Supplementary appendix

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Supplementary materials for “Global burden of acute lower respiratory infections associated with human parainfluenza virus in children under five years in 2018: a systematic review and meta-analysis”
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Appendix 1. Case definitions and glossary

Community-based studies: studies where eligible cases were actively identified through regular visits to households. We considered studies conducted in outpatient department or general practitioner in industrialised countries as good proxies of community-based studies.

Hospital-based studies: studies where children are enrolled when they are admitted into hospital.

Case definition for community-based studies

hPIV-associated ALRI: cough or difficulty breathing with increased respiratory rate for age (cut-offs same as in WHO IMCI case definition) AND laboratory confirmed hPIV.

hPIV-associated severe ALRI: children aged 2-59 months - cough or difficulty in breathing with chest wall indrawing AND laboratory confirmed hPIV; children aged <2 months - increased respiratory rate (>60 breaths/min) OR chest wall indrawing AND laboratory confirmed hPIV.

Case definition for hospital-based studies

Hospitalised hPIV-associated ALRI: all children with physician confirmed diagnosis of ALRI (pneumonia or bronchiolitis) that are hospitalised, or recommended hospital admission AND laboratory confirmed hPIV.

Hospitalised hPIV-associated ALRI with hypoxaemia: hospitalised ALRI cases with hypoxaemia (as defined below) AND laboratory confirmed hPIV.

Hypoxaemia: at altitude <=2500 m above sea level, SpO₂ <90% in children aged 1-59 months and <88% for neonates; at altitude >2500 m above sea level, SpO₂ <87% in children aged 1-59 months and <85% for neonates.

The relationship between the case definitions of different severity is displayed in Figure S1.1 A and B.

LIC: low income countries; LMIC: lower-middle income countries; UMIC: upper-middle income countries; HIC: high income countries as per World Bank Classification.

AFR: WHO African region; AMR: WHO Region of the Americas; EMR: WHO Eastern Mediterranean region; EUR: WHO European region; SEAR: WHO South-East Asian region; WPR: WHO Western Pacific region.

Neonates: children aged 0-27 days.

hPIV: human parainfluenza virus.

ALRI: acute lower respiratory infection.

hCFR: in-hospital case-fatality ratio.
Figure S1.1 The relationship between hospitalised hPIV-associated ALRI and hPIV-associated ALRI with hypoxaemia (A). The relationship between community hPIV-associated ALRI and hPIV-associated severe ALRI (B). The size of each circle is not proportionate to the number of cases for each severity.
Appendix 2. Search strategy for hPIV

Medline (Ovid)
1. exp Parainfluenza Virus 1, Human/ or exp Parainfluenza Virus 2, Human/ or exp Parainfluenza Virus 3, Human/ or exp Parainfluenza Virus 4, Human/ or exp Parainfluenza virus infection/ or infection, parainfluenza virus.mp. or infections, parainfluenza virus.mp. or virus infection, parainfluenza mp. or virus infections, parainfluenza.mp. or parainfluenza vaccine.mp. or exp Parainfluenza Vaccines/ or PIV.mp. or Parainfluenza.mp.
2. metapneumovirus.mp. or exp metapneumovirus/ or hMPV.mp.
3. Bronchiolitis.mp. or exp Bronchiolitis/ or Bronchiolitis, Viral/
4. exp Respiratory Tract Diseases/
5. exp Respiratory Tract Infections/
6. acute respiratory infections.mp.
7. exp Pneumonia, Viral/ or *Pneumonia/ or exp Pneumonia/ or Pneumonia.mp.
8. acute lower respiratory infections.mp.
9. exp Incidence/ or exp Prevalence/ or exp morbidity/ or exp child mortality/ or exp infant mortality/ or exp hospital mortality/ or *hospital mortality/ or hospitalization rate.mp. or hospitalisation rate.mp. or exp Death/ or exp Cause of Death/ or burden.mp. /or proportion.mp.
10. 1 or 2
11. 3 or 4 or 5 or 6 or 7 or 8
12. 9 and 10 and 11
13. limit 12 to (humans and ("all infant (birth to 23 months)" or "newborn infant (birth to 1 month)" or "infant (1 to 23 months)" or "preschool child (2 to 5 years)")
14. limit 14 to yr="1995 -2020"

Embase (Ovid)
1. exp parainfluenza vaccine/ or exp parainfluenza virus infection/ or para influenza virus.mp. or parainfluenza virus.mp. or parainfluenza viruses.mp. or Parainfluenzavirus.mp. or virus, parainfluenza.mp. or piv.mp. or exp Paramyxovirinae/
2. exp metapneumovirus/ or exp metapneumovirus infection/ or mpv.mp.
3. exp respiratory tract infection/ or exp pneumonia/ or exp bronchiolitis/ or exp viral bronchiolitis/
4. exp incidence/ or exp prevalence/ or exp morbidity/ or hospitalization rate.mp. or hospitalisation rate.mp. or exp Death/ or exp Cause of Death/ or burden.mp. /or proportion.mp.
5. 1 and 3 and 4
6. 2 and 3 and 4
7. limit 5 to (human and (infant <to one year> or preschool child <1 to 6 years>))
8. limit 6 to (human and (infant <to one year> or preschool child <1 to 6 years>))
9. 7 or 8
10. limit 9 to yr="1995 -2020"

CINAHL
TI parainfluenza OR TI HPIV
TI metapneumovirus OR TI HMPV
AND
TI acute respiritory infection
AND
TI children
1995-2020

Global Health Library
(tw:(parainfluenza)) OR (tw:(piv)) OR (tw:(hpiv)) OR (tw:(metapneumovirus)) OR (tw:(mpv)) OR (tw:(hmpv)) AND ( limit:("infant" OR "child, preschool" OR "child" OR "newborn"))
1995-2020

Web of Science
TITLE: (parainfluenza) OR TITLE: (HPIV) OR TITLE: (metapneumovirus) OR TITLE: (HMPV)
AND Title= (Acute Respiratory Infections) OR Title= (Pneumonia)
AND TOPIC: (children) OR TOPIC: (child) OR TOPIC: (infant)
1995-2020
Global Health (Ovid)
1. exp parainfluenza/ or exp parainfluenza viruses/ or exp human parainfluenza virus 1/ or exp human parainfluenza virus 2/ or exp human parainfluenza virus 3/ or exp human parainfluenza virus 4/ or piv.mp.
2. exp metapneumovirus/ or exp human metapneumovirus/ or metapneumovirus.mp.
3. exp respiratory diseases/ or exp bronchiolitis/ or exp lower respiratory tract infections/ or exp pneumonia/ or (respiratory diseases or lower respiratory tract infections).sh. or pneumonia.mp. or bronchiolitis.mp.
4. exp incidence/ or proportion.mp. or exp morbidity/ or hospitalization rate.mp. or hospitalisation rate.mp. or exp infant mortality/ or exp neonatal mortality/ or exp mortality/ or exp death/ or exp "causes of death"/
5. 1 or 2
6. 5 and 3 and 4
7. limit 6 to yr="1995 -2020"

CNKI
Topic: respiratory infections or pneumonia or bronchiolitis
And topic: parainfluenza virus or metapneumovirus
And topic: prevalence or deaths or incidence or disease burden or hospitalisation
And topic: children or infant
1995-2020

Wanfang
Topic: respiratory infections or pneumonia or bronchiolitis
And topic: parainfluenza virus or metapneumovirus
And topic: prevalence or deaths or incidence or disease burden or hospitalisation rate
And topic: children or infant
1995-2020

Chongqingvip
Any field: parainfluenza virus or metapneumovirus
AND title or key words: respiratory infection or respiratory tract infection or pneumonia or lung infection or severe pneumonia or bronchiolitis
AND title or key words: incidence or prevalence or death or hospitalisation or burden of disease
AND title or key words: children or infant.
1995-2020
Appendix 3. Summary of included studies and the overall approach

Table S3.1 Number of studies by age, region, and period for each outcome.

| No of studies          | Incidence rate of hPIV-associated ALRI | Hospital admission rate of hPIV-associated ALRI | Hospital admission rate of hPIV-associated ALRI with hypoxaemia | Proportion of hospitalised hPIV-associated ALRI | In-hospital case-fatality ratio of hPIV-associated ALRI |
|------------------------|----------------------------------------|-------------------------------------------------|---------------------------------------------------------------|---------------------------------------------|--------------------------------------------------|
| All studies            | 13                                     | 38                                              | 13                                                            | 168                                         | 58                                              |
| From collaboration network | 5                                      | 19                                              | 13                                                            | 37                                          | 30                                              |
| 0-59 m                 | 12                                     | 34                                              | 13                                                            | 94                                          | 46                                              |
| Reporting data by 0-5 m, 6-11 m, and 12-59 m | 6                                      | 26                                              | 13                                                            | 78                                          | 27                                              |
| Developing countries   | 8                                      | 28                                              | 13                                                            | 143                                         | 53                                              |
| By World Bank income level |                                      |                                                  |                                                               |                                             |                                                  |
| LIC                    | 1                                      | 4                                               | 2                                                             | 5                                           | 5                                               |
| LMIC                   | 6                                      | 10                                              | 5                                                             | 26                                          | 23                                              |
| UMIC                   | 1                                      | 10                                              | 6                                                             | 101                                         | 19                                              |
| HIC                    | 5                                      | 14                                              | 0                                                             | 36                                          | 11                                              |
| By WHO region          |                                        |                                                  |                                                               |                                             |                                                  |
| AFR                    | 1                                      | 11                                              | 5                                                             | 17                                          | 16                                              |
| AMR                    | 2                                      | 9                                               | 2                                                             | 19                                          | 11                                              |
| EMR                    | 1                                      | 1                                               | 1                                                             | 16                                          | 8                                               |
| EUR                    | 1                                      | 4                                               | 0                                                             | 15                                          | 3                                               |
| SEAR                   | 6                                      | 6                                               | 3                                                             | 14                                          | 8                                               |
| WPR                    | 2                                      | 7                                               | 2                                                             | 87                                          | 12                                              |
| By median study year   |                                        |                                                  |                                                               |                                             |                                                  |
| ~2005                  | 3                                      | 7                                               | 1                                                             | 34                                          | 9                                               |
| 2006-2010              | 3                                      | 11                                              | 2                                                             | 41                                          | 15                                              |
| 2011~                  | 5                                      | 20                                              | 11                                                            | 93                                          | 33                                              |
| No of hPIV-associated ALRI cases |                      |                                                  |                                                               |                                             |                                                  |
| 0-99                   | 9                                      | 24                                              | NA                                                            | 109                                         | 40                                              |
| 100-199                | 2                                      | 7                                               | NA                                                            | 29                                          | 10                                              |
| 200–                   | 1                                      | 7                                               | NA                                                            | 30                                          | 8                                               |
Table S3.2 Number of studies that were included in the main analysis by risk of bias for each outcome.

| No of studies                              | Incidence rate of hPIV-associated ALRI | Hospital admission rate of hPIV-associated ALRI | Hospital admission rate of hPIV-associated ALRI with hypoxaemia | Proportion of hospitalised hPIV-associated ALRI | In-hospital case-fatality ratio of hPIV-associated ALRI |
|--------------------------------------------|----------------------------------------|-----------------------------------------------|---------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------------|
| All studies                                | 12                                     | 26                                            | 13                                                            | 94                                            | 27                                                     |
| Study design                               | 12                                     | 25                                            | 13                                                            | 69                                            | 27                                                     |
| Adjustment for healthcare utilization      | ..                                     | 17                                            | 6                                                             | ..                                            | ..                                                     |
| Patient groups excluded                    | 8                                      | 18                                            | 8                                                             | 72                                            | 16                                                     |
| Case definition                            | 10                                     | 19                                            | 12                                                            | 51                                            | 25                                                     |
| Sampling strategy                          | 5                                      | 22                                            | 11                                                            | 63                                            | 25                                                     |
| Test method                                | 8                                      | 18                                            | 10                                                            | 64                                            | ..                                                     |
| Hypoxaemia ascertainment                   | ..                                     | ..                                            | 10                                                            | ..                                            | ..                                                     |
We report the global estimates of hPIV-associated ALRI cases, hPIV-associated ALRI hospital admissions, and hPIV-associated ALRI deaths in hospital and overall deaths (in-hospital and outpatient). This figure summarises our approach for each outcome and also shows how they relate to each other. The oval shapes show input data and the square shapes show outputs. The solid lines show the main analyses and dashed lines show the sensitivity analyses. Global hospital admissions of hPIV-associated ALRI were estimated using an incidence-based approach in the main analysis (a proportion-based approach in the sensitivity analysis). hPIV-associated in-hospital ALRI deaths were estimated by combining hCFRs and hospital admissions of hPIV-associated ALRI. The overall mortality of hPIV-associated ALRI was estimated using the “inflation factor” approach in the main analysis. The inflation factor, defined as the ratio of overall hPIV-associated ALRI deaths to in-hospital deaths, was applied to the in-hospital mortality. In a sensitivity analysis, we estimated the overall hPIV-associated ALRI deaths by combining the proportion of hPIV-associated ALRI deaths and the total ALRI mortality for children aged 0-59 months. For hPIV-attributable morbidity and mortality burden, we applied the attributable fraction to the associated burden estimates in the main analysis. In a sensitivity analysis for hPIV-attributable mortality, we combined the proportion of hPIV-attributable ALRI death and the total number of ALRI deaths. hPIV: human parainfluenza virus. ALRI: acute lower respiratory infection. hCFR: in-hospital case-fatality ratio.

Figure S3.1. Approaches for global human parainfluenza-virus-associated ALRI and human parainfluenza-virus-attributable morbidity and mortality estimation in children under five years.
Appendix 4. Details of sensitivity analysis

In this section, we present the pooled estimates adjusted for missing hPIV-4 where applicable. We assessed how the global burden estimates changed in different stratification groups or different approaches.

In Table S4.1, we estimated global hPIV-associated ALRI hospital admissions by summing up the estimates by World Bank income level, country development status, WHO regions where available.

In Table S4.2A and S4.2B, we estimated the hPIV-associated ALRI hospital admissions using a proportion-based approach. For the proportion-based approach, we applied the proportion of hPIV positives in hospitalised ALRI to the global ALRI hospital admissions for 0-59 months.\textsuperscript{1,2}

In Table S4.3, we estimated global hPIV-associated ALRI mortality by summing up the estimates by World Bank income level, country development status, WHO region where available.

In Table S4.4, we estimated the number of hPIV-severe ALRI cases for 0-59 months in the community for high child mortality settings. We did not identify relevant data in low child mortality settings, so we were unable to estimate the number of hPIV-severe ALRI cases for this setting.
Table S4.1A Adjusted hospital admission rates (per 1,000 children per year) and hospital admissions for hPIV-associated ALRI by World Bank income level and country development status*

| Age          | LMIC | UMIC | HIC | Global estimates by income levels | Developing | Industrialised | Global estimates by development status |
|--------------|------|------|-----|-----------------------------------|------------|---------------|----------------------------------------|
| **0-5 m (A)**|      |      |     |                                   |            |               |                                        |
| No. of studies | 7    | 6    | 4   |                                   | 14         | 3             |                                        |
| Hospital admission rate (/1,000) | 3.8 (1.8-7.8) | 5.7 (3-10.5) | 5.5 (3.1-9.9) | | 4.9 (3-7.9) | 3.7 (3-4.5) |                                        |
| Hospital admissions (*1,000) | 168 (81-349) | 105 (56-196) | 35 (20-62) | 308 (157-607) | 304 (188-493) | 26 (21-32) | 330 (209-524) |
| **6-11 m (B)**|      |      |     |                                   |            |               |                                        |
| No. of studies | 7    | 5    | 3   |                                   | 13         | 2             |                                        |
| Hospital admission rate (/1,000) | 3.5 (1.7-7) | 3.8 (1.9-7.6) | 3.5 (1.9-6.5) | | 3.8 (2.4-6.1) | 2.5 (1.7-3.7) |                                        |
| Hospital admissions (*1,000) | 154 (76-311) | 70 (35-139) | 22 (12-41) | 246 (123-491) | 234 (147-373) | 17 (12-26) | 252 (159-398) |
| **12-59 m (C)**|      |      |     |                                   |            |               |                                        |
| No. of studies | 8    | 8    | 4   |                                   | 19         | 1             |                                        |
| Hospital admission rate (/1,000) | 0.8 (0.4-1.4) | 0.8 (0.4-1.6) | 0.8 (0.2-2.9) | | 0.8 (0.5-1.3) | .. | .. |
| Hospital admissions (*1,000) | 274 (147-512) | 117 (59-233) | 41 (11-153) | 432 (217-898) | 388 (241-623) | .. | .. |
| **0-59 m (A+B+C)**|      |      |     |                                   |            |               |                                        |
| Hospital admissions (*1,000) | 596 (304-1171) | 292 (150-569) | 98 (42-257) | 986 (497-1997) | 926 (576-1489) | .. | .. |

* Hospitalisation rates from meta-analysis. Global estimates were calculated as the sum of estimates by age and regions.
† Hospitalisation rates were adjusted for missing hPIV-4.
### Table S4.1B Adjusted hospital admission rates (per 1,000 children per year) and hospital admissions for hPIV-associated ALRI by WHO regions*†

| Age       | 0-5 m (A) | 6-11 m (B) | 12-59 m (C) | 0-59 m (A+B+C) |
|-----------|-----------|------------|-------------|----------------|
|           | AFR | AMR | EMR | EUR | SEAR | WPR | AFR | AMR | EMR | EUR | SEAR | WPR | AFR | AMR | EMR | EUR | SEAR | WPR |
| No. of studies | 7   | 3   | 1   | 1   | 2   | 3   | 7   | 2   | 1   | 1   | 1   | 3   | 8   | 4   | 0   | 1   | 4   | 3   |
| Hospital admission rate (/1,000) | 5.9 (3.7-9.5) | 3.5 (2.7-4.4) | .. | .. | 2.8 (0.7-11.6) | 11.8 (9-15.5) | 4.1 (2.7-6.1) | 1.9 (1.4-2.6) | .. | .. | .. | 8.0 (6.1-10.6) | 0.8 (0.4-1.6) | 0.8 (0.3-2.2) | .. | .. | 0.3 (0.2-0.6) | 1.6 (0.5-5.5) | 107 (54-214) | 48 (18-129) | .. | .. | 42 (24-72) | 154 (47-509) | 283 (166-487) | 89 (49-182) | .. | .. | .. | 395 (230-825) |
| Hospital admissions (*1,000) | 104 (65-166) | 26 (21-34) | .. | .. | 50 (12-200) | 144 (110-188) | 71 (47-107) | 14 (11-19) | .. | .. | .. | 97 (74-128) | 107 (54-214) | 48 (18-129) | .. | .. | 42 (24-72) | 154 (47-509) | 283 (166-487) | 89 (49-182) | .. | .. | .. | 395 (230-825) |

* Hospitalisation rates from meta-analysis. Global estimates were calculated as the sum of estimates by age and regions.
† Hospitalisation rates were adjusted for missing hPIV-4.
Table S4.2A. Adjusted proportion of hospitalised hPIV-associated ALRI for 0-59 months by World Bank income level*†

| No. of studies | Proportion (%) for 0-59 m |
|----------------|--------------------------|
| All studies for 0-59 months | 94 | 8.8 (7.6-10.2) |
| By World Bank income group | | |
| Low income (L) | 4 | 11.1 (6.1-19.3) |
| Middle income (M) | 71 | 9.1 (7.6-11.0) |
| High income (H) | 19 | 7.1 (5.4-9.1) |

Table S4.2B. The adjusted hospital admissions of hPIV-associated ALRI for 0-59 months using the proportion-based approach

| No. of studies | Proportion (%) for 0-59 m | Hospital admissions of all-cause ALRI (thousand) | Hospital admissions of hPIV-associated ALRI (thousand) |
|----------------|--------------------------|-----------------------------------------------|---------------------------------------------------|
| 94             | 8.8 (7.6-10.2)           | 5,133 – 16,400*‡                            | 452–1,443                                          |

* Proportions from meta-analysis.
† Proportions were adjusted for missing hPIV-4.
### Table S4.3A. Adjusted hCFRs (%) and in-hospital deaths of hPIV-associated ALRI by different stratification groups.**

| Age       | LMIC     | UMIC     | HIC      | Global by income group | Developing | Industrialised | Global by country development status |
|-----------|----------|----------|----------|-------------------------|------------|---------------|-------------------------------------|
|           | No. of studies |          |          |                         |            |               |                                     |
| 0-5 m (A) | 15       | 8        | 4        |                         | 25         | 2             |                                     |
| hCFR (%)  | 3.9 (2.1-7.3) | 2.4 (1.3-4.6) | 0.9 (0.2-3.6) | 9400 (3700-24500) | 3.2 (2.0-5.0) | 1.0 (0.3-3.9) | 10000 (5200-19600) |
| Deaths    | 6600 (2600-17000) | 2500 (1100-6100) | 300 (100-1500) | 9700 (5100-18900) | 2.6 (1.2-5.8) | 1.3 (0.3-4.9) | 6300 (2500-15900) |
| 6-11 m (B)| 3.5 (2.2-5.6) | 1.9 (0.8-4.1) | 0.9 (0.4-1.9) | 6000 (1900-20800) | 2.7 (1.8-4.1) | 0.9 (0.4-2.0) |                                     |
| hCFR (%)  |          |          |          |                         |            |               |                                     |
| Deaths    | 9600 (4500-20900) | 2200 (800-6400) | 400 (100-1700) | 6100 (2400-14900) |             |               |                                     |
| 12-59 m (C)| 2 (0.5-7.4) | 3.8 (2.2-6.6) | 1.2 (0.3-4.7) |             |             |               |                                     |
| hCFR (%)  |          |          |          |                         |            |               |                                     |
| Deaths    | 3100 (700-13800) | 2700 (1100-6400) | 300 (100-1200) | 12200 (5300-28800) | 10500 (5600-19500) |             |                                     |
| 0-59 m (A+B+C) | 19400 (7800-50800) | 7400 (3000-18900) | 1000 (200-4100) | 27600 (11000-73700) | 26400 (13300-53000) |             |                                     |
| hCFR (%)  |          |          |          |                         |            |               |                                     |
| Deaths    | 6600 (2600-17000) | 2500 (1100-6100) | 300 (100-1500) | 9700 (5100-18900) | 2.6 (1.2-5.8) | 1.3 (0.3-4.9) | 6300 (2500-15900) |
| 0-59 m (A+B+C) | 19400 (7800-50800) | 7400 (3000-18900) | 1000 (200-4100) | 27600 (11000-73700) | 26400 (13300-53000) |             |                                     |

* hCFR estimates from meta-analysis. Global estimates were calculated as the sum of estimates by age and regions.

