UK Health Security Agency

Routes of transmission of zoonotic influenza A

A rapid systematic review

Contents

Main messages

1. This rapid systematic review (search up to 15 July 2025) aimed to identify and summarise evidence relating to the most common routes of transmission of zoonotic influenza A between humans. This review focussed on the following zoonotic influenza A subtypes: H7N9, H9N2, H5N5, H5N2, H5N6, H5N8, H10N3, H10N5 and H3N8.

2. In total, 5,035 records from 5 databases were screened; however, no relevant studies were identified for inclusion in this review.

3. In summary, no published observational studies (case control or cohort studies), case series or case reports were identified that reported evidence to inform what the most common routes of transmission of zoonotic influenza A between humans are.

Purpose

The purpose of this rapid systematic review was to identify and summarise the available evidence that explored the most common routes of transmission of zoonotic influenza A between humans.

The review question was:

1. What are the most common routes of transmission of zoonotic influenza A between humans: respiratory, airborne, fomite or direct contact?

Methods

A rapid systematic review was conducted, following streamlined systematic methods to accelerate the review process. A literature search was undertaken to identify relevant primary observational studies (case control and cohort studies), case series and case reports, published or available as preprint, up to 15 July 2025.

This review searched for primary evidence, case series and case reports on routes of transmission between humans, in any setting. Exposures of interest were any of the following influenza A subtypes: H7N9, H9N2, H5N5, H5N2, H5N6, H5N8, H10N3, H10N5 and H3N8, with laboratory confirmation by polymerase chain reaction test. These subtypes were included based on the rationale that they are the most common strains to infect humans. Swine influenza was excluded because it is highly complex and different to other zoonotic influenza strains due to the potential for mixing of human influenza and swine influenza genetic material.

Relevant outcomes included any measure of human-to-human transmission through the following routes: respiratory (droplets that transmit from coughing, sneezing or talking and usually spread only to people nearby), airborne or aerosol (particles that can stay suspended in the air for longer than droplets), fomites (indirect contact with contaminated surfaces) or direct contact with saliva, through kissing, sharing utensils, or nasal secretions and fluid.

A protocol was produced before the literature search was conducted, including the review question, the eligibility criteria, and all other methods. Full details of the methodology are provided in the protocol in Annexe A. There were no deviations from the protocol.

Screening on title and abstract was undertaken in duplicate by 2 reviewers for 20% of the eligible studies, with the remainder completed by one reviewer. Screening on full text was undertaken by one reviewer and checked by a second. The reference lists of relevant reviews were checked to identify any additional primary studies. Backwards and forwards citation searching was not conducted, as no studies were included at full text screening stage.

Evidence

In total, 5,035 studies were screened at title and abstract and 85 studies were screened at full text. Of these, no studies met the inclusion criteria. A PRISMA diagram showing the flow of studies through the review is shown in Annexe B, and studies excluded on full text screening are available with the reasons why in Annexe C. The main reasons for excluding records at full text were no relevant outcomes reported by the study as per the inclusion criteria (n=40) and studies not published in English language (n=21). While some studies reported probable transmission of zoonotic influenza A between humans, none of them explicitly confirmed the specific route of transmission.

Health inequalities

The review protocol explicitly defined groups who may be at higher risk of zoonotic influenza A, such as individuals on low income, migrant workers, rural farm workers, and those with immunosuppression to explore potential health inequalities within these populations. However, no studies were identified for inclusion in this review and therefore health inequalities could not be assessed.

Limitations

This rapid systematic review used streamlined systematic methods to accelerate the review process. Sources of evidence searched included databases of peer-reviewed and preprint research, but an extensive search of other sources was not conducted and most article screening was completed without duplication, so it is possible relevant evidence may have been

missed. Additionally, the review was limited to articles published in English language, and a large number of non-English language studies were excluded which may have had some relevant information. The rapid systematic review approach was discussed and agreed with the subject matter experts at the outset.

Evidence gaps

No studies were identified for inclusion in this review highlighting an evidence gap relating to the most common routes of transmission of zoonotic influenza A between humans.

Conclusion

The aim of this review was to identify and assess available evidence relating to routes of transmission of Influenza A between humans. However, no relevant evidence (from observational studies, case series or case reports) was identified and therefore this review is unable to inform on the most common routes of transmission between humans.

Acknowledgments

We would like to thank colleagues within the All Hazards Public Health Response division who either reviewed or input into aspects of the review.

Disclaimer

UKHSA's rapid systematic reviews and evidence summaries aim to provide the best available evidence to decision makers in a timely and accessible way, based on published peer-reviewed scientific papers, and papers on preprint servers. Please note that the reviews:

- use accelerated methods and may not be representative of the whole body of evidence publicly available
- have undergone an internal independent peer review but not an external peer review
- are only valid as of the date stated on the review

In the event that this review is shared externally, please note additionally, to the greatest extent possible under any applicable law, that UKHSA accepts no liability for any claim, loss or damage arising out of, or connected with the use of, this review by the recipient or any third party including that arising or resulting from any reliance placed on, or any conclusions drawn from, the review.

References

1. JBI. 'JBI Critical appraisal tools' 2020
2. The Grade Working Group. 'GRADE handbook for grading quality of evidence and strength of recommendations' 2013

Annexe A. Protocol

Review question

The review question is:

1. What are the most common routes of transmission of zoonotic influenza A between humans: respiratory, airborne, fomite or direct contact?

A search for primary evidence to answer this review question will be conducted up to 15 July 2025.

