Children hospitalised with four common viral diseases showed epidemiological differences but few socio-economic variations

Katarina Widgren1,2 | Margareta Eriksson3 | Rutger Bennet3 | Johan Giesecke4

Abstract

Aim: This study explored the differences in demographic and socio-economic factors between children hospitalised due to four common viral infections.

Methods: Demographic data were obtained from Statistics Sweden on >3000 children admitted to Astrid Lindgren Children’s Hospital in 2009–2014 with rotavirus, influenza, respiratory syncytial virus (RSV) or chickenpox. We compared demographic and socio-economic factors between case groups using logistic regression with rotavirus cases as reference.

Results: There were differences in the median age at admission; RSV cases were younger (0.4 years), influenza (2.4 years) and chickenpox cases (2.7 years) older than rotavirus cases (1.2 years). RSV and influenza cases were more likely to have underlying chronic conditions. Mothers of RSV cases were more likely to be born in Sweden. Further socio-economic differences were not robustly confirmed in sensitivity analyses.

Conclusion: We found a few differences in demographic factors between children hospitalised with the four common infections, which were mainly explained by the epidemiology and transmission patterns of these infections.

Key words
demographic factors, hospitalised children, risk factors, socio-economic factors, viral disease

Key notes
- This study compared demographic and socio-economic factors between children admitted to a Stockholm paediatric hospital with four viral diseases.
- Demographic data were obtained from Statistics Sweden on >3000 children admitted in 2009–2014 with rotavirus, influenza, respiratory syncytial virus or chickenpox.
- We found demographic differences, which could be explained by the diseases’ epidemiology and transmission patterns. Socio-economic differences were few.
1 | BACKGROUND

The association between low socio-economic status and poor health outcomes in children is well described, even in high-income countries in Europe.1–3 Demographic and socio-economic factors may also affect the risk for infectious diseases in children.4 However, the pattern of how these factors affect infectious diseases is not as clear as the effect on overall health outcomes.

A large register-based study carried out in Sweden showed how socio-economic factors among adults influenced the risk of contracting infectious diseases in different ways, depending on the mode of transmission. Factors that implied social deprivation were associated with increased rates of notification for blood-borne and antibiotic-resistant infections. In contrast, high income and high educational levels were associated with higher notification rates, for example for food- and water-borne infections.5 At the hospital where we carried out our study, asylum-seekers who arrived in 2015 were more likely to be admitted with acute infections, probably because of perceived socio-economic vulnerability.6

Before the introduction of routine rotavirus vaccination in 2014, this pathogen was a major cause of gastroenteritis admissions in young children in Sweden. In 2007–2008, our area of the country saw 444 admissions/100 000 person-years in children below 5 years of age.7 In another study, higher admission rates were linked to indicators for low health literacy in the family, but not to income.8 Influenza is a common cause for hospitalisation in children during Sweden’s winter months, particularly if they are below 5 years of age. For example, there were 19–138 admissions/100 000 person-years in Stockholm from 1998 to 2014. Underlying chronic conditions were a risk factor for admission.9 In addition, influenza admissions were linked to poverty and crowding in some high-income settings,10 but not in others.11 The respiratory syncytial virus (RSV) is an important viral cause of lower respiratory tract infections (LRTIs) in children. In 2008–2016, there were 400 admissions/100 000 person-years in children under the age of 5 years in Stockholm and the highest rate was in infants below 1 year of age. Children with underlying conditions were overrepresented among admitted cases in a previous study that included the RSV case group in the present study.12 Internationally, RSV admissions have been linked to underlying chronic conditions, crowding, having lots of siblings, low socio-economic status and a low educational level of parents.13 However, associations to low socio-economic levels and education do not appear to be as strong as other risk factors13,14 or as strong as for LTRIs not caused by RSV.15 Chickenpox was a less common reason for admissions in children under 5 years of age, as it was 21.3–41.0/100 000 person-years in 2007–2012.16 Sweden does not have a routine chickenpox vaccination programme. The same is true in Denmark, where one study reported that an increased risk for chickenpox admissions was associated with underlying conditions and being born abroad.17

We wanted to carry out a direct comparison of demographic and socio-economic factors between children hospitalised with these common viral diseases: rotavirus, influenza, RSV and chickenpox. We chose a population we know well.9,12,18 To our knowledge, this type of comparative study in children has not been carried out before and could inform prevention.

