introduced regular depopulation and disinfection of all markets in 2002 [22–24].

This review discusses the impact of different LPM interventions on (i) AIV-circulation in LPMs and (ii) AIV-transmission to humans, drawing implications for policy recommendations based on the collective scientific evidence.

2. Materials and methods

2.1. Literature search

The databases PubMed, Web of Science and MEDLINE were searched for relevant articles through the following search string: ((poultry market) OR (poultry markets)) AND (avian influenza). This search was complemented with different combinations of the following search terms: “live poultry market/markets”, “avian influenza”, “overnight”, “rest day”, “market closure”, “clos*” and “ban”. The literature search was conducted on 25 July 2015.

2.2. Inclusion criteria

Settings: live poultry markets worldwide; no time restrictions;

Interventions: temporary LPM closure, periodic rest days combined with depopulation and disinfection of the markets, sale ban of specific bird species and ban on holding live poultry within LPMs overnight;

Outcomes: AIV-detection rates in birds and/or the market environment or influenza incidence in humans;

Study design: before–after studies assessing the impact of either of the listed interventions on either of the outcomes.

2.3. Exclusion criteria

Unpublished literature, reviews, editorials, cross-sectional studies, theoretical models and publications in languages other than English were excluded.

2.4. Data extraction

All studies were individually assessed with regard to study design and potential bias or confounding. No study was excluded based on these criteria, but major limitations of specific studies are discussed in the text.

The following information was retrieved from the included studies: location, influenza strain, type and date of intervention, data collection methods, main outcomes and findings. Because of the differences in study design, data analysis and reporting methods, the computation of a pooled estimate of intervention effectiveness was not possible within this group of studies. To compare findings across studies, standardized outcome measures were computed as i) relative risk reduction (RRR) of AIV-detection in LPMs and ii) incidence rate ratios (IRRs) of H7N9-incidence in humans. When necessary, raw data was retrieved from supplementary materials.

2.5. Calculation of epidemiologic outcome measures

The following outcome measures were used to summarize the findings:

Average AIV-prevalence before (P_{pre}) or after (P_{post}) the intervention:

- P_{pre} = *total nr. of positive samples before the intervention/total nr. of samples tested before the intervention*
- P_{post} = *total nr. of positive samples after the intervention/total nr. of samples tested after the intervention*