Eligibility criteria

Table A.1. Inclusion and exclusion criteria

	Included	Excluded
Population	All humans (children and adults)	Animals
Settings	All settings	
Intervention or exposure	Laboratory-confirmed (with the polymerase chain reaction test) zoonotic influenza A. Only the following subtypes will be included: • H7N9 • H9N2 • H5N5 • H5N2 • H5N6 • H5N8 • H10N3 • H10N5 • H3N8	Any other zoonotic influenza subtypes Studies in which the subtype is not stated or confirmed with the polymerase chain reaction test
Outcomes	Any measure of human-to-human transmission through the following routes: • respiratory or droplet • airborne or aerosol • indirect contact with contaminated surfaces and fomites	Animal to human transmission Human to animal transmission Transmission through any other routes

	Included	Excluded
	• direct contact with infected saliva or nasal mucous (through kissing, sharing utensils)	
Language	English	Any other language
Date of publication	Database inception up to 15 July 2025	Published after 15 July 2025
Study design	Observational studies: case-control and cohort studies Case series and case reports	Experimental studies (randomised-controlled trials, quasi-experimental studies, cross-over designs, before-and-after studies) Systematic or narrative reviews Modelling studies Cross-sectional studies
Publication type	Peer-reviewed published research Preprints	Editorials Letters News articles Grey literature Conference abstracts

Identification of studies

The following databases will be searched for studies published up to 15 July 2025: Ovid Medline, Ovid Embase, Ovid Global Health, WHO Index Medicus and Web of Science Preprint Citation Index. The search strategy is presented below.

Backwards and forwards citation searching will be carried out using references that are included at full text screening as seed papers. Citation searching will use Lens.org via CitationChaser.

Screening

Title and abstract screening will be undertaken in duplicate by 2 reviewers for at least 20% of the eligible studies, with the remainder completed by one reviewer. Disagreement will be resolved by discussion or with involvement of a third reviewer where necessary. Screening on full text will be undertaken by one reviewer and checked by a second.

Data extraction

Summary information for each study will be extracted and reported in tabular form. Information to be extracted will include country, study period, study design, subtype of zoonotic influenza, participants, results, and any relevant contextual data. This will be undertaken by one reviewer and checked by a second.

Risk of bias assessment

Two reviewers will independently complete a risk of bias assessment for included studies, with disagreements resolved by discussion or with a third reviewer. Primary studies will be assessed using the relevant JBI checklist (1).

Certainty of evidence

If appropriate, the certainty of evidence identified within this review will be assessed using a modified version of the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) framework (2). Certainty of evidence will be assessed at the outcome level, and be rated as one of 4 levels:

- very low (the true effect is probably different from the estimated effect)
- low (the true effect might be different from the estimated effect)
- moderate (the true effect is probably close to the estimated effect)
- high (the authors are confident that the true effect is similar to the estimated effect)

The certainty of evidence will be assessed by one reviewer (and checked by a second) for each outcome across 4 domains:

1. Risk of bias: where results may not represent the true effect because of limitations in the design or conduct of the study.
2. Inconsistency: where studies show different effects for the same outcome of interest (only assessed where there are 2 or more studies measuring the same outcome). Inconsistency will be rated down if the point estimates are not similar, or the confidence intervals do not overlap.
3. Indirectness: where elements of the study differ from the intended elements in the review question (for example, the outcome of interest has not been directly measured). This will be rated down if the population, intervention, comparator, or outcome of interest have not been directly measured.
4. Imprecision: a measure of how uncertain the estimate is. Imprecision will be rated down if the confidence intervals cross the line of no effect, or if the reviewer judges that the confidence intervals are overly wide and so the true effect is likely to be different at the upper versus the lower end of the confidence interval.

Publication bias will not be used to assess the certainty of the evidence in this review.

Evidence may be downgraded one or 2 levels following the assessment of certainty or upgraded if there is a large magnitude of effect or clear dose-response gradient.

Synthesis

Where studies are similar enough to combine and present data in a consistent format, a narrative synthesis will be produced to interpret the findings. The number of studies, the number of participants in each study, effect size and variance and a summary of the risk of bias across studies reporting each outcome will be summarised and presented. Alternatively, if studies present methodological differences that would make synthesis inappropriate, a narrative summary of each study will be provided.

Health inequalities

Variations across the following populations and subgroups will be considered, where evidence is available: those who may be at high risk from influenza A including individuals on low income, migrant workers, and rural farm workers, and those with immunosuppression. Differences in outcomes by age will also be assessed if the data is available.

Search strategy

Ovid MEDLINE(R) ALL (1946 to 15 July 2025)

1. Influenza in Birds/ and (Influenza A virus/ or Influenza, Human/) (5,442)
2. Influenza A Virus, H7N9 Subtype/ (1,583)
3. h7n9*.tw,kf. (2,282)
4. ah7n9*.tw,kf. (0)
5. ((flu or influenza) adj5 H7*).tw,kf. (2,636)
6. (H7* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (1,727)
7. Influenza A Virus, H9N2 Subtype/ (1,526)
8. h9n2*.tw,kf. (2,137)
9. ah9n2*.tw,kf. (1)
10. ((flu or influenza) adj5 H9*).tw,kf. (1,680)
11. (H9* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (1,352)
12. h10n3*.tw,kf. (48)
13. ah10n3*.tw,kf. (0)
14. ((flu or influenza) adj5 H10*).tw,kf. (171)
15. (H10* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (128)
16. h10n5*.tw,kf. (17)
17. ah10n5*.tw,kf. (0)