† hCFR estimates were adjusted for missing hPIV-4.

‡ There was only one study with hPIV-associated ALRI hospitalisation rates for the stratum, thus we were unable to estimate the hPIV-associated ALRI hospitalisations and in-hospital deaths.
Table S4.3B. Adjusted hCFRs (%) and in-hospital deaths of hPIV-associated ALRI by WHO regions.†

| Age         | No. of studies | AFR      | AMR      | EMR      | EUR      | SEAR‡ | WPR      |
|-------------|----------------|----------|----------|----------|----------|-------|----------|
| 0-5 m (A)   | 11             | 3.2 (1.9-5.3) | 1.2 (0.5-3.2) | ..       | ..       | 4     | 3.4 (0.1-63.5) |
| hCFR (%)    |                | 3300 (1700-6600) | 300 (100-800) | ..       | ..       | 4900 (200-118000) |
| Deaths      | 3300 (1700-6600) | 300 (100-800) | ..       | ..       | ..       | 4900 (200-118000) |
| 6-11 m (B)  | 5              | 3.4 (1.3-8.2) | 3.2 (1.7-6) | ..       | ..       | 1.8 (0.3-11.6) |
| hCFR (%)    |                | 2400 (900-6500) | 500 (200-900) | ..       | ..       | 1700 (300-10800) |
| Deaths      | 2400 (900-6500) | 500 (200-900) | ..       | ..       | ..       | 1700 (300-10800) |
| 12-59 m (C) | 1              | 3 (1.7-5.3) | 1.4 (0.8-2.6) | ..       | ..       | 2.4 (0.6-9.2) |
| hCFR (%)    |                | 3200 (1300-7800) | 700 (200-2100) | ..       | ..       | 3700 (600-22200) |
| Deaths      | 3200 (1300-7800) | 700 (200-2100) | ..       | ..       | ..       | 3700 (600-22200) |
| 0-59 m      | 15             | 3 (1.7-5.3) | 1.4 (0.8-2.6) | ..       | ..       | 2.4 (0.6-9.2) |
| (A+B+C)     |                | 9000 (4000-20700) | 1500 (600-3700) | ..       | ..       | 10900 (1200-149500) |

* hCFR estimates from meta-analysis. Global estimates were calculated as the sum of estimates by age and regions.
† hCFR estimates were adjusted for missing hPIV-4.
‡ We were unable to calculate hCFR meta-estimates in SEAR as the four studies all reported zero death.
Table S4.4. Adjusted incidence and number of hPIV-associated severe ALRI cases for 2018 in high child mortality setting. *†

| Age       | No. of studies | High child mortality setting |
|-----------|----------------|------------------------------|
| 0-5 m (A) | 4              | Incidence rate (/1,000)      |
|           |                | 20.6 (2.8-134.8)             |
|           |                | Cases (*1,000)               |
|           |                | 948 (138-6512)               |
| 6-11 m (B)| 3              | Incidence rate (/1,000)      |
|           |                | 30.7 (8.3-106.6)             |
|           |                | Cases (*1,000)               |
|           |                | 1400 (393-4985)              |
| 12-59 m (C)| 3             | Incidence rate (/1,000)      |
|           |                | 8.1 (2.2-29.8)               |
|           |                | Cases (*1,000)               |
|           |                | 2887 (790-10557)             |
| 0-59 m    | 5 (2)          | Incidence rate (/1,000)      |
|           |                | 9.3 (3.5-24.9)               |
|           |                | Cases (*1,000)               |
|           |                | 4190 (1585-11083)            |

* Incidence rates from meta-analysis.
† Incidence rates were adjusted for missing hPIV-4.
Appendix 5. Details of adjustment for missing hPIV-4

Since we included a mix of three-type (hPIV-1 to hPIV-3) and four-type (hPIV-1 to hPIV-4) data, we adjusted for missing hPIV-4 as shown in Figure S5.1 and Figure S5.2.

![Diagram](image)

Figure S5.1. Adjustment for the missing hPIV-4 in incidence rates and hospital admission rates of hPIV-associated ALRI for children under five years.

Table S5.1. Prevalence of each hPIV type for children aged 0-59 months.*

| Prevalence of hPIV types | No. of studies | 24 |
|--------------------------|----------------|----|
| Prevalence of hPIV-1 (%)  |                | 26.7 (22.1-31.9) |
| Prevalence of hPIV-2 (%)  |                | 9.5 (6.7-13.2)   |
| Prevalence of hPIV-3 (%)  |                | 49.9 (43.6-56.2) |
| Prevalence of hPIV-4 (%)  |                | 12.0 (8.2-17.2)  |

Table S5.2. Prevalence of each hPIV type in hPIV-associated ALRI deaths for children aged 0-59 months.†

| Prevalence of hPIV cases (%) | hCFRs (%) | Prevalence of hPIV deaths (%)‡ |
|------------------------------|-----------|-------------------------------|
| hPIV-1                       | 26.7      | 9.4 (5.4-15.8)                | 36.9 |
| hPIV-2                       | 9.5       | 9.1 (3.8-20.1)                | 12.6 |
| hPIV-3                       | 49.9      | 6.0 (3.4-10.3)                | 44.1 |
| hPIV-4                       | 12.0      | 3.7 (0.6-19.1)                | 6.5  |

* Data were from hospital-based studies; data were eligible if there were at least five hPIV-associated ALRI cases, and four hPIV types were detected.
† Data were from five hospital-based studies where at least 90% of cases were tested, and there were at least five hPIV-positive ALRI deaths. Data were from Zambia, South Africa, Mali, Morocco, Philippines.
‡ Calculated based on the prevalence and hCFRs of four hPIV types. So hPIV-4 accounted for 6.5% of hPIV-associated ALRI deaths, and hPIV-1 to hPIV-3 accounted for 93.5%.
Figure S5.2. Adjustment for missing hPIV-4 in hCFRs of hPIV-associated ALRI for 0-59 months.

Table S5.3. Unadjusted and adjusted burden estimates of hPIV-associated ALRI for children under five years by outcome.

|                              | Unadjusted estimates     | Adjusted estimates        |
|------------------------------|--------------------------|---------------------------|
| Global hPIV-associated ALRI cases in the community (thousand) | 22140 (UR 16132-31951) | 25636 (UR 17694-38599) |
| Global hPIV-associated ALRI hospital admissions (thousand)   |                          |                           |
| Using the incidence-based approach | 947 (UR 561-1644)     | 1007 (UR 601-1,750)      |
| Using the proportion-based approach   | 411-1,312                | 452-1,443                 |
| Global hPIV-associated ALRI in-hospital deaths                       | 26100 (UR 12900-54200) | 25700 (UR 12000-56500) |
Appendix 6. Overall hPIV-associated ALRI mortality

(1) “inflation factor” approach - main analysis

The inflation factor of hPIV-associated ALRI in-hospital deaths was estimated by child mortality settings. For high child mortality settings, the details of the data for inflation factor estimation were described previously. Eight sites reported (1) the number of pneumonia deaths occurring in-hospital and (2) the number of deaths occurring out-hospital for the same observation period were obtained. We divided the overall pneumonia deaths by in-hospital pneumonia deaths at each site, and used the median ratio across sites as a proxy for the inflation factor for hPIV-associated ALRI deaths for high child mortality settings (Table S6.1). Using this approach, we assumed that the hPIV prevalence in community ALRI deaths was the same as that in fatal hospitalised ALRI cases.

For low child mortality settings, the inflation factor was estimated using the measure for childhood pneumonia care-seeking: the proportion of children with pneumonia symptoms who received care at health providers as measured in Multiple Indicator Cluster Surveys, Demographic and Health Surveys, and other national surveys. In this analysis, the reciprocal of percent of children with pneumonia symptoms who received care at health providers was estimated and used as a proxy for the inflation factor. The median inflation factor across regions and countries was applied to the in–hospital mortality estimate for low child mortality countries to yield the overall mortality of virus–associated ALRI deaths in that setting.

Assumptions and potential limitations

For high child mortality settings, the inflation factor estimate was based on limited data, and was extrapolated to other high child mortality countries and regions, which could lead to bias. The overall mortality estimates might be biased if hPIV-associated ALRI deaths are more or less likely to occur in hospitals compared with ALRI deaths due to other pathogens. For low child mortality countries, the inflation factor was estimated using the proportion of children with pneumonia symptoms seeking care. Using this measure, the inflation factor and overall mortality estimate is likely to be underestimated because the definition of “care-seeking” is broader than the definition of “in–hospital”; contact with primary care is included as “care–seeking” in surveys, but are not included in the “in–hospital mortality” estimates in the present analysis. The US vital statistics data show that about 40% of under–five ALRI deaths (ICD–10 J09–22; U04) occurred in outpatient or emergency departments during 2010–2017. Additionally, this analysis was based on one further assumption that CFR for hospitalised pneumonia cases was the same as CFR for pneumonia not hospitalised. The direction of bias related to this assumption could be difficult to determine: children with more severe symptoms are more likely to receive hospital care than those without; on the other hand, supportive care in hospitals can reduce the risk of death, and lack of appropriate care or delays in care can lead to rapid deterioration.
Table S6.1. Main analysis - Number of all-cause pneumonia deaths in-hospital and out-hospital, and overall hPIV-associated ALRI mortality estimation.

| Setting                  | Site                                      | Ratio of all pneumonia deaths over in-hospital deaths for 0-59 months (A) | Inflation factor (B=median of A) | In-hospital mortality of hPIV-associated ALRI for high child mortality settings (C) | Overall hPIV-associated ALRI mortality for high child mortality settings (D=B^C) |
|--------------------------|-------------------------------------------|---------------------------------------------------------------------------|----------------------------------|--------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| **High child mortality settings** |                                          |                                                                           |                                  |                                                                                |                                                                                |
| Nairobi, Kenya (urban), 2008-2015 |                                          | 1.7                                                                      | 2.2                              | 21600 (10600-44100)                                                         | 47600 (UR 23400-97100)                                                        |
| Siaya, Kenya (rural), 2011-2016 |                                          |                                                                           |                                  |                                                                                |                                                                                |
| Nouna, Burkina Faso (rural), 2014-2016 |                                          |                                                                           |                                  |                                                                                |                                                                                |
| Dodowa, Ghana (rural), 2011-2015 |                                          |                                                                           |                                  |                                                                                |                                                                                |
| Maniça, Mozambique (mixed), 2012-2016 |                                          |                                                                           |                                  |                                                                                |                                                                                |
| Agincourt, South Africa (rural); 2010-2015 |                                          |                                                                           |                                  |                                                                                |                                                                                |
| Mirzapur, Bangladesh (rural), 2008-2012 |                                          |                                                                           |                                  |                                                                                |                                                                                |
| Multi-sites, Bangladesh (mixed), 2010-2012 |                                          |                                                                           |                                  |                                                                                |                                                                                |
| **Low child mortality settings** |                                          |                                                                           |                                  |                                                                                |                                                                                |
| 28 countries and regions |                                          | Range from 1.1 to 4.5                                                   | 1.3                              | 4100 (1400-12400)                                                          | 5300 (UR 1800-16200)                                                          |
| **Global estimates†** |                                          |                                                                           |                                  |                                                                                | 53000 (UR 25300-113500)                                                       |

Table S6.2. Proportion of children with pneumonia symptoms seeking care by country.  

| Country                                      | Data Source                  | Year   | Care seeking (%) |
|----------------------------------------------|------------------------------|--------|------------------|
| Albania                                      | DHS_2008-2009                | 2009   | 70               |
| Argentina                                    | MICS_2011-2012               | 2012   | 94               |
| Armenia                                      | DHS_2010                     | 2010   | 57               |
| Belarus                                      | MICS_2012                    | 2012   | 93               |
| Belize                                       | MICS_2011                    | 2011   | 82               |
| Bosnia and Herzegovina                       | MICS_2011-2012               | 2012   | 87               |
| Brazil                                       | MoH_PNDS_2006                | 2006   | 50               |
| Colombia                                     | DHS_2010                     | 2010   | 64               |
| Costa Rica                                   | MICS_2011                    | 2011   | 77               |
| Cuba                                         | MICS_2014                    | 2014   | 93               |
| El Salvador                                  | MICS and MDG indicators(Prelim)_2014 | 2014 | 80               |
| Georgia                                      | MICS_2005                    | 2005   | 74               |
| Iran (Islamic Republic of)                   | IrMIDHS(Prelim)_2010-2011    | 2010   | 76               |
| Jamaica                                      | MICS_2011                    | 2011   | 82               |
| Jordan                                       | DHS_2012                     | 2012   | 77               |
| Kazakhstan                                   | MICS_2010-2011               | 2011   | 81               |
| Lebanon                                      | MICS_2000                    | 2000   | 74               |
| Maldives                                     | MICS_2001                    | 2001   | 22               |
| Mongolia                                     | MICS_2013-2014               | 2014   | 70               |
| Montenegro                                   | MICS_2005                    | 2005   | 89               |
| Panama                                       | MICS(prelim)_2013            | 2013   | 82               |
| Peru                                         | DHS_2014                     | 2014   | 60               |
| Republic of Moldova                          | MICS_2012                    | 2012   | 79               |
| Serbia                                       | MICS_2010                    | 2010   | 90               |
| Sri Lanka                                     | DHS_2006-2007                | 2007   | 58               |
| Thailand                                     | MICS_2012                    | 2012   | 83               |
| The former Yugoslav Republic of Macedonia    | MICS_2005-2006               | 2006   | 93               |
| Ukraine                                      | MICS_2012                    | 2012   | 92               |

*Including ARI deaths identified by community survey. ARI deaths were defined as for children under 5 years, sudden onset cough or difficulty in breathing within 2 weeks of death.
†Global estimates are the sum of estimates by child mortality setting.
(2) Sensitivity analysis of hPIV-associated ALRI overall mortality in high child mortality settings based on the proportion positives of hPIV in ALRI deaths

In sensitivity analysis, we estimated the overall hPIV-associated ALRI mortality for the high child mortality setting using the following formula:

\[
\text{Overall hPIV-associated ALRI mortality} = \%{\text{hPIV in ALRI deaths}} \times \text{ALRI mortality}
\]

We estimated the proportion of hPIV positives in ALRI deaths using data from 12 hospital-based studies (including five PERCH sites) from high mortality burden settings in which at least 90% of ALRI cases were tested and at least five ALRI deaths were identified during the study period. All the studies detected four hPIV types. Neonatal hPIV-associated ALRI deaths were reported. The proportion of hPIV was estimated for the overall age band (i.e., 0-59 months) as the data were insufficient to allow disaggregation by narrower age bands (e.g., 0-27 d and 1-59 m).

Table S6.2. Using the proportion of hPIV-associated ALRI deaths based on hospital-based studies to estimate the overall hPIV-associated ALRI mortality for children aged 0-59 months in high child mortality settings.

| hPIV-associated ALRI deaths (A) | ALRI deaths (B) | % of hPIV positives in ALRI deaths (C=A*100/B) | 2017 ALRI deaths for high child mortality settings (D) | Overall hPIV-associated ALRI deaths for high child mortality settings (E=C*D/100) |
|---------------------------------|-----------------|-----------------------------------------------|---------------------------------------------------|--------------------------------------------------------------------------------------|
| 12 hospital-based studies (including five PERCH sites)* | 42 | 584 | 7.3% (95%CI 4.6-11.3) | 769,712 | 56,100 (UR 36,500-87,400) |

* We did meta-analysis of 12 studies from Philippines, Bangladesh, Gambia, Zambia, Mali, Kenya, South Africa, and Mozambique. The percent was 9.4% (95%CI 6.6-13.3) when only pooling five PERCH sites in Gambia, Zambia, Mali, Kenya, and South Africa.
Appendix 7. ALRI burden attributable to hPIV

1. Estimating the attributable fraction for hPIV-associated ALRI cases and hospital admissions

We estimated the hPIV-attributable burden by applying the attributable fraction of hPIV-associated ALRI cases to the number of hPIV-associated ALRI cases/hospital admissions. Since the attributable fraction varies by hPIV types, we estimated the average attributable fraction by accounting for the prevalence of each hPIV type using formula 7.1. In the formula, %hPIV\(_i\) denote the prevalence of hPIV-1 to hPIV-4; AF\(_i\) denote the AF for each type. Input data and final estimates are listed in Table S7.1. Type-specific odds ratios are from two pooled analyses of multi-country data.\(^{11,12}\)

Formula 7.1 - \(AF_{\text{average}} = \sum_{i}^{4} \%\text{hPIV}_i \times AF_i\)

Table S7.1. The estimation of the average attributable fraction for hPIV-associated ALRI cases.

| Type   | Odds ratio (OR)\(^{11,12}\) | \(AF_i\) (%) = (OR-1)*100/OR* | % hPIV\(_i\) | Average AF (%) |
|--------|-----------------------------|------------------------------|-------------|---------------|
| hPIV1  | 7.5                         | 87%                          | 27          | 72%           |
| hPIV2  | 1.0 – 2.0                   | 25%                          | 10          |               |
| hPIV3  | 2.6 – 6.7                   | 79%                          | 50          |               |
| hPIV4  | 1.7 – 2.6                   | 55%                          | 12          |               |

* We used the median value of the ORs which were available in two pooled analysis of multi-country data.
2. Estimating the attributable fraction for hPIV-associated ALRI mortality

The hPIV-attributable ALRI mortality was estimated by combining the hPIV-associated ALRI mortality and the attributable fraction of hPIV-associated ALRI deaths. The attributable fraction was estimated by assuming the hCFR for ALRI cases unattributed to hPIV was the same with the hCFR for hPIV-negative cases (Figure S7.1).

Figure S7.1. Estimating the attributable fraction of hPIV-associated ALRI deaths for children under five years.

