

## Can closure of live poultry markets halt the spread of H7N9?

After isolation of avian influenza A H7N9 virus from live poultry markets (LPMs), and reports that several people who were infected with the virus had visited such markets a few days before disease onset, LPMs were suspected to be a main source of human exposure to H7N9 in China.<sup>1</sup> After LPM closure was enforced in several Chinese cities, the incidence of H7N9 human cases rapidly reduced.<sup>2</sup> In *The Lancet*, Hongjie Yu and colleagues<sup>3</sup> quantify the risk of human infections before and after LPM closure in the Chinese cities of Nanjing, Shanghai, Hangzhou, and Huzhou. The investigators used information about laboratory-confirmed cases of avian influenza A H7N9 virus infection reported in the four cities by June 7, 2013, to fit a statistical model to assess the daily probability of infection for each susceptible individual before and after LPM closure. They report that closure of LPMs reduced the mean daily number of infections by 99% (95% credibility interval 93–100%) in Shanghai, 99% (92–100%) in Hangzhou, 97% (68–100%) in Huzhou, and 97% (81–100%) in Nanjing.<sup>3</sup> They conclude that LPM closure should be sustained in areas with high risk of disease spread, and implemented in any urban areas where avian influenza A H7N9 virus appears in the future.

LPMs are known to be a high-risk environment for pathogen transmission between birds and for zoonotic transfer to people. If birds spend a sufficient amount of time in LPMs to become infected and transmit the virus to other susceptible birds, sustained virus circulation in LPMs can occur.<sup>4</sup> LPMs can then become a permanent source of infection for poultry flocks and for people who are in close contact with infected poultry and contaminated fomites. LPM closure would therefore be expected to stop human infections caused by a zoonotic pathogen transmitted within markets.

Although LPM closure seems to have had an important effect on incidence of avian influenza A H7N9 virus infection in people, the underlying epidemiological and socioeconomic system is complex. LPM closure might not have been the most important cause of a reduction in incidence. Indeed, soon after LPM closures in Nanjing, Shanghai, Hangzhou, and Huzhou, human infections were also interrupted in other cities where this measure was not implemented.<sup>3</sup> An example of the complex chain of interacting socioeconomic and epidemiological factors is that reports that poultry is

a source of avian influenza A H7N9 virus triggered a drop in demand for poultry meat and consequently in poultry prices.<sup>5</sup> Some producers were even forced to destroy their flocks because poultry rearing became cost prohibitive,<sup>6</sup> which probably reduced the absolute number of poultry substantially in affected areas and reduced viral circulation, irrespective of LPM closure.

Strong consumer reactions to zoonotic health hazards are not uncommon. Fears of avian influenza A H5N1 virus led to reduced consumption of poultry products in Asia in early 2004.<sup>7</sup> However, these reductions were temporary: consumers' anxiety decreased rapidly after the first wave of the outbreak.<sup>8</sup> Consumption of poultry products resumed within a few months, sometimes exceeding levels recorded before the outbreak,<sup>7</sup> even though the virus had become endemic and human cases were reported regularly.

Reduced consumer demand could have increased the compliance of poultry production stakeholders with LPM closures in China, because informal alternative ways to sell poultry were unavailable. Avian influenza A H7N9 virus is probably still circulating in Chinese poultry flocks, as suggested by new human cases reported in August, 2013.<sup>9</sup> If poultry consumption resumes, the seasonal increase in poultry production and trading activities that usually occurs in the months preceding Chinese New Year could amplify virus circulation, resulting in a surge in human cases. If this increase occurs and consumer reactions are not as strong as during the spring of 2013,

Published Online  
October 31, 2013  
[http://dx.doi.org/10.1016/S0140-6736\(13\)62109-1](http://dx.doi.org/10.1016/S0140-6736(13)62109-1)

See Online/Articles  
[http://dx.doi.org/10.1016/S0140-6736\(13\)61904-2](http://dx.doi.org/10.1016/S0140-6736(13)61904-2)



Yang Bo/ColorChinaPhoto/Associated Press

the apparent effect of LPM closure—whether mediated directly through reductions in human exposure or indirectly through other effects—might not be repeated. Informal marketing channels could develop, providing an opportunity for stakeholders to minimise economic losses resulting from reduced market access.

Although China has the resources to prevent development of informal trading activities, other nearby countries do not. In other countries where avian influenza A H5N1 virus is endemic, compliance to LPM closure is low<sup>10,11</sup> and smuggling of poultry is common.<sup>12,13</sup> However, the risk of introduction of avian influenza A H7N9 virus in these countries—with which China shares close epidemiological links, as indicated by the continuing spread of H5N1 variants in the region—is high. Live poultry trade creates networks of contacts between poultry and human populations, thereby affecting zoonotic disease dynamics. If LPM closure cannot be effectively enforced, unintended changes in the structure of networks could be triggered, possibly increasing the potential for disease spread, and probably resulting in reduced ability to do targeted surveillance and other risk management activities. Therefore, before such an intervention is implemented, its feasibility and the likelihood of unintended adverse results should be carefully assessed.