18. Influenza A Virus, H3N8 Subtype/ (567)
19. h3n8*.tw,kf. (650)
20. ah3n8*.tw,kf. (0)
21. ((flu or influenza) adj5 H3*).tw,kf. (5,822)
22. (H3* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (418)
23. h5n5*.tw,kf. (64)
24. ah5n5*.tw,kf. (0)
25. Influenza A Virus, H5N2 Subtype/ (474)
26. h5n2*.tw,kf. (750)
27. ah5n2*.tw,kf. (0)
28. Influenza A Virus, H5N6 Subtype/ (8)
29. h5n6*.tw,kf. (492)
30. ah5n6*.tw,kf. (0)
31. Influenza A Virus, H5N8 Subtype/ (327)
32. h5n8*.tw,kf. (638)
33. ah5n8*.tw,kf. (0)
34. ((flu or influenza) adj5 H5*).tw,kf. (7,656)
35. (H5* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (5,613)
36. or/1-35 (21,038)
37. (transmi* adj5 (route* or mode or modes or path or paths or pathway* or method* or way or ways or how or direct* or indirect* or primary or secondary or pattern* or vehicle* or window*)).tw,kf. (67,934)
38. transmi*.ti. (119,056)
39. exp Disease Transmission, Infectious/ (85,518)
40. "Person to person".tw,kf. (4,579)
41. "human to human".tw,kf. (7,489)
42. (interhuman or inter-human).tw,kf. (385)
43. transmi* between human*.tw,kf. (435)
44. ((direct* or indirect* or close or transmi* or physical* or regular* or frequent* or prolonged or infect*) adj3 contact*).tw,kf. (62,302)
45. "Skin to skin".tw,kf. (8,593)
46. "mouth-to-mouth".tw,kf. (725)
47. "mouth-to-skin".tw,kf. (166)
48. "Face to face".tw,kf. (49,358)
49. touch*.tw,kf. (47,610)
50. Fomites/ (691)
51. fomite*.tw,kf. (1,670)
52. ((Virus or viral*) adj5 (touch* or surface*)).tw,kf. (11,172)
53. (respiratory adj3 transmi*).tw,kf. (2,111)
54. Air Microbiology/ (8,772)
55. "Respiratory Aerosols and Droplets"/ (683)
56. bioaerosol*.tw,kf. (2,611)
57. aerosol*.tw,kf. (62,081)
58. airborne.tw,kf. (29,679)

59. air borne.tw,kf. (1,160)
60. Air* particle*.tw,kf. (3,372)
61. droplet*.tw,kf. (73,681)
62. exhalation*.tw,kf. (3,935)
63. exhale*.tw,kf. (15,570)
64. inhalation*.tw,kf. (78,637)
65. inhale*.tw,kf. (64,557)
66. air sampl*.tw,kf. (8,631)
67. (respiratory adj (route* or mode* or path* or method* or transmi* or spread*)).tw,kf. (9,990)
68. (airway* adj (route* or mode* or path* or method* or transmi* or spread*)).tw,kf. (1,825)
69. (air way* adj (route* or mode* or path* or method* or transmi* or spread*)).tw,kf. (0)
70. (breath* adj (route* or mode* or path* or method* or transmi* or spread*)).tw,kf. (1,777)
71. or/37-70 (71,6473)
72. 36 and 71 (2,800)
73. limit 72 to (editorial or letter or news or newspaper article) (67)
74. 72 not 73 (2,733)
75. ((flu or influenza) adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (15,883)
76. 71 and 75 (2,360)
77. 76 not 72 (490)

Embase (1974 to 24 July 2025)

1. (avian influenza/ or highly pathogenic avian influenza/ or low pathogenic avian influenza/ or avian influenza virus/) and (Influenzavirus A/ or Influenza A virus/) (2,277)
2. "Influenza A virus (H7N9)"/ (2,311)
3. h7n9*.tw,kf. (2,551)
4. ah7n9*.tw,kf. (1)
5. ((flu or influenza) adj5 H7*).tw,kf. (2,924)
6. (H7* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (1,869)
7. "Influenza A virus (H9N2)"/ (2,399)
8. h9n2*.tw,kf. (2,284)
9. ah9n2*.tw,kf. (0)
10. ((flu or influenza) adj5 H9*).tw,kf. (1,820)
11. (H9* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (1,448)
12. h10n3*.tw,kf. (44)
13. ah10n3*.tw,kf. (0)
14. ((flu or influenza) adj5 H10*).tw,kf. (178)
15. (H10* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (123)
16. h10n5*.tw,kf. (13)
17. ah10n5*.tw,kf. (0)
18. "Influenza A virus (H3N8)"/ (726)
19. h3n8*.tw,kf. (702)
20. ah3n8*.tw,kf. (0)

21. ((flu or influenza) adj5 H3*).tw,kf. (6,933)
22. (H3* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (432)
23. h5n5*.tw,kf. (61)
24. ah5n5*.tw,kf. (0)
25. "Influenza A virus (H5N2)"/ (824)
26. h5n2*.tw,kf. (766)
27. ah5n2*.tw,kf. (0)
28. "Influenza A virus (H5N6)"/ (149)
29. h5n6*.tw,kf. (488)
30. ah5n6*.tw,kf. (2)
31. "Influenza A virus (H5N8)"/ (544)
32. h5n8*.tw,kf. (664)
33. ah5n8*.tw,kf. (1)
34. ((flu or influenza) adj5 H5*).tw,kf. (8,705)
35. (H5* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw,kf. (6,139)
36. or/1-35 (22,990)
37. (transmi* adj5 (route* or mode or modes or path or paths or pathway* or method* or way or ways or how or direct* or indirect* or primary or secondary or pattern* or vehicle* or window*)).tw,kf. (81,972)
38. transmi*.ti. (125,195)
39. exp *disease transmission/ (45,215)
40. "Person to person".tw,kf. (5,872)
41. (interhuman or inter human).tw,kf. (492)
42. "human to human".tw,kf. (9,067)
43. transmi* between human*.tw,kf. (498)
44. ((direct* or indirect* or close or transmi* or physical* or regular* or frequent* or prolonged or infect*) adj3 contact*).tw,kf. (77,176)
45. "Skin to skin".tw,kf. (12,865)
46. "mouth-to-mouth".tw,kf. (898)
47. "mouth-to-skin".tw,kf. (318)
48. "Face to face".tw,kf. (68,637)
49. touch*.tw,kf. (65,169)
50. fomite/ (975)
51. fomite*.tw,kf. (1,900)
52. ((Virus or viral*) adj5 (touch* or surface*)).tw,kf. (12,683)
53. (respiratory adj3 transmi*).tw,kf. (2,412)
54. exp "respiratory droplets and aerosols"/ (747)
55. bioaerosol*.tw,kf. (3585)
56. aerosol*.tw,kf. (83,829)
57. airborne.tw,kf. (36,719)
58. air borne.tw,kf. (1,218)
59. Air* particle*.tw,kf. (4,349)
60. droplet*.tw,kf. (84,299)
61. exhalation*.tw,kf. (6,131)