As shown in the above figure, the key was to split the CFR for hPIV-associated ALRI cases into (1) the CFR for hPIV-attributable ALRI cases; (2) the CFR for hPIV-unattributable ALRI cases. We assumed the CFR for hPIV-unattributable cases was equal to the CFR for hPIV-negative cases. The AF for hPIV-associated ALRI deaths was estimated based on the following formulas:

- **Formula A** -  \( \text{Deaths (hPIV+)} = \text{Cases (hPIV+)} \times \text{hCFR (hPIV+)} \)
- **Formula B** -  \( \text{Deaths (hPIV attri)} = \left[ \text{Cases (hPIV +)} \times \frac{AF_{\text{case}}(\%)}{100} \right] + \text{hCFR (hPIV attri)} \)

The Deaths (hPIV+) and Cases (hPIV+) represented for the number of ALRI deaths and cases positive for hPIV; the hCFR (hPIV+) represented for the in-hospital case-fatality ratio for hPIV positive ALRI cases. Similarly, the Deaths (hPIVattri), Cases (hPIVattri), and hCFR (hPIVattri) represented for the measures for cases or deaths attributed to hPIV. The AFcase represented for the AF (%) for hPIV-associated ALRI cases. By definition, the AF (%) for hPIV-associated ALRI deaths could be estimated using formula A and B as follows:

- **Formula C** (Formula B/A) -  \( \frac{AF_{\text{Deaths}}(\%)}{AF_{\text{Cases}}(\%)} = \frac{AF_{\text{case}}(\%)}{100} \times \frac{\text{hCFR (hPIV attri)}}{\text{hCFR (hPIV+)} } \)

Here, we used the average AF of hPIV cases as the input for AFcases (%). Then we estimated the ratio of case-fatality of hPIV-attributable ALRI cases versus hPIV-positive cases using the formula below. The association between hCFR (hPIVattri), hCFR (hPIVnon-attri), and hCFR (hPIV+) is shown in Formula D and E:

- **Formula D** -  \( \text{Deaths (hPIV+)} = \text{Deaths (hPIV attri)} + \text{Deaths (hPIV non-attri)} \)
  \[ = \left[ \text{Cases (hPIV +)} \times \frac{AF_{\text{case}}(\%)}{100} \right] \times \text{hCFR (hPIV attri)} + \left[ \text{Cases (hPIV +)} \times \frac{100-\text{AF}_{\text{case}}(\%)}{100} \right] \times \text{hCFR (hPIV non-attri)} \]

- **Formula E** (transformed from Formula D) -
  \[ hCFR (hPIV+) = \frac{\text{AF}_{\text{case}}(\%)}{100} \times hCFR (hPIV attri) + \frac{100-\text{AF}_{\text{case}}(\%)}{100} \times hCFR (hPIV non-attri) \]
Table S7.2. Estimation of the attributable fraction for hPIV-associated ALRI deaths for 0–59 months. *

| hCFR (%) in hPIV-positive cases (A) | hCFR (%) in hPIV-negative cases (B) | Ratio of case-fatality for hPIV-unattributable cases versus hPIV-associated cases (C=B/A) | Ratio of case-fatality for hPIV-attributable cases versus hPIV-associated cases (D, estimated using A and C) | AF for hPIV-associated ALRI deaths (=AF for hPIV-associated ALRI cases * D)† |
|-----------------------------------|-----------------------------------|-------------------------------------------------|------------------------------------------------|-------------------------------------------------|
| 4.1 (2.3-6.9)                     | 4.8 (3.2-7.3)                     | 1.2                                             | 0.9                                           | 65%                                             |

* We only included hospital-based studies with high level of testing (>=90% of ALRI cases were tested) and with at least five ALRI deaths to ensure the precision of estimates. We did the meta-analysis of 12 studies from Philippines, Bangladesh, Gambia, Zambia, Mali, Kenya, South Africa, and Mozambique. The ratio was 0.75 when only including five PERCH sites in Gambia, Zambia, Mali, Kenya, and South Africa.
† We used the average AF for hPIV-associated ALRI cases (72%), as calculated in Table S7.1.
3. Estimating hPIV-attributable ALRI mortality in high child mortality settings using CHAMPS data

CHAMPS investigates the causes of under-five mortality at seven sites in sub-Saharan Africa and South Asia, which are from high child mortality settings.\textsuperscript{13} For this analysis, we extracted the number of all-cause ALRI deaths and the number of hPIV-attributable ALRI deaths, where ALRI and hPIV could be anywhere in the causal pathway (including underlying cause or condition, immediate cause or condition, co-morbid causes or conditions) for the period December 2016 to October 2019.\textsuperscript{14} The input data for this analysis and the results are in Table S7.3.

### Table S7.3. Estimating hPIV-attributable ALRI mortality using CHAMPS data

| hPIV-associated ALRI deaths (A)* | ALRI deaths (B) † | % of hPIV-attributable ALRI (C=A*100/B) | 2017 ALRI deaths for high child mortality settings (D) | hPIV-attributable ALRI deaths for high child mortality settings (E=C*D/100) |
|---------------------------------|-------------------|----------------------------------------|--------------------------------------------------|--------------------------------------------------|
| 0-27 days                       | 2                 | 91                                     | 2.2% (95%CI 0.3-7.7)                              | 146,967                                          | 3,200 (UR 700-16,800) |
| 1-59 months                     | 13                | 191                                    | 6.8% (95%CI 3.7-11.4)                             | 622,742                                          | 42,300 (UR 24,300-74,900) |
| 0-59 months                     |                   |                                        |                                                  | 45,500 (UR 24,900-91,700)                        |                      |

* hPIV as any of immediate, co-morbid, and underlying cause of death (hPIV appeared anywhere in the causal chain of deaths).
† ALRI as any of immediate, co-morbid, and underlying cause of death (ALRI appeared anywhere in the causal chain of deaths).
Appendix 8. Yearly variation in the hPIV-associated ALRI hospital admission rate

Figure S8.1. Yearly unadjusted hospital admission rates of hPIV-associated ALRI in children under five years (with at least five years’ data).

Table S8.1. The average hPIV-associated ALRI hospital admission rates (unadjusted) in the above five studies for 0-59 months

| Location                      | Period          | Average rate (per 1,000 children per year) |
|-------------------------------|-----------------|------------------------------------------|
| Nha Trang, Vietnam            | 2007-2010       | 0.4                                      |
|                               | 2011-2014       | 1.1                                      |
| Kilifi, Kenya                 | 2007-2010       | 2.0                                      |
|                               | 2011-2016       | 1.3                                      |
| Klerksdorp, South Africa      | 2010-2012       | 1.1                                      |
|                               | 2013-2015       | 1.0                                      |
| Pietermaritzburg, South Africa| 2010-2012       | 0.8                                      |
|                               | 2013-2015       | 0.9                                      |
| Buenos Aires, Argentina       | 2001-2009       | 4.5                                      |
|                               | 2010-2017       | 4.2                                      |
Appendix 9. Data imputation

Several studies reported data for 0–11 months, 0–23 months, and 0–35 months; to incorporate the information from these studies, the missing incidence rate for 0–59 months was imputed. The imputation was done as previously\textsuperscript{15}: (1) imputing the denominator; (2) imputing the rate; (3) calculating the case number using the denominator and rate. Steps (2) and (3) were skipped if the case number was available. The reference group referred to the age group with available rate data and could be one of 0–35 months, 0–23 months or 0–11 months. When two or more age groups were available, the reference group was chosen in the following order: 0–35 months, 0–23 months, and 0–11 months. Details of each step are:

(1) The denominator was imputed by country income regions based on the probability of dying between age n and n+x (nqx) obtained from WHO life tables.\textsuperscript{16} The proportion of total under–five population that are in the reference age group was calculated using the nqx estimates. Using this proportion and the denominator in the reference group, the denominator for 0–59 months was estimated.

(2) The case number was imputed using a multiple imputation approach assuming the rates for 0–59 months were missing at random.\textsuperscript{17} Figure S8.1 shows the process. First, we estimated the rate ratios between 0–59 months and any of 0–11 months, 0–23 months, and 0–35 months (meta–analysis was only done when there were three or more studies). Second, the pooled rate ratio was assumed to follow a log–normal distribution, and 100 samples of rate ratios were simulated. Third, 100 samples of rates for 0–59 months were generated based on the rate in the reference group and the corresponding rate ratios. Fourth, case numbers were calculated using the denominator and imputed rates. Using the method, 100 datasets of imputed case numbers were generated. Fifth, meta–analysis was done for each dataset, and the meta–estimates were combined together using the Rubin’s rules.\textsuperscript{18,19}

Figure S9.1. Imputing missing rates for 0–59 months using the multiple imputation approach.

Table S9.1. Pooled incidence rates of hPIV–associated ALRI for 0–59 months including and excluding imputed data\textsuperscript{*}

| Age Group                     | Pooled rates with imputed data | Pooled rates without imputed data |
|-------------------------------|--------------------------------|----------------------------------|
|                               | No of studies (No. of imputed studies) | Rate                     | No of studies | Rate                     |
| Low child mortality setting   | 4 (3)                          | 37.8 (18.5-77.3)            | 1             | 18.8 (14.3-24.2)\textsuperscript{†} |
| High child mortality setting  | 8 (3)                          | 38.8 (30.1-50.2)            | 5             | 32.0 (25.6-39.9)\textsuperscript{‡} |

\* Using multiple imputation method.

\textsuperscript{†} Only one study reported data for 0-59 months in low child mortality settings. 95% confidence intervals were calculated based on the binomial distribution.

\textsuperscript{‡} This rate was mainly driven by three studies in Bangladesh (39.5 per 1,000 children per year for 0-59 m), South Africa (43.1 per 1,000 children per year for 0-59 m), and Nepal (48 per 1,000 children per year for 0-23 m) reporting high rates. The three studies had the largest sample sizes. After imputation, the rates for 0-59 m in the Nepali study were included in the meta-analysis.
Appendix 10. Adjusting for under-detection of hPIV

1. Details of denominator scaling in incidence rate and hospital admission rate data

Since not all ALRI cases were tested, we adjusted for the level of testing at study levels: we scaled the population-at-risk by applying the original denominator to the proportion of eligible cases who are tested (Formula 10.1). The scaled denominator could better reflect the true size of each study than the original denominator, thus the weight of each study in the meta-analysis.

Formula 10.1 - scaling the denominator:

\[
\text{Rate} = \frac{\text{No. of observed cases}}{\text{Proportion of test} \times \text{Original denominator}}
\]

2. hCFR data

For hCFR estimation, we only used the information from the cases that were tested, and did not adjust for the under-detection. The hCFR of tested ALRI cases was higher than the hCFR of untested ALRI cases (Table S10.1).
Table S10.1. The hCFR for tested ALRI cases and the hCFR for untested ALRI cases for 0-59 months using available data.*†

| ID   | Location              | Year                  | Tested cases (A1) | Tested deaths (A2) | Untested cases (B1) | Untested deaths (B2) | hCFRs for tested (A=A2/A1, \%) | hCFR for untested (C=B2/B1, \%) |
|------|-----------------------|-----------------------|-------------------|-------------------|---------------------|---------------------|---------------------------------|---------------------------------|
| up_14 | Kilifi, Kenya         | 2007-2011; 2013-2017  | 2757              | 93                | 1270                | 79                  | 3.4                             | 6.2                             |
| up_21 | Basse, Gambia         | 2012-2013             | 623               | 17                | 12                  | 5                   | 2.7                             | 41.7                            |
| up_22 | Lusaka, Zambia        | 2011-2014             | 590               | 105               | 16                  | 9                   | 17.8                            | 56.2                            |
| up_24 | Soweto, South Africa  | 2011-2013             | 866               | 33                | 8                   | 0                   | 3.8                             | 0                               |
| up_27 | Kilifi, Kenya         | 2011-2013             | 566               | 27                | 2                   | 2                   | 4.8                             | 100                             |
| up_28 | Bamako, Mali          | 2012-2014             | 659               | 100               | 1                   | 0                   | 15.2                            | 0                               |
| up_29 | Rabat, Morocco        | 2010-2011             | 771               | 29                | 18                  | 1                   | 3.8                             | 5.6                             |
| up_3  | Buenos Aires, Argentina | 2000-2017          | 12311             | 227               | 1626                | 25                  | 1.8                             | 1.5                             |
| up_30 | Manhiça, Mozambique   | 2011-2014             | 478               | 12                | 14                  | 2                   | 2.5                             | 14.3                            |
| up_38 | Soweto, South Africa  | 1998-2005             | 2602              | 138               | 119                 | 32                  | 5.3                             | 26.9                            |
| up_5  | Klerksdorp, South Africa | 2010-2015            | 1259              | 31                | 45                  | 2                   | 2.5                             | 4.4                             |
| up_6  | Pietermaritzburg, South Africa | 2010-2015 | 2164              | 18                | 52                  | 1                   | 0.8                             | 1.9                             |
| up_7  | Colorado, United States of America | 2010-2016 | 6424              | 60                | 9261                | 18                  | 0.9                             | 0.2                             |
| up_8  | Berlin, Germany       | 2010-2014             | 2512              | 9                 | 13                  | 0                   | 0.4                             | 0                               |
| Meta-estimates |                      |                      |                   |                   |                     |                     | 3.0 (1.7-5.0)                 | 6.3 (1.9-18.8)                 |

* Studies with small number of ALRI deaths (<5 ALRI deaths) were excluded in this analysis. The hCFRs in these studies were very imprecise. Also, very few hPIV-deaths would be missed due to under-detection.
† Studies were not excluded in this analysis if all ALRI cases were tested. Studies were excluded in this analysis if information of testing levels was unavailable.
Appendix 11. Assessment tool for risk of bias in individual studies

We used a modified Newcastle-Ottawa Scale when assessing risk of bias. Since our study does not include comparison groups, we removed the domains in the original scale that are related to comparison groups (e.g., case vs control; exposed vs non-exposed). The original scale includes domains related to biases in different aspects of one study, such as representativeness, case definition, and exposure ascertainment. We modified these domains to assess the biases specific to our study. For example, for the representativeness of study population in the original scale, we modified to “patient group excluded” and “adjustment for health utilization”. The adequacy of case definition in the original scale is maintained in the modified scale. For the non-response rate and loss to follow-up in the original scale, we modified it to “sampling strategy for detecting influenza”. For the ascertainment of the exposure in the original scale, we modify to “test method” for virus detection. Moreover, we add a category of “study design” as retrospective studies are usually susceptible to more biases and usually provide less information than prospective studies.

Table S11.1 Assessment of risk of biases for community-based studies

| Category                | Description                                                                 | Risk of bias |
|-------------------------|-----------------------------------------------------------------------------|--------------|
| Study design            | Studies where the cases were prospectively enrolled                          | Low          |
|                         | Other studies                                                               | High         |
| Patient groups excluded | No exclusions that may affect estimates                                       | Low          |
|                         | Exclusions that may affect estimates, e.g., any of the following:            | High         |
|                         | 1. Not including very young children (e.g., neonates).                       |               |
|                         | 2. Excluding children with high-risk conditions.                            |               |
|                         | 3. Other exclusions that may affect estimates                                |               |
| Case definition         | Using common/standard definitions                                           | Low          |
|                         | Using non-standard/inconsistent definitions                                  | High         |
| Sampling strategy       | The proportion of testing is available AND either of the following:         | Low          |
|                         | 1. >=90% of eligible cases have been tested.                                |               |
|                         | 2. Testing a systematic sample of patients.                                 |               |
|                         | <90% of eligible cases have been tested                                     | High         |
|                         | OR                                                                          |               |
|                         | The proportion of eligible cases who have been tested is unavailable.        |               |
| Diagnostic test         | PCR;                                                                        | Low          |
|                         | Or using other diagnostic tests, but confirming negative samples with PCR    |               |
|                         | 1. Other diagnostic tests, e.g., culture, IFA, DFA.                         | High         |
|                         | 2. No mention of diagnostic tests                                           |               |
| Category                                                                 | Description                                                                 | Risk of bias |
|--------------------------------------------------------------------------|-----------------------------------------------------------------------------|--------------|
| Study design                                                             | Studies where the cases were prospectively enrolled                         | Low          |
|                                                                          | Other study designs                                                          | High         |
| Adjustment for healthcare utilization (only for hospital admission rate studies) | Meeting either of the following:                                            | Low          |
|                                                                          | 1. Including all or main hospitals;                                          |              |
|                                                                          | 2. Not including main hospitals, but adjusting for the proportion of patients admitted in the study hospitals |              |
|                                                                          | Not including main hospitals OR no related description; AND no adjustment for the proportion of patients admitted in the study hospitals | High         |
| Patient groups excluded                                                  | No exclusions that may affect estimates                                      | Low          |
|                                                                          | Exclusions that may affect estimates, e.g., any of the following:           | High         |
|                                                                          | 1. Not including very young children (e.g., neonates).                      |              |
|                                                                          | 2. Excluding children with high-risk conditions.                           |              |
|                                                                          | 3. Other exclusions that may affect estimates                                |              |
| Case definition                                                           | Using common/standard definitions                                           | Low          |
|                                                                          | Using non-standard/inconsistent definitions                                  | High         |
| Sampling strategy                                                        | The proportion of testing is available AND either of the following:         | Low          |
|                                                                          | 1. >=90% of eligible patients have been tested.                            |              |
|                                                                          | 2. Testing a systematic sample of patients.                                |              |
|                                                                          | <90% of eligible cases have been tested                                   | High         |
|                                                                          | OR                                                                          |              |
|                                                                          | The proportion of eligible cases who have been tested is unavailable.       |              |
| Diagnostic test (only for hospital admission rate studies)               | PCR;                                                                       | Low          |
|                                                                          | Or using other diagnostic tests, but confirming negative samples with PCR or culture |              |
|                                                                          | 1. Other diagnostic tests, e.g., culture, IFA, DFA.                        | High         |
|                                                                          | 2. No mention of diagnostic tests                                          |              |
| Hypoxaemia ascertainment (only for studies providing hypoxaemia data)    | SpO2 was recorded for all metapneumovirus-confirmed cases                  | Low          |
|                                                                          | 1. SpO2 was recorded for a proportion of metapneumovirus-confirmed cases.  | High         |
|                                                                          | 2. No mention of how many metapneumovirus-confirmed cases have been assessed for hypoxaemia. |              |
## Appendix 12. Risk of bias in included studies

Table S12.1 Risk of bias for community-based studies reporting incidence rates of hPIV-associated ALRI (13 studies)

| ID  | Location; period       | Study Design | Patient groups excluded | Case definition | Sampling strategy | Test method |
|-----|------------------------|--------------|-------------------------|-----------------|-------------------|-------------|
| 442 | India; 2001-2005       | Low          | Low                     | Low             | High              | High        |
| 742 | USA; 2009              | Low          | Low                     | Low             | High              | Low         |
| 806 | Bangladesh; 2004-2008  | Low          | Low                     | Low             | Low               | Low         |
| up_2| India; Aug 2012-Aug 2014| Low          | Low                     | Low             | Low               | Low         |
| up_39| Pakistan; Dec 2012-Dec 2013| Low      | Low                     | Low             | High              | Low         |
| up_4 | Bangladesh; 2013-2014  | Low          | Low                     | Low             | High              | Low         |
| up_40| South Africa; 2012-2017| Low          | Low                     | Low             | Low               | Low         |
| up_41| Nepal; 2004-2007       | Low          | High                    | Low             | Low               | Low         |
| 388 | USA; 1976-2001         | Low          | High                    | High            | High              | High        |
| 421 | Bangladesh; 1993-1994  | Low          | Low                     | Low             | High              | High        |
| 735 | Australia; 2010-2014   | Low          | High                    | Low             | High              | Low         |
| 737 | Australia; 1996-1999   | Low          | High                    | Low             | Low               | Low         |
| 743 | Spain; 1996-1999       | Low          | Low                     | High            | High              | High        |

Table S12.2 Risk of bias for community-based studies reporting incidence rates of hPIV-associated severe ALRI (5 studies).

| ID  | Location; period       | Study Design | Patient groups excluded | Case definition | Sampling strategy | Test method |
|-----|------------------------|--------------|-------------------------|-----------------|-------------------|-------------|
| 12  | Pakistan; 2011-2014    | Low          | Low                     | Low             | Low               | Low         |
| 442 | India; 2001-2005       | Low          | Low                     | Low             | High              | High        |
| up_2| India; 2012-2014       | Low          | Low                     | Low             | Low               | Low         |
| up_4 | Bangladesh; 2013-2014  | Low          | Low                     | Low             | High              | Low         |
| up_40| South Africa; 2012-2017| Low          | Low                     | Low             | Low               | Low         |
Table S12.3 Risk of bias for hospital-based studies reporting hospital admission rate of hPIV-associated ALRI (38 studies)

| ID  | Location; period             | Study Design | Adjustment for healthcare utilization | Patient groups excluded | Case definition | Sampling strategy | Test method |
|-----|------------------------------|--------------|----------------------------------------|-------------------------|----------------|--------------------|-------------|-------------|
| 158 | Thailand; 2005-2010          | Low          | Low                                    | Low                     | High           | Low                | High        |
| 174 | USA; 2010-2012               | Low          | Low                                    | High                    | Low            | Low                | High        |
| 27  | Nunavut; 1997-1998           | Low          | Low                                    | Low                     | High           | Low                | High        |
| 386 | USA; 2000-2004               | Low          | Low                                    | High                    | High           | Low                | Low        |
| 51  | India; 2009-2011             | Low          | Low                                    | Low                     | High           | Low                | Low        |
| 6   | Kenya; 2007-2010             | Low          | Low                                    | Low                     | High           | Low                | Low        |
| 649 | Germany; 1996-2000           | High         | Low                                    | Low                     | High           | Low                | Low        |
| 742 | USA; 2009                    | Low          | Low                                    | Low                     | High           | Low                | Low        |
| 78  | China; 2003-2006             | Low          | Low                                    | High                    | Low            | Low                | High        |
| 815 | the Gambia; 2015             | Low          | Low                                    | High                    | Low            | Low                | Low        |
| 85  | Spain; 2004-2007             | Low          | Low                                    | High                    | Low            | Low                | Low        |
| up_10 | Philippines; 2014-2016     | Low          | Low                                    | Low                     | Low            | Low                | Low        |
| up_14 | Kenya; 2007-2017            | Low          | Low                                    | Low                     | Low            | High               | Low        |
| up_15 | Viet Nam; 2007-2016         | Low          | High                                   | Low                     | Low            | Low                | Low        |
| up_16 | Argentina; Jun 2008-Dec 2010| Low          | High                                   | Low                     | Low            | Low                | High        |
| up_17 | Philippines; 2000-2004      | Low          | Low                                    | High                    | Low            | Low                | Low        |
| up_18 | Jordan; Mar 2010-Mar 2013   | Low          | High                                   | Low                     | Low            | Low                | Low        |
| up_21 | Gambia; 2012-2013           | Low          | High                                   | Low                     | Low            | Low                | Low        |
| up_23 | Thailand; Jan 2012-Dec 2013 | Low          | High                                   | Low                     | Low            | Low                | Low        |
| up_25 | Thailand; Jan 2012-Dec 2013 | Low          | High                                   | Low                     | Low            | Low                | Low        |
| up_3  | Argentina; 2000-2017         | Low          | High                                   | Low                     | Low            | Low                | High        |
| up_30 | Mozambique; 2011-2014        | Low          | Low                                    | Low                     | Low            | Low                | Low        |
| up_31 | Chile; 2012-2013             | Low          | Low                                    | Low                     | Low            | Low                | High        |
| up_32 | Chile; 2012-2013             | Low          | Low                                    | Low                     | Low            | Low                | High        |
| up_38 | South Africa; 1998-2005     | Low          | High                                   | Low                     | Low            | Low                | High        |
| up_4  | Bangladesh; 2013-2014        | Low          | Low                                    | Low                     | High           | Low                | Low        |
| up_40 | South Africa; 2012-2017     | Low          | Low                                    | Low                     | Low            | Low                | Low        |
| up_5  | South Africa; 2010-2015      | Low          | High                                   | Low                     | Low            | Low                | Low        |
| up_6  | South Africa; 2010-2015      | Low          | High                                   | Low                     | Low            | Low                | Low        |
| 122 | Germany; 1999-2001           | Low          | Low                                    | High                    | Low            | High               | Low        |
| 176 | China; 2007-2008             | High         | Low                                    | Low                     | High           | Low                | High        |
| 253 | Canada; 2007-2012            | High         | Low                                    | Low                     | High           | Low                | High        |
| 569 | Spain; 2011-2012             | Low          | Low                                    | High                    | Low            | Low                | Low        |
| 738 | Mozambique; 2006-2007        | Low          | Low                                    | Low                     | Low            | Low                | Low        |
| 739 | Kenya; 2007-2010             | Low          | Low                                    | Low                     | Low            | High               | Low        |
| up_19 | Bangladesh; 2010-2014        | Low          | Low                                    | High                    | Low            | Low                | Low        |
| 865 | Taiwan; 2010-2013            | Low          | Low                                    | High                    | High           | Low                | Low        |
| 891 | Australia; 2019-2014         | Low          | Low                                    | High                    | Low            | Low                | Low        |
Table S12.4 Risk of bias for hospital-based studies reporting proportions of hPIV-associated ALRI (168 studies)

