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Spatio-temporal network analysis of pig movements in Great Britain: implications for disease transmission and control strategies

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Animal movements represent an important means for disease transmission among animal holdings over large geographical distances. Therefore, understanding the dynamic patterns of animal movement networks is needed to inform models of disease spread and target control and risk-based surveillance strategies.

Here, we conduct a spatio-temporal analysis to explore pig movement networks throughout Great Britain (GB) over a 5-year period (2009-2013) with a view to identify spatial and temporal patterns, characterise the monthly network topology and identify trade communities. Descriptive statistics were initially generated including all premise types. A directed and weighted monthly network was then built, considering each premise (only farms, gathering areas and market premises) as a node and each daily pig movement between two premises as an edge.

Over the 5-year study period, the pig movements included 48,976 active premises and 888,613 movements, involving 64,121,604 pigs. Most of the movements originated from farms (96.0%) and gathering areas (3.8%) and were directed to slaughter houses (68.3%), farms (23.7%) and gathering areas (7.8%). The distance covered by 50%, 75% and 95% of the pig movements was 31km, 65km and 175km, respectively. A seasonal pattern was observed, with increased trade movements occurring in autumn and spring. East Anglia, North West, South East and South West England and Yorkshire and Humberside represented the major sources and receivers in term of number of movements and pigs. The monthly network exhibited both scale-free and small-world properties. The 10 largest trade communities including 18% of premises were identified and associated with specific regions, providing a basis for defining zoning areas in the context of control of endemic and epidemic disease spread.

This study demonstrates how the spatio-temporal and functional organisation of pig trade in GB can be investigated to reveal hot spots in time and space for disease spread. This information can be used to parameterise epidemic models and also to directly inform the design of targeted disease surveillance and control strategies.