62. exhale*.tw,kf. (2,4986)
63. inhalation*.tw,kf. (106,623)
64. inhale*.tw,kf. (105,122)
65. air sampl*.tw,kf. (11,551)
66. (respiratory adj (route* or mode* or path* or method* or transmi* or spread*)).tw,kf. (12,996)
67. (airway* adj (route* or mode* or path* or method* or transmi* or spread*)).tw,kf. (3,886)
68. (air way* adj (route* or mode* or path* or method* or transmi* or spread*)).tw,kf. (0)
69. (breath* adj (route* or mode* or path* or method* or transmi* or spread*)).tw,kf. (2,601)
70. or/37-69 (840,389)
71. 36 and 70 (2,942)
72. limit 71 to (conference abstract or conference paper or "conference review" or editorial or letter) (261)
73. 71 not 72 (2,681)

Global Health 1910 to 2025 Week 28

1. (avian influenza/ or avian influenza a viruses/) and influenza a/ (2,782)
2. h7n9*.tw. (2,490)
3. ah7n9*.tw. (4)
4. ((flu or influenza) adj5 H7*).tw. (2,810)
5. (H7* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw. (1,801)
6. h9n2*.tw. (1,578)
7. ah9n2*.tw. (2)
8. ((flu or influenza) adj5 H9*).tw. (1,368)
9. (H9* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw. (1,014)
10. h10n3*.tw. (32)
11. ah10n3*.tw. (0)
12. ((flu or influenza) adj5 H10*).tw. (167)
13. (H10* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw. (132)
14. h10n5*.tw. (10)
15. ah10n5*.tw. (0)
16. h3n8*.tw. (277)
17. ah3n8*.tw. (0)
18. ((flu or influenza) adj5 H3*).tw. (6,212)
19. (H3* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw. (281)
20. h5n5*.tw. (37)
21. ah5n5*.tw. (0)
22. h5n2*.tw. (371)
23. ah5n2*.tw. (0)
24. h5n6*.tw. (453)
25. h5n8*.tw. (439)
26. ah5n8*.tw. (0)
27. ((flu or influenza) adj5 H5*).tw. (6,599)

28. (H5* adj3 (bird* or avian or chicken* or duck* or fowl or poultry)).tw. (4,515)
29. or/1-28 (16,568)
30. (transmi* adj5 (route* or mode or modes or path or paths or pathway* or method* or way or ways or how or direct* or indirect* or primary or secondary or pattern* or vehicle* or window*)).tw. (40,970)
31. exp disease transmission/ (281,223)
32. transmi*.ti. (62,794)
33. "Person to person".tw. (3,276)
34. (interhuman or inter human).tw. (278)
35. "human to human".tw. (3,558)
36. transmi* between human*.tw. (422)
37. ((direct* or indirect* or close or transmi* or physical* or regular* or frequent* or prolonged or infect*) adj3 contact*).tw. (27,083)
38. "Skin to skin".tw. (2,551)
39. "mouth-to-mouth".tw. (133)
40. "mouth-to-skin".tw. (136)
41. "Face to face".tw. (17,761)
42. touch*.tw. (7,861)
43. fomite*.tw. (1,274)
44. ((Virus or viral*) adj5 (touch* or surface*)).tw. (4,100)
45. (respiratory adj3 transmi*).tw. (1,345)
46. air microbiology/ (898)
47. airborne infection/ (2,008)
48. bioaerosol*.tw. (1,496)
49. aerosol*.tw. (17,120)
50. airborne.tw. (12,755)
51. air borne.tw. (1,226)
52. Air* particle*.tw. (1,001)
53. droplet*.tw. (13,343)
54. exhalation*.tw. (524)
55. exhale*.tw. (2,565)
56. inhalation*.tw. (18,425)
57. inhale*.tw. (8,925)
58. air sampl*.tw. (4,651)
59. (respiratory adj (route* or mode* or path* or method* or transmi* or spread*)).tw. (4,568)
60. (airway* adj (route* or mode* or path* or method* or transmi* or spread*)).tw. (193)
61. (air way* adj (route* or mode* or path* or method* or transmi* or spread*)).tw. (0)
62. (breath* adj (route* or mode* or path* or method* or transmi* or spread*)).tw. (86)
63. or/30-62 (437,647)
64. 29 and 63 (3,977)
65. limit 64 to (conference or conference paper or conference proceedings or conference slides or correspondence or editorial) (213)
66. 64 not 65 (3,764)

Web of Science Preprint Citation Index (1990 to current)

Date of search: 10 July 2025

TS=(h7n9*) OR TS=(ah7n9*) OR TS=((flu or influenza) NEAR/4 (H7N* OR H7)) OR TS=((H7N* OR H7) NEAR/2 (bird* or avian or chicken* or duck* or fowl or poultry)) OR TS=(h9n2*) OR TS=(ah9n2*) OR TS=((flu or influenza) NEAR/4 (H9 OR H9N*)) OR TS=((H9N* OR H9) NEAR/2 (bird* or avian or chicken* or duck* or fowl or poultry)) OR TS=(h10n3*) OR TS=(ah10n3*) OR TS=((flu or influenza) NEAR/4 (H10 OR H10N*)) OR TS=((H10N* OR H10) NEAR/2 (bird* or avian or chicken* or duck* or fowl or poultry)) OR TS=(h10n5*) OR TS=(ah10n5*) OR TS=(h3n8*) OR TS=(ah3n8*) OR TS=((flu or influenza) NEAR/4 (H3 OR H3N*)) OR TS=((H3N* OR H3) NEAR/2 (bird* or avian or chicken* or duck* or fowl or poultry)) OR TS=(h5n5*) OR TS=(ah5n5*) OR TS=(h5n2*) OR TS=(ah5n2*) OR TS=(h5n6*) OR TS=(ah5n6*) OR TS=(h5n8*) OR TS=(ah5n8*) OR TS=((flu or influenza) NEAR/4 (H5N* OR H5)) OR TS=((H5N* OR H5) NEAR/2 (bird* or avian or chicken* or duck* or fowl or poultry))