| ID  | Location: period       | Study Design | Patient groups excluded | Case definition | Sampling strategy | Test method |
|-----|------------------------|--------------|-------------------------|-----------------|-------------------|-------------|
| 104 | Brazil; 2008-2010      | Low          | Low                     | High            | Low               | Low         |
| 110 | France; 2002-2004      | High         | Low                     | Low             | High              | High        |
| 122 | Germany; 1999-2001     | Low          | Low                     | High            | High              | Low         |
| 123 | France; 2003-2004      | Low          | Low                     | High            | High              | High        |
| 131 | Argentina; 1998-2002   | High         | Low                     | Low             | High              | High        |
| 151 | Brazil; 2012-2013      | Low          | Low                     | Low             | High              | Low         |
| 158 | Thailand; 2005-2010    | Low          | High                    | Low             | Low               | High        |
| 161 | USA; 1996-1998         | High         | Low                     | High            | High              | High        |
| 167 | France; 2007-2008      | High         | Low                     | High            | Low               | High        |
| 189 | Cameroon; 2011-2013    | Low          | Low                     | High            | Low               | Low         |
| 190 | Oman; 2007-2008        | Low          | High                    | Low             | High              | Low         |
| 191 | Malaysia; 1992-2008    | High         | Low                     | High            | High              | High        |
| 206 | Ghana; 2008            | Low          | Low                     | Low             | Low               | Low         |
| 223 | China; 2011-2013       | High         | Low                     | High            | Low               | Low         |
| 229 | China; 2013-2015       | Low          | Low                     | Low             | Low               | High        |
| 253 | Canada; 2007-2012      | High         | Low                     | Low             | High              | High        |
| 284 | Brazil; 2005-2007      | Low          | High                    | Low             | High              | High        |
| 291 | Thailand; 2013-2014    | Low          | High                    | Low             | High              | Low         |
| 329 | USA; 2005-2007         | Low          | Low                     | High            | High              | Low         |
| 340 | Brazil; 1992           | High         | Low                     | High            | High              | High        |
| 349 | China; 2001-2006       | High         | Low                     | Low             | Low               | High        |
| 355 | Taiwan; 1997-1999      | High         | Low                     | High            | Low               | High        |
| 373 | Argentina; 1998-2002   | High         | Low                     | Low             | High              | High        |
| 378 | China; 2004-2012       | High         | Low                     | High            | High              | High        |
| 379 | China; 2012-2015       | Low          | Low                     | High            | Low               | High        |
| 383 | USA; 2010-2014         | Low          | Low                     | High            | Low               | Low         |
| 386 | USA; 2000-2004         | Low          | High                    | Low             | Low               | Low         |
| 391 | Israel; 2001-2005      | Low          | Low                     | Low             | Low               | Low         |
| 401 | China; 2010-2011       | Low          | Low                     | Low             | Low               | Low         |
| 410 | Italy; 2004-2008       | High         | Low                     | Low             | Low               | Low         |
| 421 | Bangladesh; 1993-1994  | Low          | Low                     | Low             | High              | High        |
| 428 | Saudi Arabia; 1997-2001| Low          | Low                     | High            | High              | High        |
| 436 | Saudi Arabia; 1993-1996| High         | Low                     | High            | Low               | High        |
| 443 | Saudi Arabia; 2005-2010| High         | Low                     | Low             | High              | Low         |
| 449 | China; 2014            | High         | Low                     | Low             | Low               | Low         |
| 463 | Viet Nam; 2009-2010    | Low          | High                    | High            | Low               | Low         |
| 469 | Republic of Korea; 2011-2012| High   | Low                     | High            | High              | Low         |
| 488 | Japan; 2007-2012       | Low          | Low                     | Low             | High              | Low         |
| 503 | China; 2011            | Low          | Low                     | High            | Low               | Low         |
| 51  | India; 2009-2011       | Low          | High                    | Low             | Low               | Low         |
| ID  | Location: period     | Study Design | Patient groups excluded | Case definition | Sampling strategy | Test method |
|-----|----------------------|--------------|-------------------------|----------------|------------------|-------------|
| 530 | China; 2009-2014     | Low          | Low                     | High           | High             | Low         |
| 534 | China; 2010-2012     | High         | Low                     | High           | Low              | Low         |
| 556 | Australia; 2000-2005 | High         | Low                     | Low            | Low              | Low         |
| 566 | Mexico; 2002-2004    | Low          | Low                     | High           | Low              | Low         |
| 57  | Spain; 2005-2008     | Low          | Low                     | High           | High             | Low         |
| 570 | China; 2007          | High         | Low                     | Low            | Low              | Low         |
| 573 | Poland; 2008-2011    | High         | Low                     | High           | High             | Low         |
| 576 | China; 2014          | High         | High                    | Low            | Low              | Low         |
| 593 | Spain; 2011          | Low          | High                    | High           | Low              | High        |
| 604 | India; 2011-2012     | Low          | Low                     | Low            | Low              | Low         |
| 605 | Thailand; 1998-2001  | Low          | Low                     | High           | High             | Low         |
| 613 | Brazil; 1987-1989    | Low          | Low                     | High           | High             | Low         |
| 630 | Paraguay; 2009       | High         | Low                     | Low            | Low              | Low         |
| 642 | China; 2001-2003     | High         | High                    | Low            | Low              | High        |
| 649 | Germany; 1996-2000   | High         | Low                     | High           | High             | Low         |
| 660 | China; 2007-2008     | Low          | Low                     | Low            | High             | Low         |
| 675 | China; 2011-2012     | Low          | Low                     | High           | Low              | Low         |
| 695 | Bangladesh; 2014-2015| Low          | High                    | High           | Low              | Low         |
| 7   | Republic of Korea; 1996-1998 | High | High                    | High           | Low              | High        |
| 730 | Spain; 2011-2013     | Low          | Low                     | High           | Low              | Low         |
| 731 | United Kingdom; 2009-2012 | Low | High                    | Low            | Low              | Low         |
| 733 | Cyprus; 2010-2013    | Low          | Low                     | High           | High             | Low         |
| 736A| Egypt; 2007-2014     | Low          | Low                     | High           | Low              | Low         |
| 736B| Jordan; 2008-2010    | Low          | Low                     | High           | High             | Low         |
| 736C| Oman; 2008-2009      | Low          | Low                     | High           | High             | Low         |
| 736D| Qatar; 2008-2009     | Low          | Low                     | High           | High             | Low         |
| 736E| Yemen; 2010-2014     | Low          | Low                     | High           | High             | Low         |
| 738 | Mozambique; 2006-2007 | Low          | Low                     | Low            | Low              | Low         |
| 739 | Kenya; 2007-2010     | Low          | Low                     | Low            | High             | Low         |
| 740 | China; 2007-2010     | Low          | Low                     | High           | Low              | Low         |
| 741 | Brazil; 2008-2009    | Low          | Low                     | High           | Low              | Low         |
| 742 | USA; 2009            | Low          | Low                     | Low            | High             | Low         |
| 744 | South Africa; 2003-2004 | High    | Low                     | High           | High             | High        |
| 745 | China; 2010-2011     | Low          | Low                     | High           | Low              | Low         |
| 769 | China; 2016-2017     | Low          | Low                     | High           | Low              | Low         |
| 785 | China; 2012-2015     | Low          | Low                     | High           | Low              | Low         |
| 827 | China; 2014-2016     | Low          | High                    | Low            | Low              | Low         |
| 831 | China; 2008-2014     | Low          | Low                     | High           | Low              | Low         |
| 833 | China; 2006-2015     | Low          | Low                     | High           | High             | High        |
| 838 | China; 2017-2018     | Low          | Low                     | Low            | Low              | Low         |
| 841 | China; 2014-2017     | Low          | Low                     | High           | Low              | Low         |
| 843 | China; 2017          | High         | Low                     | High           | High             | High        |
| 847 | China; 2017          | High         | Low                     | High           | High             | Low         |
| ID  | Location: period | Study Design | Patient groups excluded | Case definition | Sampling strategy | Test method |
|-----|------------------|--------------|-------------------------|-----------------|------------------|-------------|
| 85  | Spain; 2004-2007 | Low          | Low                     | High            | Low              | Low         |
| c100 | China; 2012-2013 | Low          | Low                     | Low             | Low              | Low         |
| c112 | China; 2003-2006 | High         | Low                     | High            | Low              | High        |
| c12  | China; 2011-2012 | High         | Low                     | Low             | Low              | High        |
| c139 | China; 2012-2013 | High         | Low                     | High            | Low              | High        |
| c14  | China; 2011-2012 | High         | Low                     | High            | Low              | Low         |
| c143 | China; 2014      | High         | Low                     | High            | Low              | High        |
| c155 | China; 2014-2015 | High         | Low                     | High            | Low              | High        |
| c195 | China; 2011-2013 | High         | Low                     | High            | Low              | High        |
| c203 | China; 2013-2014 | High         | Low                     | Low             | Low              | High        |
| c213 | China; 2011      | High         | Low                     | High            | Low              | High        |
| c231 | China; 2009-2012 | High         | Low                     | High            | Low              | High        |
| c233 | China; 2000      | High         | Low                     | Low             | Low              | High        |
| c235 | China; 2014-2015 | High         | Low                     | High            | Low              | High        |
| c283 | China; 2013-2014 | Low          | Low                     | High            | Low              | Low         |
| c287 | China; 2014      | Low          | High                    | Low             | Low              | High        |
| c290 | China; 2014-2015 | High         | High                    | Low             | Low              | High        |
| c293 | China; 2015      | High         | Low                     | High            | Low              | Low         |
| c294 | China; 2015      | High         | Low                     | High            | Low              | High        |
| c295 | China; 2016      | High         | Low                     | High            | Low              | High        |
| c296 | China; 2013-2015 | High         | Low                     | High            | Low              | High        |
| c297 | China; 2015-2016 | High         | Low                     | High            | Low              | High        |
| c299 | China; 2009-2010 | Low          | Low                     | Low             | Low              | Low         |
| c300 | China; 2001-2002 | Low          | High                    | Low             | Low              | High        |
| c301 | China; 2006-2007 | Low          | High                    | Low             | Low              | High        |
| c302 | China; 2003-2006 | Low          | Low                     | Low             | Low              | High        |
| c303 | China; 2012-2013 | Low          | Low                     | Low             | Low              | Low         |
| c304 | China; 2013      | High         | Low                     | Low             | Low              | High        |
| c305 | China; 2010-2011 | Low          | Low                     | Low             | Low              | Low         |
| c311 | China; 1994-1997 | High         | Low                     | Low             | Low              | High        |
| c312 | China; 2007-2009 | High         | Low                     | High            | Low              | High        |
| c313 | China; 1996-1997 | Low          | High                    | Low             | Low              | High        |
| c314 | China; 2005-2007 | Low          | Low                     | Low             | Low              | High        |
| c315 | China; 2001-2003 | High         | Low                     | Low             | Low              | High        |
| c36  | China; 2013-2014 | Low          | Low                     | Low             | Low              | Low         |
| c362 | China; 2016-2017 | Low          | High                    | Low             | Low              | Low         |
| c44  | China; 2009-2012 | Low          | Low                     | Low             | Low              | Low         |
| c47  | China; 2010      | High         | Low                     | Low             | Low              | Low         |
| c59  | China; 2005-2006 | High         | Low                     | Low             | Low              | High        |
| c61  | China; 2013-2014 | High         | Low                     | High            | Low              | High        |
| c83  | China; 2006-2010 | High         | Low                     | Low             | Low              | High        |
| c87  | China; 2013-2014 | Low          | Low                     | Low             | Low              | High        |
| c95  | China; 2007      | High         | Low                     | Low             | Low              | High        |
| c97  | China; 2011-2012 | High         | Low                     | Low             | Low              | High        |
| up_10 | Philippines; 2014-2016 | Low  | Low                     | Low             | Low              | Low         |
| ID   | Location: period                      | Study Design | Patient groups excluded | Case definition | Sampling strategy | Test method |
|------|--------------------------------------|--------------|-------------------------|-----------------|-------------------|-------------|
| up_11| Philippines; Sep 2012-Jul 2016       | Low          | Low                     | Low             | Low               | Low         |
| up_12| Philippines; Sep 2012-Feb 2015       | Low          | Low                     | Low             | Low               | Low         |
| up_13| Philippines; Aug 2012-Feb 2015       | Low          | Low                     | Low             | Low               | Low         |
| up_14| Kenya; 2007-2017                      | Low          | Low                     | Low             | High              | Low         |
| up_15| Viet Nam; 2007-2016                  | Low          | Low                     | Low             | Low               | Low         |
| up_16| Argentina; Jun 2008-Dec 2010         | Low          | High                    | High            | Low               | High        |
| up_17| Philippines; 2000-2004                | Low          | Low                     | Low             | Low               | Low         |
| up_18| Jordan; Mar 2010-Mar 2013             | Low          | Low                     | Low             | Low               | Low         |
| up_19| Bangladesh; 2010-2014                 | Low          | Low                     | Low             | High              | Low         |
| up_20| Bangladesh; Jan 2012 - Dec 2013      | Low          | High                    | Low             | Low               | Low         |
| up_21| Gambia; 2012-2013                     | Low          | High                    | Low             | Low               | Low         |
| up_22| Zambia; Oct 2011 - Oct 2014           | Low          | High                    | Low             | Low               | Low         |
| up_23| Thailand; Jan 2012-Dec 2013           | Low          | High                    | Low             | Low               | Low         |
| up_24| South Africa; Aug 2011 - Aug 2013     | Low          | High                    | Low             | Low               | Low         |
| up_25| Thailand; Jan 2012-Dec 2013           | Low          | High                    | Low             | Low               | Low         |
| up_26| Bangladesh; Jan 2012 - Dec 2013      | Low          | High                    | Low             | Low               | Low         |
| up_27| Kenya; Aug 2011 - Nov 2011            | Low          | High                    | Low             | Low               | Low         |
| up_28| Mali; Jan 2012 - Jan 2014             | Low          | High                    | Low             | Low               | Low         |
| up_29| Morocco; Nov 2010-Dec 2011            | Low          | High                    | Low             | Low               | Low         |
| up_3 | Argentina; 2000-2017                  | Low          | Low                     | Low             | Low               | High        |
| up_30| Mozambique; 2011-2014                 | Low          | Low                     | Low             | Low               | Low         |
| up_31| Chile; 2012-2013                      | Low          | Low                     | Low             | Low               | High        |
| up_32| Chile; 2012-2013                      | Low          | Low                     | Low             | Low               | High        |
| up_33| Iran (Islamic Republic of); 2008-2009 | High         | Low                     | High            | High              | Low         |
| up_34| Iran (Islamic Republic of); 2017      | High         | Low                     | High            | Low               | Low         |
| up_35| Iran (Islamic Republic of); Sep 2012- Sep 2013 | High     | Low                     | High            | Low               | Low         |
| up_36| Iran (Islamic Republic of); Jan 2003 to Jan 2004 | High       | Low                     | High            | Low               | High        |
| up_37| Iran (Islamic Republic of); Oct 1998-Oct 2000 | High       | Low                     | High            | Low               | Low         |
| up_38| South Africa; 1998-2005               | Low          | High                    | Low             | Low               | High        |
| up_4 | Bangladesh; 2013-2014                 | Low          | Low                     | Low             | High              | Low         |
| up_40| South Africa; 2012-2017               | Low          | Low                     | Low             | Low               | Low         |
| up_42| Nepal; Jan 2006-Jan 2008              | Low          | High                    | Low             | Low               | Low         |
| up_5 | South Africa; 2010-2015               | Low          | Low                     | Low             | Low               | Low         |
| up_6 | South Africa; 2010-2015               | Low          | Low                     | Low             | Low               | Low         |
| up_8 | Germany; Jan 2010-Dec 2014            | Low          | Low                     | Low             | Low               | Low         |
| ID  | Location: period                     | Study Design | Patient groups excluded | Case definition | Sampling strategy | Test method |
|-----|-------------------------------------|--------------|-------------------------|-----------------|-------------------|-------------|
| up_9 | Philippines; May 2008-Feb 2015      | Low          | Low                     | Low             | Low               | Low         |
| 865  | Taiwan; 2010-2013                   | Low          | High                    | High            | High              | Low         |
| 874  | South Korea (Republic of Korea); 2010-2015 | High        | Low                     | Low             | High              | Low         |
| 875  | China; 2017-2018                    | High         | High                    | High            | High              | High        |
| 886  | China; 2008-2017                    | High         | Low                     | Low             | High              | High        |
| ID  | Location; period       | Study Design | Patient groups excluded | Case definition | Sampling strategy |
|-----|------------------------|--------------|-------------------------|----------------|-------------------|
| 104 | Brazil; 2008-2010      | Low          | Low                     | High           | Low               |
| 148 | Cambodia; 2007-2010    | Low          | High                    | Low            | High              |
| 263 | Thailand; 2003-2007    | Low          | Low                     | High           | High              |
| 284 | Brazil; 2005-2007      | Low          | High                    | Low            | High              |
| 329 | USA; 2005-2007         | Low          | Low                     | High           | High              |
| 368 | Chile; 2001-2004       | High         | Low                     | Low            | High              |
| 406 | India; 2002-2004       | Low          | Low                     | High           | Low               |
| 438 | Mali; 2011-2012        | Low          | High                    | Low            | Low               |
| 458 | South Africa; 2009-2014| Low          | Low                     | Low            | Low               |
| 459 | South Africa; 2010-2013| Low          | Low                     | Low            | Low               |
| 462 | Viet Nam; 2004-2008    | Low          | High                    | High           | Low               |
| 463 | Viet Nam; 2009-2010    | Low          | High                    | Low            | High              |
| 480 | Spain; 1994-2000       | Low          | Low                     | High           | High              |
| 492 | Turkey; 2006-2007      | Low          | High                    | High           | Low               |
| 51  | India; 2009-2011       | Low          | Low                     | High           | Low               |
| 519 | Republic of Korea; 1994-1998| High      | Low                     | High           | High              |
| 64  | Argentina; 1993-1994   | Low          | High                    | Low            | Low               |
| 696 | Tunisia; 2013-2014     | High         | High                    | High           | High              |
| 736A| Egypt; 2007-2014       | Low          | Low                     | High           | High              |
| 736B| Jordan; 2008-2010      | Low          | Low                     | High           | High              |
| 736C| Oman; 2008-2009        | Low          | Low                     | High           | High              |
| 736D| Qatar; 2008-2009       | Low          | Low                     | High           | High              |
| 736E| Yemen; 2010-2014       | Low          | Low                     | High           | High              |
| 738 | Mozambique; 2006-2007   | Low          | Low                     | Low            | Low               |
| 78  | China; 2003-2006       | Low          | High                    | High           | Low               |
| 801 | Brazil; 1990-2017      | Low          | Low                     | High           | Low               |
| c310| China; 2009-2010       | Low          | High                    | High           | Low               |
| up_10| Philippines; 2014-2016 | Low          | Low                     | Low            | Low               |
| up_11| Philippines; Sep 2012-Jul 2016| Low      | Low                     | Low            | Low               |
| up_12| Philippines; Sep 2012-Feb 2015| Low     | Low                     | Low            | Low               |
| up_13| Philippines; Aug 2012-Feb 2015| Low    | Low                     | Low            | Low               |
| up_14| Kenya; 2007-2017       | Low          | Low                     | Low            | High              |
| up_16| Argentina; Jun 2008-Dec 2010 | Low | High                    | High           | Low               |
| up_17| Philippines; 2000-2004 | Low          | High                    | Low            | Low               |
| up_18| Jordan; Mar 2010-Mar 2013| Low       | Low                     | Low            | Low               |
| up_19| Bangladesh; 2010-2014  | Low          | Low                     | High           | Low               |
| up_20| Bangladesh; Jan 2012-Dec 2013| Low  | High                    | Low            | Low               |
| up_21| Gambia; 2012-2013      | Low          | High                    | Low            | Low               |
| up_22| Zambia; Oct 2011 - Oct 2014| Low       | High                    | Low            | Low               |
| up_23| Thailand; Jan 2012-Dec 2013| Low    | High                    | Low            | Low               |
| up_24| South Africa; Aug 2011 - Aug 2013| Low | High                    | Low            | Low               |
| up_25| Thailand; Jan 2012-Dec 2013| Low    | High                    | Low            | Low               |
| Code | Country                  | Start Date              | End Date     | Low  | High | Low  | Low  |
|------|--------------------------|-------------------------|--------------|------|------|------|------|
| up_26| Bangladesh; Jan 2012 - Dec 2013 | Low                     | High         | Low  | Low  |
| up_27| Kenya; Aug 2011 - Nov 2011 | Low                     | High         | Low  | Low  |
| up_28| Mali; Jan 2012 - Jan 2014 | Low                     | High         | Low  | Low  |
| up_29| Morocco; Nov 2010-Dec 2011 | Low                     | High         | Low  | Low  |
| up_3 | Argentina; 2000-2017     | Low                     | Low          | Low  | Low  |
| up_30| Mozambique; 2011-2014     | Low                     | Low          | Low  | Low  |
| up_31| Chile; 2012-2013          | Low                     | Low          | Low  | Low  |
| up_32| Chile; 2012-2013          | Low                     | Low          | Low  | Low  |
| up_38| South Africa; 1998-2005   | Low                     | High         | Low  | Low  |
| up_40| South Africa; 2012-2017   | Low                     | Low          | Low  | Low  |
| up_5 | South Africa; 2010-2015   | Low                     | Low          | Low  | Low  |
| up_6 | South Africa; 2010-2015   | Low                     | Low          | Low  | Low  |
| up_7 | USA; 2010-2016            | Low                     | Low          | Low  | High |
| up_8 | Germany; Jan 2010-Dec 2014| Low                     | Low          | Low  | Low  |
| up_9 | Philippines; May 2008-Feb 2015 | Low                     | Low          | Low  | Low  |
| 861  | Jordan; Jan-Apr 2016      | Low                     | Low          | High | Low  |
### Appendix 13. Details of individual studies