Although LPM closure in specific circumstances can effectively interrupt human exposure to avian influenza A H7N9 virus, if applied alone this measure is unlikely to eliminate the zoonotic threat. Because disease incidence in people is low at present, the focus should move beyond detection of human cases and emergency response towards prevention at the infection source.<sup>14</sup> A multisectoral approach would be needed first to identify and then target the inter-related social, economic, cultural, biological, and environmental drivers underlying disease emergence and spread. These drivers are often ignored during attempts to deal with human and animal health risks, but the motivation behind adoption of some trading practices and factors affecting purchasing behaviour of consumers needs to be considered. By

contrast with LPM closure, a multisectoral approach leading to restructuring rather than destabilisation of the LPM system would be more likely to result in a sustainable reduction in the risk of disease spread while also protecting livelihoods and food security.

\*Guillaume Fournié, Dirk U Pfeiffer

Veterinary Epidemiology, Economics and Public Health Group, Production and Population Health Department, Royal Veterinary College, Hatfield AL9 7TA, UK  
gfournie@rvc.ac.uk

We declare that we have no conflicts of interest.

- 1 Chen Y, Liang W, Yang S, et al. Human infections with the emerging avian influenza A H7N9 virus from wet market poultry: clinical analysis and characterisation of viral genome. *Lancet* 2013; **381**: 1916–25.
- 2 Murhekar M, Arima Y, Horby P, et al. Avian influenza A(H7N9) and the closure of live bird markets. *Western Pac Surveill Response J* 2013; **4**: 4–7.
- 3 Yu H, Wu JT, Cowling BJ, et al. Effect of closure of live poultry markets on poultry-to-person transmission of avian influenza A H7N9 virus: an ecological study. *Lancet* 2013; published online Oct 31. [http://dx.doi.org/10.1016/S0140-6736\(13\)61754-7](http://dx.doi.org/10.1016/S0140-6736(13)61754-7).
- 4 Fournié G, Guitian FJ, Mangtani P, Ghani AC. Impact of the implementation of rest days in live bird markets on the dynamics of H5N1 highly pathogenic avian influenza. *J R Soc Interface* 2011; **8**: 1079–89.
- 5 Reuters. China poultry sector losses exceed \$1.6 billion on bird flu scare. April 16, 2013. <http://www.reuters.com/article/2013/04/16/us-china-birdflu-poultry-idUSBRE93F06Z20130416> (accessed Sept 24, 2013).
- 6 ProMED-mail. Avian influenza (43): (China) zoonotic LPAI H7N9, animal update. April 22, 2013. <http://www.promedmail.org/direct.php?id=20130422.1664423> (accessed Sept 24, 2013).
- 7 Taha FA. How highly pathogenic avian influenza (H5N1) has affected world poultry-meat trade. A report from the Economic Research Service, USDA. 2007. <http://www.ers.usda.gov/publications/ldpm-livestock,-dairy,-and-poultry-outlook/ldpm-15902.aspx> (accessed Sept 24, 2013).
- 8 Figue M, Fournier T. Avian influenza in Vietnam: chicken-hearted consumers? *Risk Anal* 2008; **28**: 441–51.
- 9 ProMED-mail. Avian influenza, human (104): China (GD), H7N9 poultry worker. Aug 11, 2013. <http://www.promedmail.org/direct.php?id=20130811.1875467> (accessed Sept 24, 2013).
- 10 Fournié G, Guitian J, Desvaux S, et al. Interventions for avian influenza A (H5N1) risk management in live bird market networks. *Proc Natl Acad Sci USA* 2013; **110**: 9177–82.
- 11 Naysmith S. Observations from a live bird market in Indonesia following a contained outbreak of avian influenza A (H5N1). *Ecohealth* 2013; published online July 10. DOI:10.1007/s10393-013-0858-y.
- 12 Yupiana Y, de Vlas SJ, Adnan NM, Richardus JH. Risk factors of poultry outbreaks and human cases of H5N1 avian influenza virus infection in West Java province, Indonesia. *Int J Infect Dis* 2010; **14**: e800–05.
- 13 Biswas PK, Christensen JP, Ahmed SS, et al. Risk for infection with highly pathogenic avian influenza virus (H5N1) in backyard chickens, Bangladesh. *Emerg Infect Dis* 2009; **15**: 1931–36.
- 14 Chatham House. Shifting from emergency response to prevention of pandemic disease threats at source. Meeting report. April, 2010. <http://www.chathamhouse.org/publications/papers/view/109284> (accessed Sept 24, 2013).