AND

TS=((transmi* NEAR/4 (route* or mode or modes or path or paths or pathway* or method* or way or ways or how or direct* or indirect* or primary or secondary or pattern* or vehicle* or window*))) OR TS=(transmi*) OR TS=("Person to person") OR TS=("human to human") OR TS=(“inter-human” OR interhuman) OR TS=("transmi* between human*") OR TS=(((direct* or indirect* or close or transmi* or physical* or regular* or frequent* or prolonged or infect*) NEAR/2 contact*)) OR TS=("Skin to skin") OR TS=("mouth-to-mouth") OR TS=("mouth-to-skin") OR TS=("Face to face") OR TS=(touch*) OR TS=(fomite*) OR TS=(((Virus or viral*) NEAR/4 (touch* or surface*))) OR TS=((respiratory NEAR/2 transmi*)) OR TS=(bioaerosol* OR aerosol*) OR TS=(“air borne” OR airborne) OR TS=("Air* particle*") OR TS=(droplet*) OR TS=(exhalation*) OR TS=(exhaled) OR TS=(inhalation*) OR TS=(inhaled) OR TS=("air sampl*") OR TS=((respiratory NEAR/0 (route* or mode* or path* or method* or transmi* OR spread*))) OR TS=((airway* NEAR/0 (route* or mode* or path* or method* or transmi* OR spread*))) OR TS=(("air way*" NEAR/0 (route* or mode* or path* or method* or transmi* OR spread*))) OR TS=((breath* NEAR/0 (route* or mode* or path* or method* or transmi* OR spread*)))

116 results

WHO Index Medicus

Date of search:10 July 2025

(h7n9 OR ah7n9 OR h9n2 OR ah9n2 OR h10n3 OR ah10n3 OR h10n5 OR ah10n5 OR h3n8 OR ah3n8 OR h5n5 OR ah5n5 OR h5n2 OR ah5n2 OR h5n6 OR ah5n6 OR h5n8 OR ah5n8)

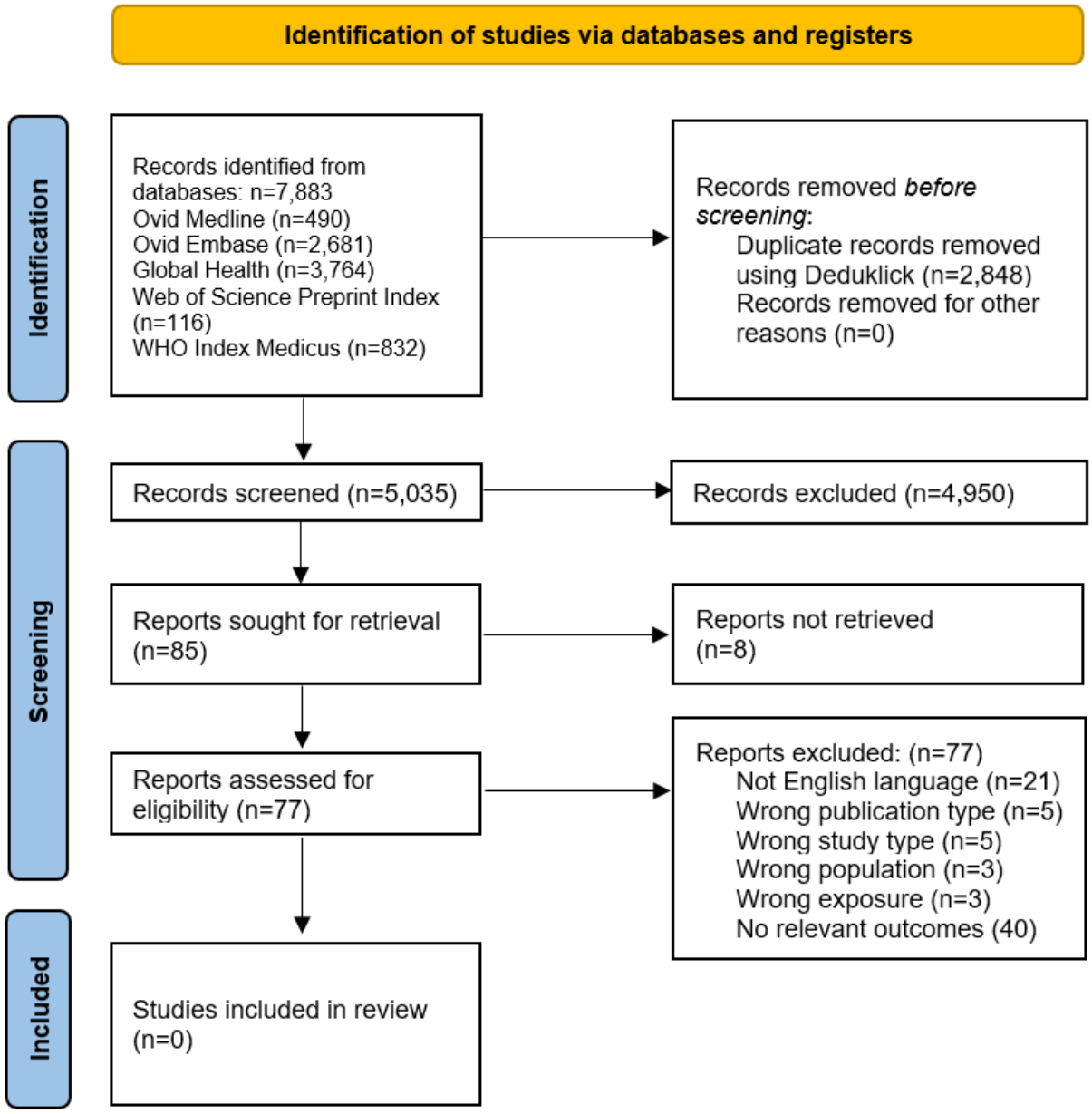
AND

(transmission OR fomite* OR inhalation* OR inhale* OR exhalation* OR exhale* OR bioaerosol* OR aerosol* OR droplet* OR breath*)

832 results

Annexe B. Study selection flowchart

Figure B.1. PRISMA diagram



Text version of Figure B.1. PRISMA diagram

This is a PRISMA diagram showing the flow of studies through this review, ultimately including 0 studies.