Table S13.1 Glossary of abbreviations used in this section

| Abbreviation | Full name                                      |
|--------------|-----------------------------------------------|
| ALRI         | acute lower respiratory infection             |
| APAAP        | alkaline phosphatase and monoclonal anti–alkaline phosphatase |
| ARI          | acute respiratory infection                   |
| BAL          | bronchoalveolar lavage                        |
| DFA          | Direct fluorescent antibody test              |
| EIA          | enzyme immunoassay                            |
| ELISA        | enzyme-linked immunosorbent assay             |
| hPIV         | human parainfluenza virus                     |
| IFA          | indirect immunofluorescence assay             |
| m            | month(s)                                      |
| NA           | Not applicable                                |
| NPA          | nasopharyngeal aspirate                       |
| NPS          | nasopharyngeal swab                           |
| NPW          | nasopharyngeal wash                           |
| NS           | nasal swab                                    |
| NW           | Nasal wash                                    |
| OP specimen  | oropharyngeal specimen                        |
| OPS          | oropharyngeal swab                            |
| PCR          | polymerase chain reaction                     |
| TS           | throat swab                                   |
Figure S13.1. Location of included studies with data on human parainfluenza virus-associated incidence rates, hospital admission rates, proportion, and in-hospital case-fatality ratios.
Figure S13.2 Forest plot of hospital admission rates of hPIV-ALRI for age 0-5 months for low child mortality settings (above) and high child mortality settings (below).

| Study                          | Case | Rate/1,000 and 95%CI       | Rate/1,000 and 95%CI       |
|-------------------------------|------|-----------------------------|-----------------------------|
| Jordan; Mar 2010-Mar 2013     | 51   | 0.8 (0.6-1.1)               |                             |
| Argentina; Jun 2008-Dec 2010  | 1    | 3 (0.4-21.3)                |                             |
| USA; 2000-2004                | 66   | 3.4 (2.7-4.4)               |                             |
| Thailand; 2005-2010           | 28   | 4 (2.8-5.8)                 |                             |
| Spain; 2004-2007              | 26   | 4.5 (3.1-6.7)               |                             |
| Nunavut; 1997-1998            | 1    | 8.9 (1.3-60.6)              |                             |
| China; 2003-2006              | 14   | 12.5 (7.4-21.1)             |                             |
| Overall (I²=93.6%; P<0.000)  |      | 3.6 (1.8-7)                 |                             |

Figure S13.3 Forest plot of hospital admission rates of hPIV-ALRI for age 6-11 months for low child mortality settings (above) and high child mortality settings (below).

| Study                          | Case | Rate/1,000 and 95%CI       | Rate/1,000 and 95%CI       |
|-------------------------------|------|-----------------------------|-----------------------------|
| Bangladesh; 2013-2014         | 1    | 0.8 (0.1-5.4)               |                             |
| Mozambique; 2011-2014         | 16   | 3.5 (2.1-5.7)               |                             |
| South Africa; 2010-2015       | 67   | 3.7 (2.9-4.6)               |                             |
| South Africa; 2010-2015       | 42   | 3.9 (2.9-5.3)               |                             |
| Kenya; 2007-2017              | 106  | 5 (4.1-6)                   |                             |
| South Africa; 1998-2005       | 40   | 5.7 (4.2-7.7)               |                             |
| Gambia; 2012-2013             | 50   | 7.6 (5.8-10)                |                             |
| Philippines; 2014-2016        | 3    | 9.1 (2.9-27.8)              |                             |
| Philippines; 2000-2004        | 35   | 11.9 (8.5-16.5)             |                             |
| South Africa; 2012-2017       | 15   | 30.1 (18.2-49.3)            |                             |
| Overall (I²=94.3%; P<0.000)  |      | 5.8 (3.7-9.2)               |                             |

Figure S13.4 Forest plot of hospital admission rates of hPIV-ALRI for age 6-11 months for low child mortality settings (above) and high child mortality settings (below).
Figure S13.4 Forest plot of hospital admission rates of hPIV-ALRI for age 12-59 months for low child mortality settings (above) and high child mortality settings (below).

Figure S13.5 Forest plot of community incidence rates of hPIV-ALRI for age 0-59 months in high child mortality settings. Note: the pooled estimate differed from that in main Table 1 as only the 5 non-imputed studies were included here. The remaining 3 studies were imputed using a multiple imputation method, so were not presented in this figure.
Figure S13.6 Funnel plots for hospital admission rates of hPIV-ALRI for ages 0-5 months (above), 6-11 months (middle) and 12-59 months (below).
Figure S13.7 Funnel plot of community incidence rates of hPIV-ALRI for 0-59 months. Note: only non-imputed studies were presented in this plot. The remaining 4 studies were imputed using a multiple imputation method, and were not presented in this plot.
Table S13.2. Description of included studies reporting incidence rates of hPIV-associated ALRI cases in children younger than five years (13 studies)*

| Location (reference) | Case Definition | Denominator type | Specimen and test | Incidence rates (per 1,000 children per year) | Published references (for unpublished data) |
|----------------------|----------------|------------------|-------------------|---------------------------------------------|---------------------------------------------|
| Ballabgarh, India (2001–2005) (Broor et al. 2007) 26 | ALRI | Defined population base | NPA; DFA | 80.4 | -- | -- | -- | -- |
| Navajo and White Mountain Apache, USA (2009) (Bhat et al. 2013) 27 | ALRI | Defined population base | Nasal wash; PCR | -- | -- | -- | -- | -- |
| Faridabad, India (Aug 2012–Aug 2014) (Krishnan and colleagues, unpublished) | ALRI | Census derived estimate | OP and nasal specimens; PCR | 45.5 | 90 | 46.2 | 11.9 | 29.4 | 22 |
| Oshikhandass, Pakistan (Dec 2012–Dec 2013) (Rasmussen and colleagues, unpublished) | ALRI | Defined population base | NPS; PCR | 0 | 15.9 | 46.2 | 9.2 | 17.3 | 25 |
| Kamalapur, Bangladesh (2013–2014) (Brooks and colleagues, unpublished) | ALRI | Defined population base | NPW; PCR | 11.5 | 59.8 | 92.1 | 45.2 | 39.5 | 24 |
| Paarl, South Africa (Jun 2012–Dec 2017) (Zar and colleagues, unpublished) | ALRI | Defined population base | NPS; PCR | 91.6 | 70.4 | 52.8 | 18 | 43.1 | 25 |
| Bhaktapur, Nepal (2004–2007) (Strand and colleagues, unpublished) | ALRI | Defined population base | NPA; PCR | 64.3 | 81.4 | 53.6 | -- | -- | 26 |
| Nashville, USA (1976–2001) (Williams et al. 2004) 27 | ALRI; croup | Defined population base | NW; Culture | -- | -- | -- | -- | -- | 18.8 |
| Mirzapur, Bangladesh (1993–1994) 28 | ALRI | Defined population base | NPA; ELISA | -- | -- | -- | -- | -- |
| Brisbane, Australia (2010–2014) (Sarna et al. 2018) 29 | ALRI | Defined population base | NS; PCR | -- | -- | -- | -- | -- |
| Perth, Australia (1996–1999) (Kusel et al. 2006) 30 | ALRI | Defined population base | NPA; PCR | -- | -- | -- | -- | -- |
| Barcelona, Spain (1996–1999) (Puig et al. 2008) | ALRI; croup | Defined population base | NPA; Culture with IFA | -- | -- | -- | -- | -- |
| Kamalapur, Dhaka, Bangladesh (2004–2008) (Havers, et al. 2019) 31 | ALRI | Defined population base | NPW; PCR | 248.7 | 123.0 | 64.8 | 7.3 | 27.4 | -- |

* ALRI: acute lower respiratory infections according to 2005 WHO IMCI. NP specimens: nasopharyngeal specimens. OP specimens: oropharyngeal specimens. NS: nasal swab. TS: throat swab. NPA: nasopharyngeal aspirate. NPS: nasopharyngeal swab. NPW: nasopharyngeal wash. NW: nasal wash. IFA: indirect immunofluorescence assay. DFA: direct immunofluorescence assay. PCR: polymerase chain reaction.

† Some of the studies had no data presented as they reported data for other age bands (eg, 0–23 months).
Table S13.3. Description of included studies reporting incidence rates of hPIV-associated severe ALRI cases in children younger than five years (5 studies)*

| Location (reference)                                                                 | Case Definition | Denominator type | Specimen and test | Incidence rates per 1,000 children per year | Published references (for unpublished data) |
|-------------------------------------------------------------------------------------|-----------------|------------------|-------------------|---------------------------------------------|---------------------------------------------|
| Karachi, Pakistan (2011–2014) (Ali et al. 2016)25                                    | sALRI           | Defined population base | NPS; PCR           | 72.7 -- -- -- --                           |                                             |
| Ballabgarh, India (2001–2005) (Broor et al. 2007)26                                  | sALRI           | Defined population base | NPA; DFA           | -- -- 8.7 -- --                           |                                             |
| Faridabad, India (Aug 2012–Aug 2014) (Krishnan and colleagues, unpublished)         | sALRI           | Census derived estimate | OP and nasal specimens; PCR | 25.3 58.8 29.7 9.1 19.6 22               |                                             |
| Kamalapur, Bangladesh (2013–2014) (Brooks and colleagues, unpublished)              | sALRI           | Defined population base | NPW; PCR           | 0.6 5.4 0 2.2 1.6 24                      |                                             |
| Paarl, South Africa (Jun 2012–Dec 2017) (Zar and colleagues, unpublished)           | sALRI           | Defined population base | NPS; PCR           | 76.9 58 29.9 10.2 30.4 25                 |                                             |

*sALRI: severe acute lower respiratory infections (with chest wall indrawing and danger signs) according to 2005 WHO IMCI. OP specimens: oropharyngeal specimens. NPA: nasopharyngeal aspirate. NPS: nasopharyngeal swab. NPW: nasopharyngeal wash. DFA: direct immunofluorescence assay. PCR: polymerase chain reaction.
Table S13.4. Description of included studies reporting hospital admission rates of hPIV-associated ALRI cases in children younger than five years (38 studies)*

| Location (reference)                      | Case Definition                | Denominator type       | Specimen and test                                      | Hospital admission rates per 1,000 children per year | Published references (for unpublished data) |
|------------------------------------------|--------------------------------|------------------------|--------------------------------------------------------|-----------------------------------------------------|---------------------------------------------|
| Sa Kaeo and Nakhon Phanom, Thailand (2005–2010) (Hasan et al. 2014) | ARI                           | Census derived estimate | NPS and serum specimens; PCR, serologic test and culture | 3.6 - - - 3.2 5.5 - - - - |                                             |
| Memphis, Nashville, and Salt Lake City (EPIC), USA (2010–2012) (Jain et al. 2015) | ALRI                          | Census derived estimate | NPS and OPS; PCR and serologic test                      | - - - - 0.2 0.2 - - - - |                                             |
| Iqaluit, Nunavut (1997–1998) (Banerji et al. 2001) | ALRI                          | Census derived estimate | NPA; IFA                                               | 8.9 - - - - - - - - |                                             |
| NVSN sites, USA (2000–2004) (Weinberg et al. 2009) | Fever; ARI                   | Census derived estimate | NS and TS; PCR                                         | 3 1.7 1.5 0.4 1 - - - - |                                             |
| Haryana, India (2009–2011) (Broor et al. 2014) | ARI                           | Census derived estimate | NS and TS; PCR                                         | - - - - - - - 0.7 - - - - |                                             |
| Kakuma and Dadaab, Kenya (2007–2010) (Ahmed et al. 2012) | ALRI                          | Census derived estimate | NPS and OPS; PCR                                       | - - - - 6.2 - - - - |                                             |
| Kiel, Germany (1996–2000) (Weigl et al. 2005) | ALRI; croup                   | Census derived estimate | NPA; PCR                                               | - - - - 0.5 - - - - |                                             |
| Navajo and White Mountain Apache, USA (2009) (Bhat et al. 2013) | ALRI                          | Defined population base | NW; PCR                                                | - - - - - - - - - - |                                             |
| PYNEH and QMH, Hong Kong (2003–2006) (Chiu et al. 2010) | ARI–Fever                    | Census derived estimate | NPA; DFA and culture                                    | 10.8 7.2 9.9 4.8 6.6 - - - - |                                             |
| Gipuzkoa, Spain (2004–2007) (Cilla et al. 2009) | ARI; ARI–Fever               | Census derived estimate | NPA; PCR and culture                                    | 4 3.2 1.2 - - - - - - |                                             |
| Kawayan and Calibiran, Philippines (2014–2016) (Oshitani and colleagues, unpublished) | ALRI                          | Defined population base | NPS; PCR                                               | 9.1 10.9 0 1.2 2.4 - - - - - |                                             |
| Kilifi, Kenya (2007–2017) (Nokes and colleagues, unpublished) | ALRI                          | Census derived estimate | NPS; PCR                                               | 5 3.9 1.6 0.4 1.5 - - - - - |                                             |
| Nha Trang city, Viet Nam (2007–2016) (Yoshida and colleagues, unpublished) | ALRI                          | Census derived estimate | NPS; PCR                                               | - - 1.6 0.2 0.8 - - - - - |                                             |
| Buenos Aires, Argentina (Jun 2006–Dec 2010) (Echavarria and colleagues, unpublished) | ALRI                          | Defined population base | NPA; IFA                                               | 3 1 - - - - - - 2.2 - - - - |                                             |
| multiple areas, Philippines (Jul 2000–Dec 2004) (Lucero and colleagues, unpublished) | ALRI                          | Defined population base | Blood, NPS and NPA; serum and culture                  | 11.9 7.8 2.3 - - - - - - |                                             |

* ARI: acute respiratory infections requiring hospital admission. ALRI: physician diagnosed acute lower respiratory infections requiring hospital admission. ARI–Fever: hospitalised acute respiratory infections with fever. NS: nasal swab. TS: throat swab. NW: nasal wash. PCR: polymerase chain reaction. NPA: nasopharyngeal aspirate. NPS: nasopharyngeal swab. OPS: oropharyngeal swab. NPW: nasopharyngeal wash. DFA: direct immunofluorescence assay. IFA: indirect immunofluorescence assay. PCR: polymerase chain reaction. IF: immunofluorescence.
| Location (reference) | Case Definition | Denominator type | Specimen and test | Hospital admission rates per 1,000 children per year | Published references (for unpublished data) |
|----------------------|-----------------|------------------|-------------------|---------------------------------------------------|--------------------------------------------|
| Amman, Jordan (Mar 2010–Mar 2013) (Khuri-Bulos and colleagues, unpublished) | ALRI | Census derived estimate | NS and TS; PCR | 0.7 0.5 0.3 .. .. | 47 |
| Basse, Gambia (2012–2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NPS/OPS, Induced sputum; PCR | 7.6 5.8 1.6 0.5 2 | 11 |
| Nakhon Phanom, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NP/OP and induced sputum; PCR | .. .. 0.3 0.1 0.3 | 11 |
| Sa Kaeo, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NP/OP and induced sputum; PCR | .. .. 0.7 0.1 0.5 | 11 |
| Basse, Gambia (2012–2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NPS/OPS, Induced sputum; PCR | 7.6 5.8 1.6 0.5 2 | 11 |
| Nakhon Phanom, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NP/OP and induced sputum; PCR | .. .. 0.3 0.1 0.3 | 11 |
| Sa Kaeo, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NP/OP and induced sputum; PCR | .. .. 0.7 0.1 0.5 | 11 |
| Buenos Aires, Argentina (2000–2017) (Gentile and colleagues, unpublished) | ALRI | Defined population base | NPA; IFA | 5 3.3 0.9 0.1 1 | 50 |
| Manhiça, Mozambique (Jan 2011–Jul 2014) (Bassat and colleagues, unpublished) | ALRI | Defined population base | NPA; PCR | 3.5 2.3 0.8 0.2 0.9 | 11 |
| Iquique, Chile (2012–2013) (Fasce and colleagues, unpublished) | ALRI | Census derived estimate | NPA; IF | .. .. .. 0.4 0.2 0.4 | 49 |
| Concepcion, Chile (2012–2013) (Fasce and colleagues, unpublished) | ALRI | Census derived estimate | NPA; IF | .. .. 0.4 0.2 0.4 | 49 |
| Soweto, South Africa (Mar 1998–Oct 2005) (Madhi and colleagues, unpublished) | ALRI | Defined population base | NPA; IFA | 5 3.3 0.9 0.1 1 | 50 |
| Kamalaipur, Bangladesh (2013–2014) (Brooks and colleagues, unpublished) | ALRI | Defined population base | NPA; PCR | 3.4 2.8 1.4 0.3 1.1 | 51 |
| Paarl, South Africa (Jun 2012–Dec 2017) (Zar and colleagues, unpublished) | ALRI | Defined population base | NPA; PCR | 3.4 2.8 1.4 0.3 1.1 | 51 |
| Klerksdorp, South Africa (2010–2015) (Cohen and colleagues, unpublished) | ALRI | Census derived estimate | NPA; PCR | 3.4 2.8 1.4 0.3 1.1 | 51 |
| Pietermaritzburg, South Africa (2010–2015) (Cohen and colleagues, unpublished) | ALRI | Census derived estimate | NPA; PCR | 3.2 2.3 0.9 0.2 0.9 | 51 |
| Hamburg, Dresden, Freiburg, Bochum, Germany (1999–2001) (Forster et al. 2004) | ALRI; croup | Defined population base | NP secretion; PCR | .. .. .. .. .. | 52 |
| Suzhou, China (2007–2008) (Ji et al. 2010) | ALRI | Census derived estimate | Nasal aspirate; DFA | .. .. .. 0.6 .. | 53 |
| Sioux Lookout, Ontario, Canada (2007–2012) (McCuske et al. 2014) | ALRI | Census derived estimate | ..; immunochromatography assay and culture (all tested by culture) | .. .. .. .. .. | 54 |
| Severo Ochoa Hospital, Madrid, Spain (2011–2012) (Olabarrieta et al. 2015) | ALRI | Defined population base | NPA; PCR | .. .. .. .. .. | 55 |
| Manhica, Mozambique (2006–2007) (O’Callaghan-Gordo et al. 2011) | ALRI | Census derived estimate | NPA; PCR | .. .. .. 1.5 .. | 56 |
| Location (reference)                                                                 | Case Definition | Denominator type          | Specimen and test | Hospital admission rates per 1,000 children per year | Published references (for unpublished data) |
|-----------------------------------------------------------------------------------|----------------|---------------------------|-------------------|-------------------------------------------------|------------------------------------------|
| Asembo, Kenya (2007–2010) (Feikin et al. 2013)                                    | ALRI           | Census derived estimate   | NPS or OPS; PCR   | 0–5 m: -- 6–11 m: -- 12–23 m: -- 24–59 m: -- 0–59 m: 30 | 1953                                    |
| multiple areas, Bangladesh (2010–2014) (Homaira and colleagues, unpublished)     | ARI–Fever; ALRI | Census derived estimate   | NS and TS; PCR    | 0–5 m: -- 6–11 m: -- 12–23 m: -- 24–59 m: -- 0–59 m: 1.4 | 1953                                    |
| Basse, the Gambia (2015) (Mackenzie, et al. 2019)                                 | ALRI           | Census derived estimate   | NPS and OPS; PCR  | 0–5 m: -- 6–11 m: -- 12–23 m: -- 24–59 m: -- 0–59 m: 9.0 | 1953                                    |
| Taiwan (2010-2013) (Chi et al. 2020)                                              | ALRI           | Census derived estimate   | NPS; PCR          | 0–5 m: -- 6–11 m: -- 12–23 m: -- 24–59 m: -- 0–59 m: 0.09 | 1953                                    |
| Brisbane, Australia (2010-2014) (Saha et al, 2020)                                | ALRI           | Defined population base   | NS; PCR           | 0–5 m: -- 6–11 m: -- 12–23 m: -- 24–59 m: -- 0–59 m: -- | 1953                                    |
Table S13.5. Description of included studies reporting hCFRs (%) of hPIV-associated ALRI cases in children younger than five years (58 studies)†

| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m | Published references (for unpublished data) |
|----------------------|-----------------|-------------------|-------|-------|---------|-------|---------------------------------------------|
| São Paulo city, Brazil (2008–2010) (Durigon et al. 2015)52 | ARI–Fever; ARI | NPA; PCR | -- | -- | -- | -- | -- |
| Takeo Province and Kampong Cham Province, Cambodia (2007–2010) (Guerrier et al. 2013)53 | ALRI | NPA; PCR | -- | -- | -- | -- | 51 | 0 |
| Sa kaeo, Nakhon Phanom, Thailand (2003–2007) (Morgan et al. 2013)54 | ARI | NPS and serum specimen; PCR, serologic test and culture | -- | -- | -- | -- | 370 | 0 |
| São Paulo city, Brazil (2005–2007) (Pecchini et al. 2015)55 | ARI–Fever; ARI | NP secretion; IFA | -- | -- | -- | -- | 45 | 8.9 |
| Yukon Kuskokwim Delta, USA (2005–2007) (Singleton et al. 2010)56 | ALRI | NP specimens; PCR | -- | -- | -- | -- | -- | -- |
| Santiago, Chile (2001–2004) (Vega-Briceño et al. 2007)57 | ALRI | NPS; DFA | -- | -- | -- | -- | -- | -- |
| Pune, India (2002–2004) (Yeolekar et al. 2008)58 | ARI | NPA; IFA | -- | -- | -- | -- | -- | -- |
| Bamako, Mali (2011–2012) (Benet et al. 2015)59 | ALRI | NS; PCR | -- | -- | -- | -- | 13 | 15.4 |
| multi sites, South Africa (2009–2014) (Cohen et al. 2015)60 | ALRI | NPA; PCR | -- | -- | -- | -- | 952 | 1.6 |
| multi sites, South Africa (2010–2013) (Cohen et al. 2016)61 | ALRI | NPA; PCR | 226 | 2.7 | -- | -- | -- | -- |
| Ho Chi Minh City, Vietnam (2004–2008) (Do et al. 2011)2 | ARI | NS, TS, and NPA; PCR | -- | -- | -- | -- | 19 | 0 |
| Ho Chi Minh City, Vietnam (2009–2010) (Do et al. 2016)2 | ARI | NPS; PCR | -- | -- | -- | -- | -- | -- |
| Madrid, Spain (1994–2000) (García García et al. 2001)74 | ALRI; croup | NP secretions; IFA | -- | -- | -- | -- | -- | -- |

* ARI: hospitalised acute respiratory infections. ALRI: physician diagnosed acute lower respiratory infections requiring hospital admission. ARI–Fever: hospitalised acute respiratory infections with fever. NS: nasal swab. TS: throat swab. NW: nasal wash. PCR: polymerase chain reaction. NPA: nasopharyngeal aspirate. NPS: nasopharyngeal swab. OPS: oropharyngeal swab. NPW: nasopharyngeal wash. IFA: indirect immunofluorescence assay. DFA: direct immunofluorescence assay. IF: immunofluorescence. EIA: enzyme immunoassay. ELISA: enzyme-linked immunosorbent assay. BAL: bronchoalveolar lavage. APAAP: alkaline phosphatase and monoclonal anti-alkaline phosphatase.

† :: not available. Some included studies did not provide data for 0-5 m, 6-11 m, 12-59 m, or 0-59 m while provided data for other age groups (e.g., 0-23 m).
| Location (reference)                                                                                                                                                                                                 | Case definition | Specimen and test | Cases (No.) | hCFR (%) | Cases (No.) | hCFR (%) | Cases (No.) | hCFR (%) | Cases (No.) | hCFR (%) | Published references (for unpublished data) |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------|-------------|---------|-------------|---------|-------------|---------|-------------|---------|---------------------------------------------|
| Istanbul, Turkey (2006–2007) (Hatipoglu et al. 2011)                                                                                                                                                                    | ALRI–Fever; ALRI| NPS; DFA         | --          | --      | --          | --      | --          | --      | --          | --      | --                                                                                     |
| Haryana, India (2009–2011) (Broor et al. 2014)                                                                                                                                                                        | ARI             | NS and TS; PCR    | --          | --      | --          | --      | --          | --      | 10          | 0       | --                                                                                     |
| multiple sites, Korea (1994–1998) (Kim et al. 2011)                                                                                                                                                                   | ALRI; croup     | NPA; IFA          | --          | --      | --          | --      | --          | --      | --          | --      | --                                                                                     |
| Bueno Aires, Cordoba, Santa Fe, Mar del Plata, Argentina (1993–1994) (Carballal et al. 2001)                                                                                                                                 | ALRI            | NPA; DFA          | --          | --      | --          | --      | --          | --      | 27          | 0       | --                                                                                     |
| Sousse area, Tunisia (2013–2014) (Brini et al. 2017)                                                                                                                                                                  | ARI             | NPA; PCR          | --          | --      | --          | --      | --          | --      | 44          | 15.9    | --                                                                                     |
| Egypt (2007–2014) (Horton et al. 2017)                                                                                                                                                                                   | ARI             | NPS and OPS; PCR  | --          | --      | --          | --      | 151         | 1.3     | 335         | 3.6     | --                                                                                     |
| Jordan (2008–2010) (Horton et al. 2017)                                                                                                                                                                                    | ARI             | NPS and OPS; PCR  | --          | --      | --          | --      | 25          | 0       | 58          | 1.7     | --                                                                                     |
| Oman (2008–2009) (Horton et al. 2017)                                                                                                                                                                                    | ARI             | NPS and OPS; PCR  | --          | --      | --          | --      | 23          | 0       | 40          | 0       | --                                                                                     |
| Qatar (2008–2009) (Horton et al. 2017)                                                                                                                                                                                     | ARI             | NPS and OPS; PCR  | --          | --      | --          | --      | 1           | 0       | 2           | 0       | --                                                                                     |
| Yemen (2010–2014) (Horton et al. 2017)                                                                                                                                                                                   | ARI             | NPS and OPS; PCR  | --          | --      | --          | --      | 21          | 0       | 64          | 1.6     | --                                                                                     |
| Manhica, Mozambique (2006–2007) (O’Callaghan-Gordo et al. 2011)                                                                                                                                                    | ALRI            | NPA; PCR          | --          | --      | --          | --      | --          | --      | 31          | 3.2     | --                                                                                     |
| PYNEH and QNIH, Hong Kong (2003–2006) (Chiu et al. 2010)                                                                                                                                                              | ARI–Fever       | NPA; DFA and culture | --          | --      | --          | --      | --          | --      | 74          | 0       | --                                                                                     |
| Kunming, China (2009–2010) (郑文静 2011)                                                                                                                                                                                  | ARI             | NPS; PCR          | --          | --      | --          | --      | --          | --      | 102         | 0       | --                                                                                     |
| Rio Grande do Sul, Brazil (1990-2017) (Gregianini, et al. 2019)                                                                                                                                                         | ARI             | NPA and NPS; IFA  | 160         | 5.6     | --          | --      | --          | --      | --          | --      | --                                                                                     |
| Kawayan and Caibiran, Philippines (2014–2016) (Oshitani and colleagues, unpublished)                                                                                                                                   | ALRI            | NPS; PCR          | 3           | 0       | 5           | 0       | 4           | 0       | 12          | 0       | 42                                                                                     |
| Naval, Philippines (Sep 2012–Jul 2016) (Oshitani and colleagues, unpublished)                                                                                                                                              | ALRI            | NPS; PCR          | 22          | 0       | 21          | 0       | 30          | 0       | 73          | 0       | 42                                                                                     |
| Muntinlupa, Philippines (Sep 2012–Feb 2015) (Oshitani and colleagues, unpublished)                                                                                                                                     | ALRI            | NPS; PCR          | 1           | 100     | 1           | 0       | 1           | 0       | 3           | 33.3    | 42                                                                                     |
| Ospital ng Palawan, Philippines (Aug 2012–Feb 2015) (Oshitani and colleagues, unpublished)                                                                                                                               | ALRI            | NPS; PCR          | 8           | 0       | 5           | 0       | 20          | 5       | 33          | 3       | 42                                                                                     |
| Kilifi, Kenya (2007–2017) (Nokes and colleagues, unpublished)                                                                                                                                                             | ALRI            | NPS; PCR          | 84          | 2.4     | 50          | 2       | 67          | 4.5     | 201         | 3       | 43                                                                                     |
| Location (reference)                                                                 | Case definition | Specimen and test                                                                 | 0–5 m Cases (No.) | hCFR (%) | 6–11 m Cases (No.) | hCFR (%) | 12–59 m Cases (No.) | hCFR (%) | 0–59 m Cases (No.) | hCFR (%) | Published references (for unpublished data) |
|-------------------------------------------------------------------------------------|-----------------|------------------------------------------------------------------------------------|--------------------|----------|--------------------|----------|--------------------|----------|--------------------|----------|--------------------------------------------|
| Buenos Aires, Argentina (Jun 2008–Dec 2010) (Echavarria and colleagues, unpublished) | ARI             | NPA; IFA                                                                            | 3                  | 0        | 2                  | 0        | 6                  | 0        | 11                 | 0        | 45                                         |
| multiple areas, Philippines (Jul 2000–Dec 2004) (Lucero and colleagues, unpublished) | ALRI            | Blood, NPS and NPA; Serum and culture                                              | 35                 | 2.9      | 35                 | 0        | ..                 | ..        | ..                 | ..        | 46                                         |
| Amman, Jordan (Mar 2010–Mar 2013) (Khuri-Bulos and colleagues, unpublished)        | ALRI            | Nasal and throat swabs; PCR                                                         | 45                 | 0        | 31                 | 0        | ..                 | ..        | ..                 | ..        | 47                                         |
| multiple areas, Bangladesh (2010–2014) (Homaira and colleagues, unpublished)        | ARI-Fever; ALRI | Nasal and throat swabs; PCR                                                         | 27                 | 0        | 16                 | 0        | 15                 | 0        | 58                 | 0        | 58                                         |
| Matlab, Bangladesh (Jan 2012 – Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI            | NPS/OPS, Induced Sputum; PCR                                                       | 9                  | 0        | 8                  | 0        | 25                 | 0        | 42                 | 0        | 11                                         |
| Basse, Gambia (2012–2013) (Deloria-Knoll and colleagues, unpublished)               | ALRI            | NPS/OPS, Induced Sputum; PCR                                                       | 50                 | 2        | 43                 | 2.3      | 39                 | 2.6      | 132                | 2.3      | 11                                         |
| Lusaka, Zambia (Oct 2011 – Oct 2014) (Deloria-Knoll and colleagues, unpublished)   | ALRI            | NPS/OPS, Induced Sputum; PCR                                                       | 26                 | 7.7      | 24                 | 12.5     | 17                 | 11.8     | 67                 | 10.4     | 11                                         |
| Nakhon Phanom, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI            | NP/OP and induced sputum; PCR                                                      | 1                  | 0        | 1                  | 0        | 2                  | 0        | 4                  | 0        | 11                                         |
| Soweto, South Africa (Aug 2011 – Aug 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI            | NPS/OPS, Induced Sputum; PCR                                                       | 46                 | 4.3      | 33                 | 9.1      | 32                 | 0        | 116                | 4.5      | 11                                         |
| Sa Kaeo, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished)  | ALRI            | NP/OP and induced sputum; PCR                                                      | ..                 | ..       | 3                  | 0        | 3                  | 0        | 6                  | 0        | 11                                         |
| Dhaka, Bangladesh (Jan 2012 – Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI            | NPS/OPS, Induced Sputum; PCR                                                      | 6                  | 0        | 10                 | 0        | 13                 | 0        | 29                 | 0        | 11                                         |
| Kilifi, Kenya (Aug 2011 – Nov 2011) (Deloria-Knoll and colleagues, unpublished)     | ALRI            | NPS/OPS, Induced Sputum; PCR                                                      | 17                 | 5.9      | 20                 | 0        | 35                 | 2.9      | 72                 | 2.8      | 11                                         |
| Bamako, Mali (Jan 2012 – Jan 2014) (Deloria-Knoll and colleagues, unpublished)      | ALRI            | NPS/OPS, Induced Sputum; PCR                                                      | 39                 | 5.1      | 32                 | 18.8     | 29                 | 10.3     | 100                | 11       | 11                                         |
| Rabat, Morocco (Nov 2010–Dec 2011) (Bassat and colleagues, unpublished)             | ALRI            | NPA; PCR                                                                           | 21                 | 9.5      | 20                 | 0        | 116                | 3.4      | 157                | 3.8      | 11                                         |
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m | Published references (for unpublished data) |
|---------------------|----------------|-------------------|-------|--------|---------|--------|--------------------------------------------|
| Buenos Aires, Argentina (2000–2017) (Gentile and colleagues, unpublished) | ALRI | NPA; IFA | 140 | 134 | 110 | 384 | 48 |
| Manhiça, Mozambique (Jan 2011–Jul 2014) (Bassat and colleagues, unpublished) | ALRI | NPA; PCR | 16 | 11 | 18 | 45 | 14 |
| Iquique, Chile (2012–2013) (Fasce and colleagues, unpublished) | ALRI | NPA; IF | 5 | 2 | 7 | 14 | 49 |
| Concepcion, Chile (2012–2013) (Fasce and colleagues, unpublished) | ALRI | NPA; IF | 10 | 6 | 16 | 32 | 49 |
| Soweto, South Africa (Mar 1998–Oct 2005) (Madhi and colleagues, unpublished) | ALRI | NPA; IFA | 35 | 32 | 21 | 88 | 50 |
| Paarl, South Africa (Jun 2012–Dec 2017) (Zar and colleagues, unpublished) | ALRI | NPS; PCR | 13 | 9 | 9 | 31 | 25 |
| Klerksdorp, South Africa (2010–2015) (Cohen and colleagues, unpublished) | ALRI | NPA; PCR | 37 | 31 | 49 | 117 | 71 |
| Pietermaritzburg, South Africa (2010–2015) (Cohen and colleagues, unpublished) | ALRI | NPA; PCR | 59 | 42 | 60 | 161 | 71 |
| Colorado, United States of America (2010–2016) (Simões and colleagues, unpublished) | ALRI | NW; PCR (and DFA) | 129 | 105 | 484 | 718 | 45 |
| Berlin, Germany (Jan 2010–Dec 2014) (Rath and colleagues, unpublished) | ALRI | NPS; PCR | 52 | 38 | 104 | 194 | 16 |
| Taclobal City, Philippines (May 2008–Feb 2015) (Oshitani and colleagues, unpublished) | ALRI | NPS; PCR | 28 | 24 | 27 | 79 | 42 |
| Irbid, Jordan (Jan-Apr 2016) (Awad et al, 2020) | ARI | NPS; PCR | 10 | 0 | - | - | - |
Table S13.6. Description of included studies reporting proportions of hospitalised hPIV-associated ALRI cases in children younger than five years (168 studies)

| Location (reference)                                                                 | Case definition | Specimen and test                                                                 | 0–5 m        | 6–11 m        | 12–59 m       | 0–59 m       | Published reference (for unpublished data) |
|-------------------------------------------------------------------------------------|-----------------|-----------------------------------------------------------------------------------|--------------|--------------|--------------|--------------|------------------------------------------|
| São Paulo city, Brazil (2008–2010) (Durigon et al. 2015)                           | ARI             | NPA; PCR                                                                          | --           | --           | --           | --           | --                                       |
| Paris, France (2002–2004) (El-Hajje et al. 2008)                                  | ALRI            | NPA; IF                                                                           | 41           | 14.6         | --           | --           | --                                       |
| Hamburg, Dresden, Freiburg, Bochum, Germany (1999–2001) (Forster et al. 2004)    | ALRI; croup     | NP secretion; PCR                                                                  | --           | --           | --           | --           | --                                       |
| Montpellier, France (2003–2004) (Foulongne et al. 2006)                           | ARI             | NPA; DFA and viral culture                                                        | --           | --           | --           | --           | 602                                      |
| Buenos Aires, Argentina (CEMIC) (1998–2002) (Galiano et al. 2004)                 | ALRI            | NPA and NPS; IFA                                                                  | --           | --           | --           | --           | 440                                      |
| Aracaju’, Salvador, Recife, and Maceio, Brazil (2012–2013) (Gurgel et al. 2016)  | ALRI            | NPA; PCR                                                                          | --           | --           | --           | --           | --                                       |
| Sa Kaeo and Nakhon Phanom, Thailand (2005–2010) (Hasan et al. 2014)                | ARI             | NPS and serum specimens; PCR, serologic test and culture                          | 397          | 6.3          | --           | --           | 3810                                    |
| Milwaukee County, USA (1996–1998) (Henrickson et al. 2004)                        | ALRI; croup     | mainly NPS; EIA, culture, PCR                                                      | --           | --           | --           | --           | 2750                                    |
| Reims, France (2007–2008) (Huguenin et al. 2012)                                 | ALRI            | NPA; PCR                                                                          | --           | --           | --           | --           | --                                       |
| Yaounde, Cameroon (2011–2013) (Kenmoe et al. 2016)                                | ARI–Fever       | NPS; PCR                                                                          | --           | --           | --           | --           | 307                                      |

* ARI: hospitalised acute respiratory infections. ALRI: physician diagnosed acute lower respiratory infections requiring hospital admission. ARI–Fever: hospitalised acute respiratory infections with fever. NS: nasal swab. TS: throat swab. NW: nasal wash. PCR: polymerase chain reaction. NPA: nasopharyngeal aspirate. NPS: nasopharyngeal swab. OPS: oropharyngeal swab. NPW: nasopharyngeal wash. IFA: indirect immunofluorescence assay. DFA: direct immunofluorescence assay. IF: immunofluorescence. EIA: enzyme immunoassay. ELISA: enzyme-linked immunosorbent assay. BAL: bronchoalveolar lavage. APAAP: alkaline phosphatase and monoclonal anti-alkaline phosphatase.