From identification of studies via databases and registers, n=X records identified from databases:

- Ovid Medline (n=490)
- Ovid Embase (n=2,681)
- Global Health (n=3,764)
- Web of Science Preprint index (n=116)
- WHO Index Medicus (n=832)

From these, records removed before screening:

- duplicate records removed using Deduklick (n=2,848)
- records removed for other reasons (n=0)

n=5,035 records screened, of which n=4,950 were excluded, leaving n=85 papers sought for retrieval, of which n=8 were not retrieved.

No studies were identified from identification of studies via other methods: n=0 studies were identified from expert consultation.

Of the n=77 papers assessed for eligibility, n=77 reports were excluded:

- not English language (n=21)
- wrong publication type (n=5)
- wrong study type (n=5)
- wrong population (n=3)
- wrong exposure (n=3)
- no relevant outcomes (n=40)

n=0 papers included in the review.

Annexe C. Excluded full texts

Not English language (21 studies)

Chai C and others. 'Clinical and epidemiological characteristics of the 6 confirmed human cases with novel influenza A (H7N9) virus infection in Zhejiang' Chinese Journal of Epidemiology 2013: volume 34, issue 5, pages 443 to 445

Chen JinKun CJ and others. 'Epidemiology of human infection with avian influenza A (H7N9) virus and environmental virus surveillance in Shaoxing, Zhejiang' Disease Surveillance 2015: volume 30, issue 2, pages 122 to 125

Gou Y and others. 'A strain of influenza A H9N2 virus repeatedly isolated from human population in China' Chinese journal of experimental and clinical virology 2000: volume 14, issue 3, pages 209 to 212

Hu XiaoShen HX and others. 'Epidemiological investigation analysis of first family cluster of patients with avian influenza H7N9 infection in Anhui' China Tropical Medicine 2017: volume 17, issue 2, pages 151 to 155

Jiang Min JM and others. 'Epidemiological investigation of the first human infection with avian H7N9 influenza virus in Jiujiang city' Modern Preventive Medicine 2016: volume 43, issue 12, pages 2,139 to 2,140

Li B-d and others. 'Comparative analysis of influenza A (H7N9) virus genomes in human infection cases in Gansu' Disease Surveillance 2021: volume 36, issue 3, pages 280 to 286

Li H and others. 'Investigation of a family clustering of human infection with avian influenza A (H7N9) virus in Nanning, Guangxi' Chinese Journal of Epidemiology 2015: volume 36, issue 5, pages 481 to 483

Li WeiQiang LW and others. 'Epidemiological characteristics and external environmental monitoring of human infection with H7N9 avian influenza in Panyu district of Guangzhou' Journal of Tropical Medicine (Guangzhou) 2016: volume 16, issue 12, pages 1,571 to 1,573

Liu J and others. 'Investigation of H5N6 avian influenza virus in a human infection case in Quanzhou City, Fujian Province, 2024' China Tropical Medicine 2025: volume 25, issue 3, pages 380 to 384

Luo ChunRui LC and others. 'Survey of an epidemic of human infection with avian influenza A (H7N9) in Yunnan' Disease Surveillance 2018: volume 33, issue 11, pages 927 to 930

Lyu Yong LY and others. 'Epidemiological characteristics of 24 children cases of influenza A (H7N9) virus infection in China' Disease Surveillance 2015: volume 30, issue 7, pages 570 to 573

Pang ZhiFeng PZ and others. 'Epidemiological analysis on avian influenza A (H7N9) in Jinhua city, Zhejiang province, 2014-2016' Chinese Journal of Vector Biology and Control 2018: volume 29, issue 4, pages 369 to 372

Ren R and others. 'Epidemiological characteristics of human avian influenza A (H7N9) virus infection in China' Chinese Journal of Epidemiology 2014: volume 35, issue 12, pages 1,362 to 1,365

Su Qi SQ and others. 'Epidemiological investigation of influenza H7N9 virus infection in humans in Huaian City in 2014' Modern Preventive Medicine 2015: volume 42, issue 18, pages 3,286 to 3,288

Sun B-H and others. 'Epidemiological features of human infection with avian influenza A (H7N9) virus in Liaoning in 2016-2017' Chinese Preventive Medicine 2019: volume 20, issue 7, pages 561 to 564

Wang XueCai and others. 'Serologic survey of influenza A viruses subtype H7N9, H9, H5, H1N1pdm09, H3 and H1 in rural area of Deqing, Zhejiang' Disease Surveillance 2016: volume 31, issue 2, pages 120 to 125

Wu AiLan and others. 'Epidemiological investigation of a family clustering of human infection with avian influenza A (H7N9) virus' Disease Surveillance 2015: volume 30, issue 6, pages 513 to 515

Ye XiaLiang and others. 'Surveillance for avian influenza A virus in environments in Lishui, Zhejiang, 2009-2015' Disease Surveillance 2015: volume 30, issue 7, pages 564 to 569

Zhao S-l and others. 'Surveillance for avian influenza A (H9N2) virus in human infection cases and H9 subtype Avian influenza virus in the external environment in Hunan, 2013-2022' Disease Surveillance 2024: volume 39, issue 7, pages 836 to 840

Zhao W-s and others. 'Avian influenza virus surveillance in the poultry market environment in Zhaoqing, Guangdong, 2015-2018' China Tropical Medicine 2020: volume 20, issue 6, pages 514 to 518

Zhou Lei ZL and others. 'Epidemiology of human infection with avian influenza A(H7N9) virus in China, September-December, 2014' Disease Surveillance 2015: volume 30, issue 4, pages 265 to 268

Wrong publication type (5 studies)

Anonymous. 'Emergence of avian influenza A(H7N9) virus causing severe human Illness - China, February-April 2013 A1 - Anonymous' American Journal of Transplantation 2013: volume 13, issue 8, pages 2,216 to 2,221

Anonymous. 'Severe respiratory disease associated with a novel influenza A virus, A(H7N9) - China: 3 April 2013' ECDC Rapid Risk Assessment 2013: page 10

Anonymous. 'Suspected transmission of avian flu from person to person reported A1 - Anonymous' Pharmaceutical Journal 2005: volume 274, issue 7,334, page 104

Zhou L and others. 'Estimated incubation period and serial interval for human-to-human influenza A(H7N9) virus transmission' Emerging Infectious Diseases 2019: volume 25, issue 10, pages 1,982 to 1,983

Zhou Lei ZL and others. 'Clusters of human infection and human-to-human transmission of avian influenza A(H7N9) virus, 2013-2017' Emerging Infectious Diseases 2018: volume 24, issue 2, pages 397 to 400

Wrong study type (5 studies)

Jallow MM and others. 'Genetic and Molecular Characterization of Avian Influenza A(H9N2) Viruses from Live Bird Markets (LBM) in Senegal' Viruses 2025: volume 17, issue 1, page 73

Virlogeux V and others. 'Evaluation of animal-to-human and human-to-human transmission of influenza A (H7N9) virus in China, 2013-15' Scientific reports 2018: volume 8, issue 1, page 552

Yang Y and others. 'Household transmissibility of avian influenza a (H7N9) virus, China, February to May 2013 and October 2013 to March 2014' Eurosurveillance 2015: volume 20, issue 10

Zhao Y and others. 'Airborne transmission may have played a role in the spread of 2015 highly pathogenic avian influenza outbreaks in the United States' Scientific reports 2019: volume 9, issue 1, article number 11755

Zhou Y and others. 'Origin, spread, and interspecies transmission of a dominant genotype of BJ/94 lineage H9N2 avian influenza viruses with increased threat' Virus Evolution 2024: volume 10, issue 1, page 106

Wrong population (3 studies)

Guo K and others. 'Risk of Environmental Exposure to H7N9 Influenza Virus via Airborne and Surface Routes in a Live Poultry Market in Hebei, China' Frontiers in Cellular and Infection Microbiology 2021: volume 11, 688007

Sorrell EM and others. 'Minimal molecular constraints for respiratory droplet transmission of an avian-human H9N2 influenza A virus' Proceedings of the National Academy of Sciences of the United States of America 2009: volume 106, issue 18, pages 7,565 to 7,570

Torremorell M and others. 'Investigation into the Airborne Dissemination of H5N2 Highly Pathogenic Avian Influenza Virus During the 2015 Spring Outbreaks in the Midwestern United States' Avian diseases 2016: volume 60, issue 3, pages 637 to 643

Wrong exposure (3 studies)

Dilantika C and others. 'Influenza virus infection among pediatric patients reporting diarrhea and influenza-like illness' BMC Infectious Diseases 2010: volume 10, issue 3

Wu J and others. 'Serologic screenings for H7N9 from three sources among high-risk groups in the early stage of H7N9 circulation in Guangdong Province, China' Virology Journal 2014: volume 11, issue 1, page 184

Zhang W and others. 'An airborne transmissible avian influenza H5 hemagglutinin seen at the atomic level' Science 2013: volume 340, issue 6139, pages 1,463 to 1,467

No relevant outcomes (40 studies)

Ai J and others. 'Case-control study of risk factors for human infection with influenza a(H7N9) virus in Jiangsu province, China, 2013' Eurosurveillance 2013: volume 18, issue 26

Bao P and others. 'Human infection with a reassortment avian influenza A H3N8 virus: an epidemiological investigation study' Nature Communications 2022: volume 13, issue 1, page 6,817

Bi F-y and others. 'Epidemiological and genetic characterization of human infection with avian influenza AI H5N6 virus in Guangxi, China, 2021' International Journal of Infectious Diseases 2025: volume 150

Bi Y and others. 'Two novel reassortants of avian influenza A (H5N6) virus in China' Journal of General Virology 2015: volume 96, issue 5, pages 975 to 981

Chen H and others. 'Nosocomial co-transmission of avian influenza A(H7N9) and a(H1N1)pdm09 viruses between 2 patients with hematologic disorders' Emerging Infectious Diseases 2016: volume 22, issue 4, pages 598 to 607

Chen Z and others. 'Asymptomatic, mild, and severe influenza A(H7N9) virus infection in humans, Guangzhou, China' Emerging Infectious Diseases 2014: volume 20, issue 9, pages 1,535 to 1,540

Cheng VCC and others. 'Infection control preparedness for human infection with influenza a H7N9 in Hong Kong' Infection Control and Hospital Epidemiology 2015: volume 36, issue 1, pages 87 to 92

Dai J and others. 'Phylogenetic and mutational analysis of H10N3 avian influenza A virus in China: potential threats to human health' Frontiers in Cellular and Infection Microbiology 2024: volume 14, 1433661

Ding H and others. 'A family cluster of three confirmed cases infected with avian influenza a (H7N9) virus in Zhejiang province of China' BMC Infectious Diseases 2014: volume 14, issue 1, page 698

Fang CF and others. 'Nosocomial transmission of avian influenza A (H7N9) virus in China: Epidemiological investigation' The BMJ (Online) 2015: volume 351

Gao HN and others. 'Viral genome and antiviral drug sensitivity analysis of two patients from a family cluster caused by the influenza A(H7N9) virus in Zhejiang, China, 2013' International Journal of Infectious Diseases 2014: volume 29, pages 254 to 258

Guo L and others. 'A family cluster of two fatal cases infected with influenza A (H7N9) virus in Kunming China, 2017' Infection, Genetics and Evolution 2018: volume 66, pages 152 to 158