† --: not available. Some included studies did not provide data for 0–5 m, 6–11 m, 12–59 m, or 0–59 m while provided data for other age groups (e.g., 0–23 m).
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | Published reference (for unpublished data) |
|----------------------|-----------------|-------------------|-------|--------|---------|----------------------------------------|
| Seeb, Oman (2007–2008) (Khamis et al. 2012) | ALRI | NPA; PCR | .. | .. | .. | 518 | 7.7 |  |
| Kuala Lumpur, Malaysia (1992–2008) (Khor et al. 2012) | ALRI | mixed specimen; DFA and culture | 3319 | 2.9 | 4241 | 4 | 2709 | 3.4 | 10269 | 3.5 |  |
| Kumasi, Ghana (2008) (Kwofie et al. 2012) | ALRI | NPS; PCR | 30 | 0 | .. | .. | .. | .. | 128 | 3.9 |  |
| Shandong, China (2011–2013) (Liu et al. 2015) | ALRI | NPA; PCR | .. | .. | .. | .. | .. | .. | 243 | 9.5 |  |
| Shanghai, China (2013–2015) (Lu et al. 2017) | ALRI | NPA; DFA | .. | .. | .. | .. | .. | .. |  |
| SiouxFootlookout, Ontario, Canada (2007–2012) (McCuskeee et al. 2014) | ALRI | ..; immunochromatography assay and culture | .. | .. | .. | .. | .. | .. |  |
| São Paulo city, Brazil (2005–2007) (Pecchini et al. 2015) | ALRI-Fever; ARI | NP secretion; IFA | .. | .. | .. | .. | .. | .. | 510 | 8 |  |
| Chonburi, Thailand (2013–2014) (Pratheepamornkull et al. 2015) | ALRI | NP specimen; PCR | .. | .. | .. | .. | .. | .. | 102 | 2 |  |
| Yukon Kuskokwim Delta, USA (2005–2007) (Singleton et al. 2010) | ALRI | NP specimens; PCR | .. | .. | .. | .. | .. | .. | .. | .. |  |
| Porto Alegre, Brazil (1992) (Straliotto et al. 2002) | ALRI-Fever; ARI | NP secretion; IFA | .. | .. | .. | .. | .. | .. | 42 | 2.4 |  |
| Zhejiang, China (2001–2006) (Tang et al. 2008) | ALRI | NPA; IFA | .. | .. | .. | .. | .. | .. |  |
| Taiwan (1997–1999) (Tsai et al. 2001) | ALRI | TS and NPA; Culture | 524 | 0 | 522 | 0.8 | .. | .. | .. | .. |  |
| Buenos Aires city and Greater Buenos Aires, Argentina (1998–2002) (Viegas et al. 2004) | ALRI | NPA; IFA | .. | .. | .. | .. | .. | .. | 18561 | 1.6 |  |
| Beijing, China (2004–2012) (Wang et al. 2015) | ARI-Fever; ARI | NPA; DFA | 8538 | 6.2 | 4077 | 10.3 | .. | .. | 21815 | 7.4 |  |
| Shenzhen, China (2012–2015) (Wang et al. 2016) | ARI-Fever; ARI | NPS; DFA | .. | .. | .. | .. | .. | .. |  |
| Arizona, USA (2010–2014) (Wansaula et al. 2016) | ARI-Fever; ALRI | NPS; PCR | .. | .. | .. | .. | .. | .. | 17 | 17.6 |  |
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
|----------------------|----------------|------------------|-------|--------|--------|--------|
|                       |                | Tested ALRI (No.) | Proportion of hPIV (%) | Tested ALRI (No.) | Proportion of hPIV (%) | Tested ALRI (No.) | Proportion of hPIV (%) | Tested ALRI (No.) | Proportion of hPIV (%) | Published reference (for unpublished data) |
| NVSN sites, USA (2000–2004) (Weinberg et al. 2009) | Fever; ARI | NS and TS; PCR | 1324 | 4.4 | 386 | 8.8 | -- | -- | 2798 | 6.8 | -- |
| Beersheba, Israel (2001–2005) (Wolf et al. 2010) | ALRI | NPIW; DFA and culture | -- | -- | -- | -- | -- | -- | 997 | 3.1 | -- |
| Changsha, China (2010–2011) (Xiao et al. 2016) | ALRI | NPA; PCR | -- | -- | -- | -- | -- | -- | 707 | 21.4 | -- |
| Milan, Italy (2004–2008) (Zappa et al. 2011) | ALRI | Pharyngeal swabs; PCR | 144 | 0 | 36 | 0 | -- | -- | -- | -- | -- |
| Mirzapur, Bangladesh (1993–1994) | ALRI | NPA; ELISA | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| ACH, Abha, Saudi Arabia (1997–2001) (Al-Shehri et al. 2005) | ALRI | NPA; ELISA and IFA | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| KKUH, Riyadh, Saudi Arabia (1993–1996) (Bakir et al. 1998) | ALRI-Fever; ALRI | NPA; IFA and culture | -- | -- | -- | -- | -- | -- | 1429 | 3.6 | -- |
| Riyadh, Saudi Arabia (2005–2010) (Bukhari and Elhazmi 2013) | ALRI | NPA; DFA | 342 | 1.5 | 131 | 0 | -- | -- | -- | -- | -- |
| Hainan, China (2014) (Chen 2016) | ALRI | NPA; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Ho Chi Minh City, Vietnam (2009–2010) (Do et al. 2016) | ARI | NPS; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Seoul, Korea (2011–2012) (Eem et al. 2014) | ARI | NPS; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Tokyo, Japan (2007–2012) (Hamada et al. 2014) | ARI | NS; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Lanzhou, China (2011) (Huang et al. 2013) | ARI | TS; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Haryana, India (2009–2011) (Broor et al. 2014) | ARI | NS and TS; PCR | -- | -- | -- | -- | -- | -- | 245 | 4.1 | -- |
| Guangzhou, China (2009–2014) (Liao et al. 2015) | ARI | Pharyngeal swabs; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Beijing, China (2010–2012) (Liu et al. 2013) | ARI | TS; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Perth, Australia (2000–2005) (Moore et al. 2012) | ALRI | NPA; DFA, PCR and culture | -- | -- | -- | -- | -- | -- | 5520 | 5.4 | -- |
| Location (reference) | Case definition | Specimen and test | Tested ALRI (No.) | Proportion of hPIV (%) | Tested ALRI (No.) | Proportion of hPIV (%) | Tested ALRI (No.) | Proportion of hPIV (%) | Tested ALRI (No.) | Proportion of hPIV (%) | Published reference (for unpublished data) |
|----------------------|-----------------|-------------------|------------------|-----------------------|------------------|-----------------------|------------------|-----------------------|------------------|-----------------------|-----------------------------------------|
| San Luis Potosi’, Mexico (2002–2004) (Noyola et al. 2005) | ARI | NW; PCR | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Leganes, Madrid, Spain (2005–2008) (Calvo et al. 2010) | ALRI | NPA; PCR | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Shantou, China (2007) (Ou et al. 2009) | ALRI | NPA; PCR | .. | .. | .. | .. | .. | .. | 345 | 10.7 | .. |
| Warsaw, Poland (2008–2011) (Pancer et al. 2014) | ARI | NPS; PCR and EIA | .. | .. | .. | .. | .. | .. | 297 | 6.1 | .. |
| Chongqing, China (2014) (Peng et al. 2015) | ALRI | NPA; PCR | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Cordoba, Spain (2011) (Rodriguez et al. 2016) | ALRI | NPA; DFA | .. | .. | .. | .. | .. | .. | 223 | 5.8 | .. |
| King George’s Medical University, Lucknow, India (2011–2012) (Singh et al. 2014) | ALRI | NPA; PCR | .. | .. | .. | 85 | 0 | 155 | 0 | .. | .. |
| Amphoe Takhli, Thailand (1998–2001) (Siritantikorn et al. 2002) | ALRI; croup | NPA; IFA | .. | .. | .. | .. | .. | .. | 421 | 5.5 | .. |
| Rio de Janeiro, Brazil (1987–1989) (Sutmoller et al. 1995) | ALRI | NPA; IFA | .. | .. | .. | .. | .. | .. | 241 | 0.8 | .. |
| Paraguay (2009) (Vázquez et al. 2011) | ALRI | NS, pharyngeal samples, NPA and BAL; PCR | .. | .. | .. | .. | .. | .. | 367 | 6 | .. |
| Hangzhou, China (2001–2003) (Wang et al. 2005) | ALRI | NPA; DFA | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Kiel, Germany (1996–2000) (Weigl et al. 2005) | ALRI; croup | NPA; PCR | .. | .. | .. | 217 | 4.6 | 443 | 2.9 | .. | .. |
| Changsha, China (2007–2008) (Xiao et al. 2012) | ALRI | NPA; PCR | 350 | 14.3 | 320 | 17.5 | 453 | 13.9 | 1123 | 15 | .. |
| Beijing, China (2011–2012) (Zhang et al. 2015) | ALRI | Tracheal aspirate; PCR | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Dhaka, Bangladesh (2014–2015) (Bhuyan et al. 2017) | ARI | NS; PCR | .. | .. | .. | 43 | 4.7 | 200 | 11 | .. | .. |
| Seoul, Korea (1996–1998) (Ahn et al. 1999) | ALRI; croup | NPA; IFA | 37 | 29.7 | 62 | 29 | .. | .. | .. | .. | .. |
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m | Published reference (for unpublished data) |
|----------------------|-----------------|-------------------|-------|--------|---------|--------|---------------------------------------------|
| Spain (2011–2013) (Cebey-López et al. 2015) | ALRI | NP specimens; PCR | .. | .. | .. | .. | .. |
| London, UK (2009–2012) (Cebey-López et al. 2015) | ALRI | NP specimens; PCR | .. | .. | .. | .. | .. |
| Nicosia, Cyprus (2010–2013) (Richter et al. 2016) | ARI | NS; PCR | .. | .. | .. | .. | .. |
| Egypt (2007–2014) (Horton et al. 2017) | ARI | NPS and OPS; PCR | .. | .. | .. | .. | .. |
| Jordan (2008–2010) (Horton et al. 2017) | ARI | NPS and OPS; PCR | .. | .. | .. | .. | .. |
| Oman (2008–2009) (Horton et al. 2017) | ARI | NPS and OPS; PCR | .. | .. | .. | .. | .. |
| Qatar (2008–2009) (Horton et al. 2017) | ARI | NPS and OPS; PCR | .. | .. | .. | .. | .. |
| Yemen (2010–2014) (Horton et al. 2017) | ARI | NPS and OPS; PCR | .. | .. | .. | .. | .. |
| Manhica, Mozambique (2006–2007) (O’Callaghan-Gordo et al. 2011) | ALRI | NPA; PCR | .. | .. | .. | .. | .. |
| Asembo, Kenya (2007–2010) (Feikin et al. 2013) | ALRI | NPS or OPS; PCR | .. | .. | .. | .. | .. |
| Shenzhen, China (2007–2010) (He et al. 2014) | ARI | NPA; PCR | 595 | 7.9 | 408 | 9.1 | 812 | 9.1 | 1815 | 8.7 |
| Recife, Brazil (2008–2009) (Bezerra et al. 2011) | ARI | NPA; PCR | .. | .. | .. | .. | .. | .. | 211 | 8.5 |
| Navajo and White Mountain Apache, USA (2009) (Bhat et al. 2013) | ALRI | NW; PCR | .. | .. | .. | .. | .. | .. | .. | .. |
| Cape Town, South Africa (2003–2004) (Smitus 2008) | ARI | NPA, tracheal aspirate, BAL; IFA | .. | .. | .. | .. | .. | .. | 1055 | 4 |
| Guangdong, China (2010–2011) (Xu et al. 2012) | ARI | TS; PCR | .. | .. | .. | .. | .. | .. | .. | .. |
| Gipuzkoa, Spain (2004–2007) (Cilla et al. 2009) | ARI; ARI–Fever | NPA; PCR and culture | 386 | 6 | 153 | 11.8 | .. | .. | .. | .. |
| Changsha, China (2012–2013) (Chen et al. 2014) | ARI | NPA; PCR | 143 | 48.3 | 159 | 42.1 | 293 | 34.1 | 595 | 39.7 |
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m | Published reference (for unpublished data) |
|----------------------|-----------------|------------------|-------|--------|---------|---------|------------------------------------------|
| Shanghai, China (2003–2006) (曾玫 et al. 2008) \(^{148}\) | ARI | NPA; DFA | -- | -- | -- | -- | 10240 | 3.8 | -- |
| Jiangxi, China (2011–2012) (付晶晶 et al. 2013) \(^{141}\) | ALRI | NPA; DFA | -- | -- | -- | -- | -- | -- | -- |
| Wuhan, China (2012–2013) (杜帅先 et al. 2016) \(^{142}\) | ARI | NP secretions; DFA | -- | -- | -- | -- | -- | -- | -- |
| Yanting, China (2011–2012) (何杨 2015) \(^{144}\) | ARI | NPA; PCR | -- | -- | -- | -- | -- | -- | -- |
| Wuhan, China (2014) (杨泉 and 席金瓯 2016) \(^{144}\) | ARI | NPA; DFA | 1342 | 3.3 | 1621 | 4.8 | -- | -- | -- |
| Qingyuan, China (2014–2015) (梁大立 et al. 2015) \(^{146}\) | ARI | NPS; DFA | -- | -- | -- | -- | -- | -- | -- |
| Shaoxing, China (2011–2013) (朱建伟 et al. 2014) \(^{146}\) | ARI | NPA; DFA | 1854 | 6.9 | 672 | 5.2 | -- | -- | -- |
| Nanjing, China (2013–2014) (蒋晶和 李军 2015) \(^{147}\) | ALRI | NP secretions; DFA | 240 | 5.8 | 94 | 9.6 | -- | -- | -- |
| Zhuzhou, China (2011) (蒋晶和 李军 2013) \(^{148}\) | ARI | NPA; DFA | -- | -- | -- | -- | -- | -- | -- |
| Nanjing, China (2009–2012) (赵荣丰 et al. 2013) \(^{149}\) | ARI | NP secretions; DFA | -- | -- | -- | -- | -- | -- | -- |
| Shanghai, China (2000) (车大钿 et al. 2004) \(^{150}\) | ALRI | NPA; APAAP | -- | -- | -- | -- | -- | 1027 | 22.7 | -- |
| Mianyang, China (2014–2015) (邓益斌 et al. 2016) \(^{151}\) | ARI | NPS; IFA | -- | -- | -- | -- | -- | -- | -- |
| Chenzhou, China (2013–2014) (吴琼 et al. 2017) \(^{152}\) | ARI–Fever | NS; PCR | -- | -- | -- | -- | -- | 489 | 17.6 | -- |
| Wenzhou, China (2014) (张海锋 et al. 2017) \(^{153}\) | ALRI | NPA; DFA | -- | -- | -- | -- | -- | 922 | 15.7 | -- |
| Wuxi, China (2014–2015) (杨俊钧 et al. 2017) \(^{154}\) | ARI | NPS; DFA | -- | -- | -- | -- | -- | -- | -- |
| Guangzhou, China (2015) (蔡勇 et al. 2017) \(^{155}\) | ARI | NPS; PCR | 216 | 7.4 | 310 | 8.1 | -- | -- | -- |
| Changsha, China (2015) (谢红军 and 李征 2017) \(^{156}\) | ARI | NPS; DFA | -- | -- | -- | -- | -- | -- | -- |
| Location (reference)          | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m | Published reference (for unpublished data) |
|------------------------------|-----------------|------------------|-------|-------|---------|--------|------------------------------------------|
| Jiujiang, China (2016)       | ARI             | NP secretion; DFA| 2163  | 2.8   |         |        |                                          |
| Yangzhou, China (2013–2015)  | ARI             | NP secretion; DFA| 567   | 12.7  | 435     | 11     |                                          |
| Bengbu, China (2015–2016)    | ARI             | NP secretion; DFA| 229   | 3.9   | 122     | 6.6    |                                          |
| Guangzhou, China (2009–2010) | ALRI            | NPS; PCR         |       |       |         |        |                                          |
| Shanghai, China (2001–2002)  | ALRI            | nasotracheal aspiration; APAAP | 233 | 3.4 | 134 | 0.7 | |
| Nanjing, China (2006–2007)   | ALRI            | NPA; DFA         | 199   | 1.5   | 207     | 4.8    | 449 | 9.4 | 855 | 6.4 | |
| Wenzhou, China (2003–2006)   | ARI             | NP secretion; DFA|       |       |         |        |                                          |
| Baiyin, China (2012–2013)    | ALRI            | NPA; PCR         | 20    | 20    | 93      | 23.7   | 391 | 18.2 | |
| Guangxi, China (2013)        | ALRI            | NPS; DFA         |       |       |         |        |                                          |
| Dujiangyan, China (2007–2009)| ALRI            | NPA; IFA         |       |       |         |        |                                          |
| Lanzhou, China (2010–2011)   | ALRI            | NPA; PCR         | 166   | 21.7  | 130     | 36.2   | 174 | 20.7 | 470 | 25.3 | |
| Xi'an, China (1994–1997)     | ALRI            | NP secretion; APAAP | 65 | 20   | 52      | 15.4   |       | |
| Dujiangyan, China (2007–2009)| ALRI            | NPA; IFA         |       |       |         |        |                                          |
| Fuzhou, China (1996–1997)    | ALRI            | NP secretion; APAAP | 99 | 9.1 | 128 | 13.3 | |
| Kunming, China (2005–2007)   | ALRI            | NPA; IFA         |       |       |         |        |                                          |
| Hangzhou, China (2001–2003)  | ALRI            | NPA; DFA         |       |       |         |        |                                          |
| Changsha, China (2013–2014)  | ALRI            | NPA; PCR         | 138   | 21    | 142     | 31     | 262 | 23.7 | 542 | 24.9 | |
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
|----------------------|----------------|-------------------|-------|--------|----------|--------|
|                      |                |                   | Tested | Proportion of hPIV (%) | Tested | Proportion of hPIV (%) | Tested | Proportion of hPIV (%) | Tested | Proportion of hPIV (%) | Published reference (for unpublished data) |
| Chongqing, China (2009–2012) (卢庆彬 2013) 173 | ARI | NPA; PCR | 1028 | 24.7 | 506 | 26.7 | 739 | 21.4 | 2273 | 24.1 | -- |
| Chenzhou, China (2010) (史文元 et al. 2012) 174 | ALRI | NP secretions; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Kunming, China (2005–2006) (吴霞 et al. 2007) 175 | ALRI | NPA; DFA | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Jinhua, China (2013–2014) (吴远桥 2013) 176 | ARI | NPS; DFA | 411 | 13.4 | 324 | 6.5 | -- | -- | -- | -- | -- |
| Zhejiang, China (2006–2010) (张冰 et al. 2012) 177 | ARI | NPA; DFA | -- | -- | -- | -- | -- | -- | 3932 | 3.9 | -- |
| Foshan, China (2013–2014) (张巧玲 et al. 2014) 178 | ALRI | NP specimens; DFA | 424 | 8.5 | 506 | 12.3 | -- | -- | 1922 | 10.8 | -- |
| Chengdu, China (2007) (张蕾 2008) 179 | ALRI | NP specimens; DFA | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Shanghai, China (2011–2012) (张雪清 et al. 2013) 180 | ALRI | NP secretions; DFA | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Shanghai, China (2016–2017) (Li et al. 2018) 181 | ARI | NPS or sputum specimens; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Beijing and Shandoing, China (2012–2015) (Yu et al. 2018) 182 | ARI | respiratory specimens (NPS, NPA, sputum, bronchoalveolar lavage); PCR | -- | -- | -- | -- | -- | -- | 1206 | 17.2 | -- |
| Wenzhou, China (2014–2016) (Wen, et al. 2019) 183 | ALRI | NP secretion; PCR | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Shanghai, China (2008–2014) (Zhao, et al. 2019) 184 | ALRI | NPA; PCR | 139 | 8.6 | 68 | 26.5 | -- | -- | -- | -- | -- |
| Suzhou, China (2006-2015) (任吟莹 et al. 2019) 185 | ARI | NPA; DFA | -- | -- | -- | -- | -- | -- | 15583 | 2.8 | -- |
| Dongguan, China (2017–2018) (孙志豪, et al. 2019) 186 | ALRI | throat swab; PCR | 1051 | 5.4 | 554 | 6.7 | -- | -- | -- | -- | -- |
| Shijiazhuang, China (2014–2017) (曹丽洁, et al. 2019) 187 | ARI | NPS; Immunofluorescence assay | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Xiaogan, China (2017) (李正, et al. 2019) 188 | ARI | NPS; DFA | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Location (reference) | Case definition | Specimen and test | Proportion of hPIV (%) | Proportion of hPIV (%) | Proportion of hPIV (%) | Published reference (for unpublished data) |
|----------------------|-----------------|-------------------|------------------------|------------------------|------------------------|-------------------------------------------|
| Huizhou, China (2017) (王春晖, et al. 2019) | ARI | NS or TS; PCR | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Taiwan (2010–2013) (Chi et al, 2020) | Radiologically confirmed; ALRI | NPS; PCR | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Republic of Korea (South Korea) (2010–2015) (Lee et al, 2020) | ALRI | NP sample; PCR | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Zunyi, China (2017–2018) (Li et al, 2020) | Radiologically confirmed; ALRI | NPS, NPA, sputum; DFA | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Wenzhou, China (2008–2017) (Wen et al, 2020) | ALRI | NPA, sputum; DFA | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Naval, Philippines (Sep 2012–Jul 2016) (Oshitani and colleagues, unpublished) | ALRI | NPS; PCR | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Muntinlupa, Philippines (Sep 2012–Feb 2015) (Oshitani and colleagues, unpublished) | ALRI | NPS; PCR | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Ospital ng Palawan, Philippines (Aug 2012–Feb 2015) (Oshitani and colleagues, unpublished) | ALRI | NPS; PCR | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Kilifi, Kenya (2007–2017) (Nokes and colleagues, unpublished) | ALRI | NPS; PCR | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Nha Trang city, Viet Nam (2007–2016) (Yoshida and colleagues, unpublished) | ALRI | NPS; PCR | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Buenos Aires, Argentina (Jun 2008–Dec 2010) | ARI | NPA; IFA | 0–5 m | 6–11 m | 12–59 m | 0–59 m |
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m | Published reference (for unpublished data) |
|----------------------|-----------------|------------------|-------|--------|----------|--------|-------------------------------------------|
| multiple areas, Philippines (Jul 2000–Dec 2004) (Lucero and colleagues, unpublished) | ALRI | Blood, NPS and NPA; Serum and culture | 233 | 15 | 278 | 12.6 | | | |
| Amman, Jordan (Mar 2010–Mar 2013) (Khuri-Bulos and colleagues, unpublished) | ALRI | Nasal and throat swabs; PCR | -- | -- | -- | -- | | | |
| multiple areas, Bangladesh (2010–2014) (Homaira and colleagues, unpublished) | ARI–Fever; ALRI | Nasal and throat swabs; PCR | 451 | 6 | 198 | 8.1 | 182 | 8.2 | 831 | 7 | |
| Matlab, Bangladesh (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | NPS/OPS, Induced Sputum; PCR | 94 | 9.6 | 74 | 10.8 | 159 | 15.7 | 327 | 12.8 | |
| Basse, Gambia (2012–2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | NPS/OPS, Induced Sputum; PCR | 256 | 19.5 | 138 | 31.2 | 229 | 17 | 623 | 21.2 | |
| Lusaka, Zambia (Oct 2011–Oct 2014) (Deloria-Knoll and colleagues, unpublished) | ALRI | NPS/OPS, Induced Sputum; PCR | 314 | 8.3 | 143 | 16.8 | 133 | 12.8 | 590 | 11.4 | |
| Nakhon Phanom, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | NP/OP and induced sputum; PCR | 9 | 11.1 | 13 | 7.7 | 51 | 3.9 | 73 | 5.5 | |
| Soweto, South Africa (Aug 2011–Aug 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | NPS/OPS, Induced Sputum; PCR | 431 | 10.7 | 212 | 15.6 | 223 | 14.3 | 866 | 12.8 | |
| Sa Kaeo, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | NP/OP and induced sputum; PCR | 7 | 0 | 11 | 27.3 | 33 | 9.1 | 51 | 11.8 | |
| Dhaka, Bangladesh (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | NPS/OPS, Induced Sputum; PCR | 42 | 14.3 | 47 | 21.3 | 109 | 11.9 | 198 | 14.6 | |
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m | Published reference (for unpublished data) |
|----------------------|-----------------|-------------------|-------|--------|--------|--------|--------------------------------------------|
| Knoll and colleagues, unpublished | ALRI | NPS/OPS, Induced Sputum; PCR | 185 | 9.2 | 116 | 17.2 | 265 | 13.2 | 566 | 12.7 | 11 |
| Kilifi, Kenya (Aug 2011 – Nov 2011) (Deloria-Knoll and colleagues, unpublished) | ALRI | NPS/OPS, Induced Sputum; PCR | 297 | 13.1 | 151 | 21.2 | 211 | 13.7 | 659 | 15.2 | 11 |
| Bamako, Mali (Jan 2012 – Jan 2014) (Deloria-Knoll and colleagues, unpublished) | ALRI | NPA; PCR | 100 | 19 | 112 | 16.1 | 419 | 24.6 | 631 | 22.2 | 83 |
| Rabat, Morocco (Nov 2010–Dec 2011) (Bassat and colleagues, unpublished) | ALRI | NPA; IFA | 4674 | 3 | 3634 | 3.7 | 4016 | 2.7 | 12311 | 3.1 | 48 |
| Manhiça, Mozambique (Jan 2011–Jul 2014) (Bassat and colleagues, unpublished) | ALRI | NPA; PCR | 114 | 14 | 96 | 11.5 | 203 | 6.9 | 413 | 9.9 | 84 |
| Iquique, Chile (2012–2013) (Fasce and colleagues, unpublished) | ALRI | NPA; IF | 312 | 3.2 | 148 | 5.4 | 217 | 6 | 677 | 4.6 | 40 |
| Concepcion, Chile (2012–2013) (Fasce and colleagues, unpublished) | ALRI | NPA; IF | 216 | 4.6 | 85 | 7.1 | 163 | 9.8 | 464 | 6.9 | 49 |
| Tehran, Iran (Islamic Republic of) (2008–2009) (Vahid and colleagues, unpublished) | ARI–Fever | Throat swabs and washes; PCR | -- | -- | -- | -- | -- | -- | 80 | 18.8 | 193 |
| Tehran, Iran (Islamic Republic of) (2017) (Vahid and colleagues, unpublished) | ARI–Fever | NP secretions; IFA | -- | -- | -- | -- | -- | -- | 100 | 26 | -- |
| Tehran, Iran (Islamic Republic of) (Sep 2012–Sep 2013) (Vahid and colleagues, unpublished) | ARI–Fever | Throat swabs; PCR | -- | -- | -- | -- | -- | -- | 78 | 15.4 | 194 |
| Location (reference) | Case definition | Specimen and test | 0–5 m | 6–11 m | 12–59 m | 0–59 m | Published reference (for unpublished data) |
|----------------------|----------------|-------------------|-------|--------|---------|--------|------------------------------------------|
| Tehran, Iran (Islamic Republic of) (Jan 2003 to Jan 2004) (Vahid and colleagues, unpublished) | ARI–Fever | NP secretions; IFA | 11    | 18.2   | 30      | 43.3   | 55  | 18.2 | 96  | 26  | 195 |
| Tehran, Iran (Islamic Republic of) (Oct 1998–Oct 2000) (Vahid and colleagues, unpublished) | ARI | NPS; Culture | --   | --    | --      | --    | 111 | 18   | 200 | 17.5 | 196 |
| Soweto, South Africa (Mar 1998–Oct 2005) (Madhi and colleagues, unpublished) | ALRI | NPA; IFA | 962   | 3.6   | 605      | 5.3    | 1035 | 2    | 2602 | 3.4 | 30 |
| Kamalapur, Bangladesh (2013–2014) (Brooks and colleagues, unpublished) | ALRI | NPW; PCR | 19    | 5.3   | 16       | 12.5   | 32   | 0    | 67   | 4.5 | 24 |
| Paarl, South Africa (Jun 2012–Dec 2017) (Zar and colleagues, unpublished) | ALRI | NPS; PCR | 102   | 12.7  | 42       | 21.4   | 57   | 15.8 | 201  | 15.4 | 25 |
| Kathmandu and surrounding districts, Nepal (Jan 2006–Jan 2008) (Strand and colleagues, unpublished) | ALRI | NPA; PCR | 248   | 8.1   | 173      | 6.9    | --   | --   | --   | --   | 26 |
| Klerksdorp, South Africa (2010–2015) (Cohen and colleagues, unpublished) | ALRI | NPA; PCR | 504   | 7.3   | 269      | 11.5   | 486  | 10.1 | 1259 | 9.3 | 71 |
| Pietermaritzburg, South Africa (2010–2015) (Cohen and colleagues, unpublished) | ALRI | NPA; PCR | 883   | 6.7   | 442      | 9.5    | 746  | 8    | 2164 | 7.4 | 71 |
| Berlin, Germany (Jan 2010–Dec 2014) (Rath and colleagues, unpublished) | ALRI | NPS; PCR | 730   | 7.1   | 424      | 9      | 1358 | 7.7  | 2512 | 7.7 | 36 |
| Taclobal City, Philippines (May 2008–Feb 2015) (Oshitani and colleagues, unpublished) | ALRI | NPS; PCR | 816   | 2.9   | 510      | 3.9    | 1094 | 2.3  | 2420 | 2.9 | 42 |
Table S13.7. Description of included studies reporting hospital admission rates of hPIV-associated ALRI with hypoxaemia (13 studies)*