Hu J and others. 'Limited human-to-human transmission of avian influenza A(H7N9) virus, Shanghai, China, March to April 2013' Eurosurveillance 2014: volume 19, issue 25, pages 1 to 10

Krueger WS and others. 'Prospective study of avian influenza virus infections among rural Thai villagers' PLoS ONE 2013: volume 8, issue 8, e72196

Liu B and others. 'Clusters of human infections with avian influenza a(h7n9) virus in China, March 2013 to June 2015' Journal of Infectious Diseases 2017: volume 216, pages S548 to S554

Liu Ti LT and others. 'One family cluster of avian influenza A(H7N9) virus infection in Shandong, China' BMC Infectious Diseases 2014: volume 14, issue 98

Mao C and others. 'An internet-based epidemiological investigation of the outbreak of H7N9 Avian influenza A in China since early 2013' Journal of medical Internet research 2014: volume 16, issue 9, page e221

Mao H and others. 'A study of family clustering in two young girls with novel avian influenza A (H7N9) in Dongyang, Zhejiang Province, in 2014' Journal of Clinical Virology 2015: volume 63, pages 18 to 24

Pan Hao PH and others. 'A case report of avian influenza H7N9 killing a young doctor in Shanghai, China' BMC Infectious Diseases 2015: volume 15, issue 237

Qi Xian QX and others. 'Probable person to person transmission of novel avian influenza A (H7N9) virus in Eastern China, 2013: epidemiological investigation' BMJ 2013: volume 347

Shi C and others. 'Person-to-Person Transmission of Avian Influenza A (H7N9) Among Family Members in Eastern China, 2016' Disaster medicine and public health preparedness 2021: volume 15, issue 2, pages 164 to 169

Sun H and others. 'Airborne transmission of human-isolated avian H3N8 influenza virus between ferrets' Cell 2023: volume 186, issue 19, pages 4,074 to 4,084

Wang J and others. 'The fifth influenza A(H7N9) epidemic: A family cluster of infection in Suzhou city of China, 2016' International Journal of Infectious Diseases 2018: volume 74, pages 128 to 135

Wang J and others. 'A study on mother-to-fetus/infant transmission of influenza A(H7N9) virus: Two case reports and a review of literature' Clinical Respiratory Journal 2018: volume 12, issue 11, pages 2,539 to 2,545

Wang X and others. 'Assessment of human-to-human transmissibility of avian influenza A(H7N9) virus across 5 waves by analyzing clusters of case patients in Mainland China, 2013-2017' Clinical Infectious Diseases 2019: volume 68, issue 4, pages 623 to 631

Wu Z and others. 'Epidemiological and virological differences in human clustered and sporadic infections with avian influenza A H7N9' International Journal of Infectious Diseases 2016: volume 49, pages 9 to 17

Xiang N and others. 'Comparison of the first three waves of avian influenza A(H7N9) virus circulation in the mainland of the People's Republic of China' BMC Infectious Diseases 2016: volume 16, issue 1, page 734

Xiang N and others. 'Sero-epidemiologic study of influenza A(H7N9) infection among exposed populations, China 2013-2014' Influenza and other Respiratory Viruses 2017: volume 11, issue 2, pages 170 to 176

Xiao XC and others. 'Transmission of avian influenza A(H7N9) virus from father to child: A report of limited person-to-person transmission, Guangzhou, China, January 2014' Eurosurveillance 2014: volume 19, issue 25, pages 1 to 9

Xie J and others. 'Epidemiological, clinical, and virologic features of two family clusters of avian influenza A (H7N9) virus infections in Southeast China' Scientific reports 2017: volume 7, issue 1, page 1,512

Xie L and others. 'Clinical and epidemiological survey and analysis of the first case of human infection with avian influenza A(H7N9) virus in Hangzhou, China' European Journal of Clinical Microbiology and Infectious Diseases 2013: volume 32, issue 12, pages 1,617 to 1,620

Yu H and others. 'The novel H10N3 avian influenza virus acquired airborne transmission among chickens: an increasing threat to public health' mBio 2025: volume 16, issue 2

Yu XinFen YX and others. 'Influenza H7N9 and H9N2 viruses: coexistence in poultry linked to human H7N9 infection and genome characteristics' Journal of Virology 2014: volume 88, issue 6, pages 3,423 to 3,431

Zhang R and others. 'Live poultry feeding and trading network and the transmission of avian influenza A(H5N6) virus in a large city in China, 2014-2015' International Journal of Infectious Diseases 2021: volume 108, pages 72 to 80

Zhang T and others. 'A human case died by avian influenza A (H5N6) infection in Jiangxi Province, China: An epidemiological and clinical survey' International Journal of Clinical and Experimental Medicine 2016: volume 9, issue 7, pages 14,848 to 14,856

Zhang W and others. 'A hospital cluster combined with a family cluster of avian influenza H7N9 infection in Anhui Province, China' Journal of Infection 2019: volume 79, issue 1, pages 49 to 55

Zhang ZH and others. 'A suspected person-to-person transmission of avian influenza a (H7N9) case in ward' Chinese Medical Journal 2017: volume 130, issue 10, pages 1,255 to 1,256

Zhao Z and others. 'A case report of human infection with avian influenza H10N3 with a complex respiratory disease history' BMC Infectious Diseases 2024: volume 24, issue 1, page 918

Zhou L and others. 'Epidemiology of human infections with avian influenza A(H7N9) virus in China' New England Journal of Medicine 2014: volume 370, issue 6, pages 520 to 532

Zhou L and others. 'Risk factors for influenza a(H7N9) disease in China, a matched case control study, October 2014 to April 2015' Open Forum Infectious Diseases 2016: volume 3, issue 3

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Prepared by Aishwarya Bhatia, Aina Madathinal Shaju, Jennifer Hill, Jodie Walker, Stefano Brini and Serena Carville.

For queries relating to this document, please contact: enquiries@ukhsa.gov.uk

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