| Location (reference) | Case Definition | Denominator type | Specimen and test | 0–5 m | 6–11 m | 11–23 m | 24–59 m | 0–59 m | Published references (for unpublished data) |
|----------------------|----------------|------------------|-------------------|-------|--------|---------|---------|--------|--------------------------------------------|
| Kawayan and Caibiran, Philippines (2014–2016) (Oshitani and colleagues, unpublished) | ALRI | Defined population base | NPS; PCR | 0 | 0 | 0 | 0 | 0 | 42 |
| Kilifi, Kenya (2007–2017) (Nokes and colleagues, unpublished) | ALRI | Census derived estimate | NPS; PCR | 2.5 | 1.2 | 0.7 | 0.1 | 0.6 | 43 |
| Nha Trang city, Viet Nam (2007–2016) (Yoshida and colleagues, unpublished) | ALRI | Census derived estimate | NPS; PCR | -- | -- | 0.2 | 0 | 0.1 | 44 |
| Buenos Aires, Argentina (Jun 2008–Dec 2010) (Echavarria and colleagues, unpublished) | ARI | Defined population base | NPA; IFA | 3 | 0 | -- | -- | 0.9 | 45 |
| Amman, Jordan (Mar 2010–Mar 2013) (Khuri-Bulos and colleagues, unpublished) | ALRI | Census derived estimate | NS and TS; PCR | 0.1 | 0.1 | 0 | -- | -- | 47 |
| Basse, Gambia (2012–2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NP/OP and induced sputum; PCR | 0.9 | 0.3 | 0.1 | 0.1 | 0.2 | 11 |
| Nakhon Phanom, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NP/OP and induced sputum; PCR | -- | -- | 0 | 0 | 0.1 | 11 |
| Sa Kaeo, Thailand (Jan 2012–Dec 2013) (Deloria-Knoll and colleagues, unpublished) | ALRI | Census derived estimate | NP/OP and induced sputum; PCR | -- | -- | 0 | 0 | 0.1 | 11 |
| Buenos Aires, Argentina (2000–2017) (Gentile and colleagues, unpublished) | ALRI | Defined population base | NPA; IFA | -- | -- | 3.2 | 1 | 4 | 48 |
| Manhica, Mozambique (Jan 2011–Jul 2014) (Bassat and colleagues, unpublished) | ALRI | Defined population base | NPA; PCR | 0.7 | 0.8 | 0.1 | 0.1 | 0.2 | 54 |
| Soweto, South Africa (Mar 1998–Oct 2005) (Madhi and colleagues, unpublished) | ALRI | Defined population base | NPA; IFA | 1.3 | 1 | 0.2 | 0 | 0.3 | 50 |
| Kamalapur, Bangladesh (2013–2014) (Brooks and colleagues, unpublished) | ALRI | Defined population base | NPW; PCR | 0.8 | 0 | 0 | 0 | 0.3 | 24 |
| Paarl, South Africa (Jun 2012–Dec 2017) (Zar and colleagues, unpublished) | ALRI | Defined population base | NPS; PCR | 6 | 0 | 0 | 0 | 0.8 | 25 |

* ARI: hospitalised acute respiratory infections. ALRI: physician diagnosed acute lower respiratory infections requiring hospital admission. NS: nasal swab. TS: throat swab. PCR: polymerase chain reaction. NPA: nasopharyngeal aspirate. NPS: nasopharyngeal swab. OPS: oropharyngeal swab. NPW: nasopharyngeal wash. IFA: indirect immunofluorescence assay.
† --: not available.
Appendix 14. Meta-estimates by narrow age groups

Table S14.1 Incidence rates of hPIV-associated ALRI cases (per 1,000 children per year) in children younger than five years*

| Age Group | High child mortality setting | Lower middle income | 0-27 d | 1-2 m | 3-5 m | 6-11 m | 12-23 m | 24-59 m |
|-----------|------------------------------|---------------------|--------|-------|-------|--------|---------|---------|
|           | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate |
| 0-27 d    | 4 | 1.8 (0-263) | 5 | 9.3 (1.8-46.4) | 5 | 62.9 (38-102.5) | 6 | 77.9 (61.8-97.7) | 7 | 60.3 (50-72.7) | 5 | 14.9 (8.1-27.1) |
| 1-2 m     | 5 | 9.3 (1.8-46.4) | 5 | 62.9 (38-102.5) | 6 | 77.9 (61.8-97.7) | 7 | 60.3 (50-72.7) | 5 | 14.9 (8.1-27.1) |
| 3-5 m     | 5 | 62.9 (38-102.5) | 6 | 77.9 (61.8-97.7) | 7 | 60.3 (50-72.7) | 5 | 14.9 (8.1-27.1) |
| 6-11 m    | 6 | 77.9 (61.8-97.7) | 7 | 60.3 (50-72.7) | 5 | 14.9 (8.1-27.1) |
| 12-23 m   | 7 | 60.3 (50-72.7) | 5 | 14.9 (8.1-27.1) |
| 24-59 m   | 4 | 14 (6.6-29.8) | 4 | 14 (6.6-29.8) |

* Rates were not adjusted for missing hPIV-4.
Table S14.2 Incidence rates of hPIV-associated severe ALRI cases (per 1,000 children per year) by narrow age groups. *

| Age Group | High child mortality setting | Low and lower middle income |
|-----------|------------------------------|-----------------------------|
|           | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate |
| 0-27 d    | 3              | 2.3 (0-265.2)   | 3              | 5.1 (0.2-118.3) | 3              | 19.8 (2.9-123) | 3              | 28.2 (8.2-92.2) |
| 1-2 m     | 3              | 5.1 (0.2-118.3) | 3              | 5.1 (0.2-118.3) | 3              | 19.8 (2.9-123) | 3              | 28.2 (8.2-92.2) |
| 3-5 m     | 3              | 19.8 (2.9-123)  | 3              | 19.8 (2.9-123)  | 3              | 28.2 (8.2-92.2) | 3              | 28.2 (8.2-92.2) |
| 6-11 m    | 3              | 28.2 (8.2-92.2) | 3              | 28.2 (8.2-92.2) | 3              | 28.2 (8.2-92.2) | 3              | 28.2 (8.2-92.2) |
| 12-23 m   | 4              | 8.9 (1.6-49.2)  | 3              | 7.3 (4.1-13.1)  | 3              | 7.3 (4.1-13.1)  | 3              | 7.3 (4.1-13.1)  |
| 24-59 m   | 3              | 7.3 (4.1-13.1)  | 3              | 7.3 (4.1-13.1)  | 3              | 7.3 (4.1-13.1)  | 3              | 7.3 (4.1-13.1)  |

* Rates were not adjusted for missing hPIV-4.
| 0-27 d | 1-2 m | 3-5 m | 6-11 m | 12-23 m | 24-59 m |
|--------|--------|--------|--------|---------|---------|
|        |         |        |        |         |         |
| No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate | No of studies | Incidence rate |
| High child mortality setting | 8 | 1.5 (0.2-8.8) | 10 | 4.8 (2.9-7.9) | 10 | 5.7 (4.8-8.1) | 10 | 4.4 (3.6-6.4) | 11 | 1.3 (1.1-1.6) | 10 | 0.3 (0.2-0.6) |
| Low child mortality setting | 1 | .. | 0 | .. | 0 | .. | 5 | 1.8 (0.8-4.1) | 9 | 1.1 (0.5-2.3) | 10 | 0.4 (0.2-0.9) |
| Low and lower middle income | 5 | 2.1 (1.3-3.5) | 6 | 4.9 (2.4-9.6) | 6 | 6.3 (3.9-10.2) | 7 | 3.4 (1.6-7) | 8 | 1 (0.5-1.7) | 6 | 0.3 (0.2-0.5) |
| Upper middle income | 4 | 0.4 (0-31.3) | 4 | 5.1 (2.2-11.5) | 4 | 4.7 (3.2-6.8) | 5 | 3.4 (1.8-6.6) | 7 | 1.3 (0.8-2.2) | 8 | 0.4 (0.1-1.1) |
| High income | 0 | .. | 0 | .. | 0 | .. | 3 | 3 (1.6-5.7) | 5 | 1.5 (0.6-3.7) | 6 | 0.3 (0.1-0.9) |

* Rates were not adjusted for missing hPIV-4.
Table S14.4 Hospital admission rates of hPIV-associated ALRI with hypoxaemia (per 1,000 children per year) by narrow age groups. *

| Age Group | No of studies | Incidence rate |
|-----------|---------------|----------------|
| 0-27 d    | 6             | 0.5 (0-13)     |
| 1-2 m     | 7             | 0.6 (0.1-3)    |
| 3-5 m     | 7             | 1.7 (1.2-2.4)  |
| 6-11 m    | 7             | 0.8 (0.5-1.4)  |
| 12-23 m   | 8             | 0.2 (0.1-0.5)  |
| 24-59 m   | 8             | 0 (0-0.1)      |

* Rates were not adjusted for missing hPIV-4.
### Table S14.5 hPIV-associated ALRI in-hospital proportion meta-estimates by narrow age groups

| Age Group | No of studies | Proportion (%) | No of studies | Proportion (%) | No of studies | Proportion (%) | No of studies | Proportion (%) | No of studies | Proportion (%) |
|-----------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|
| 0-27 d    | 13            | 5.7 (3.8-8.5)  | 24            | 6.4 (4.8-8.3)  | 24            | 9.1 (7.2-11.5) | 24            | 10.8 (8.5-13.7)| 25            | 8.4 (6.3-11.1) |
|           |               |                |               |                |               |                |               |                |               |                |
| 1-2 m     | 15            | 1.8 (0.9-3.3)  | 9             | 3.8 (2.4-5.9)  | 10            | 5.8 (4.4-7.5)  | 40            | 9.4 (6.9-12.7) | 23            | 9.8 (6.8-13.8) |
|           |               |                |               |                |               |                |               |                |               |                |
| 3-5 m     | 11            | 5.1 (3.1-8.3)  | 20            | 6.4 (4.7-8.7)  | 20            | 8.8 (6.6-11.5) | 19            | 10.8 (8-14.3)  | 21            | 8.3 (6-11.3)   |
|           |               |                |               |                |               |                |               |                |               |                |
| 6-11 m    | 14            | 2.2 (1.1-4.5)  | 10            | 4.7 (2.8-7.8)  | 11            | 7.6 (5.5-10.4) | 36            | 11.1 (8.6-14.4)| 17            | 10.8 (7.2-15.8)|
|           |               |                |               |                |               |                |               |                |               |                |
| 12-23 m   | 3             | 1.7 (0.2-4.5)  | 3             | 5.8 (4.1-12.4)| 3             | 6.6 (4.5-9.7)  | 9             | 4.4 (1.6-11.4) | 10            | 7.9 (4.6-13)   |
|           |               |                |               |                |               |                |               |                |               |                |
| 24-59 m   | 7             | 7.2 (5-10.1)   | 7             | 7.2 (5-10.1)   |               |                |               |                |               |                |

*Pooled estimates using all available data on in-hospital proportions of hPIV-associated ALRI.
### Appendix 15. Checklist of information that should be included in new reports of global health estimates

| Item # | Checklist item                                                                 | Reported on page #                          |
|-------|--------------------------------------------------------------------------------|---------------------------------------------|
|       | **Objectives and funding**                                                     |                                             |
| 1     | Define the indicator(s), populations (including age, sex, and geographic entities), and time period(s) for which estimates were made. | summary; P4                                |
| 2     | List the funding sources for the work.                                         | summary                                     |
|       | **Data Inputs**                                                               |                                             |
|       | For all data inputs from multiple sources that are synthesized as part of the study: |                                             |
| 3     | Describe how the data were identified and how the data were accessed.         | P4-5                                        |
| 4     | Specify the inclusion and exclusion criteria. Identify all ad-hoc exclusions.  | P5                                          |
| 5     | Provide information on all included data sources and their main characteristics. For each data source used, report reference information or contact name/institution, population represented, data collection method, year(s) of data collection, sex and age range, diagnostic criteria or measurement method, and sample size, as relevant. | P4-5; appendix P17-23; 40-59                |
| 6     | Identify and describe any categories of input data that have potentially important biases (e.g., based on characteristics listed in item 5). | Appendix P8, P30-38                         |
|       | For data inputs that contribute to the analysis but were not synthesized as part of the study: |                                             |
| 7     | Describe and give sources for any other data inputs.                          | P20; P40-59                                |
|       | For all data inputs:                                                          |                                             |
| 8     | Provide all data inputs in a file format from which data can be efficiently extracted (e.g., a spreadsheet rather than a PDF), including all relevant meta-data listed in item 5. For any data inputs that cannot be shared because of ethical or legal reasons, such as third-party ownership, provide a contact name or the name of the institution that retains the right to the data. | Data have been presented in the supplementary material. Data will be made available on Edinburgh Datashare (https://datashare.is.ed.ac.uk/) later. |
|       | **Data analysis**                                                            |                                             |
| 9     | Provide a conceptual overview of the data analysis method. A diagram may be helpful. | Appendix P9                                 |
| 10    | Provide a detailed description of all steps of the analysis, including mathematical formulae. This description should cover, as relevant, data cleaning, data pre-processing, data adjustments and weighting of data sources, and mathematical or statistical model(s). | P5-7; appendix P15-23; 25-26.               |
| 11    | Describe how candidate models were evaluated and how the final model(s) were selected. | P7; appendix p10-14, 16, 19, 23.            |
| 12    | Provide the results of an evaluation of model performance, if done, as well as the results of any relevant sensitivity analysis. | Appendix p10-14, 16-23.                    |
| 13    | Describe methods for calculating uncertainty of the estimates. State which sources of uncertainty were, and were not, accounted for in the uncertainty analysis. | P6                                          |
| 14    | State how analytic or statistical source code used to generate estimates can be accessed. | Major code used in this study will be made available upon request. |
|       | **Results and Discussion**                                                    |                                             |
| 15    | Provide published estimates in a file format from which data can be efficiently extracted. | Estimates can be easily extracted in main table and supplementary table. Main tables will be provided on Edinburgh Datashare (https://datashare.is.ed.ac.uk/) later. |
| 16    | Report a quantitative measure of the uncertainty of the estimates (e.g. uncertainty intervals). | Uncertainty was reported for burden estimates throughout. |
| 17    | Interpret results in light of existing evidence. If updating a previous set of estimates, describe the reasons for changes in estimates. | Not applicable                              |
| 18    | Discuss limitations of the estimates. Include a discussion of any modelling assumptions or data limitations that affect interpretation of the estimates. | P10-11; appendix P17.                      |
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