2 | METHODS

This retrospective study collected data on all children hospitalised with rotavirus, influenza, RSV or chickenpox, between 1 January 2009 and 31 December 2014. The study was carried out at the Solna site of the Astrid Lindgren Children’s Hospital, which is a part of the Karolinska University Hospital, Stockholm. The Solna site is situated in the northern part of Stockholm, and its catchment area covers approximately 235 000 children under the age of 18 years. All children admitted to the hospital with symptoms of respiratory or gastrointestinal infections were routinely screened for viral aetiology. This meant that all rotavirus, influenza and RSV diagnoses were confirmed with polymerase chain reaction (PCR) tests on biological samples. They were included irrespective of the International Classification of Diseases, Tenth Revision (ICD-10) diagnosis at discharge. The most frequent discharge diagnoses were A08.0, A08.4 or A09 for rotavirus, J09 or J10 for influenza, and J12.1, J21.0 or J25 for RSV. Chickenpox diagnoses were generally made on clinical appearance and selected for the study by their ICD-10 code: B01, at discharge. Apparent varicella zoster virus reactivations were excluded.

At the end of each study year, two members of the study team (ME and RB) verified the diagnoses in the case records and removed cases who were not resident in the catchment area. They also collected information on the presence of any pre-existing complex chronic conditions19 and admissions to the paediatric intensive care unit (PICU).

We obtained data from Statistics Sweden, and this included the gender of the child, their age at admission, their municipality and the country or countries where the child and their parents were born. The data also included the mother’s year of birth, whether the parents were single or lived with another adult, the number of children in the household, the educational level of both parents and the disposable income of their household.

Demographic and socio-economic data for 31 December the year before admission were used. If the children were born, or had migrated to Sweden in the same year as admission, then data for 31 December in the year of admission were used. Demographic data were matched to case data by Statistics Sweden, using the personal identity number of each child, and then anonymised. We carried out all the statistical analyses without any information that could identify the cases. The final analyses included cases resident in the catchment area, which comprises the northern municipalities of Stockholm County, including half of Stockholm City. For practical reasons, we included all cases resident in the city.

We used rotavirus admissions as the reference in a logistic regression model, as we hypothesised that rotavirus admissions were least likely to be affected by demographic and socio-economic factors. The
mothers' ages when the cases were born were grouped into below 25 years, 25–34 years and 35 years and above. Three educational levels were defined as none, primary or lower secondary (0–9 years), upper secondary (10–12 years) and post-secondary (more than 12 years). We created income level quartiles from the distribution of the mothers' and fathers' disposable income, respectively. The countries of birth of the children and their parents were divided into four categories: child born outside Sweden, Swedish-born child with both parents born in Sweden, one parent born in Sweden and both parents born outside Sweden. The parents' educational level and income, mother's age group and the categories of countries of birth of the children and their parents were treated as categorical variables.

In a backward stepwise logistic regression model, we used the likelihood ratio test to select the relevant variables for the best model. We only included complete cases in the model, that is cases without missing values in any of the included variables. The number of children in the household of mothers and fathers, and the parents being single or not would be the same in a majority of cases. Therefore, these factors for the fathers were excluded from the multivariable analysis.

Three sensitivity analyses were carried out to assess the robustness of the results. One was restricted to children below 5 years of age and another used the secondary outcome of PICU admission. In the third sensitivity analysis, influenza cases admitted in 2009 and rotavirus cases admitted in 2014 were removed. Cases of the 2009 H1N1 influenza pandemic were older than other paediatric influenza patients, as previously shown. The rotavirus vaccination was implemented in Stockholm in April 2014, although by that time the epidemic was over for the season. The restrictions in this sensitivity analysis were put in place, as there could have been other predictors for hospitalisation in these deviant years.

We wanted to provide context for the differences in demographic and socio-economic factors among our cases. That is why we present the corresponding numbers for the general population in the catchment area in 2013, here defined as the northern municipalities of Stockholm County and all of Stockholm City. The data were aggregated by the relevant age groups: below 5 years and 5–17 years for the children and 25–44 years for parents. The latter corresponded to the age of 90% of the mothers in our dataset. When it was available, we used general population data for adults with children, but in a few cases, we had to rely on data on all adults in the specified age group.

The statistical analyses were carried out with StataCorp 2013, Stata Statistical Software, Release 13 (StataCorp).

Ethics approval was obtained from the Regional Ethical Committee in Stockholm (Dnr: 2015/588-31/4).

3 | RESULTS

We identified 3590 relevant case records: 3445 (96.0%) were included in the descriptive analyses and 3125 (87.0%) in the regression models (Figure 1).

The overall number of cases differed by diagnosis. RSV was the most frequent (52.6%), followed by rotavirus (32.9%), and influenza (11.2%) and chickenpox cases (3.3%) were much less frequent (Table 1). There were seasonal variations in the number of cases with each diagnosis (Figure 2).

Table 1 presents the demographic and socio-economic factors for each group of patients, characterised by their viral disease, along with corresponding figures for the general population of the
**TABLE 1** Distribution of demographic and socio-economic factors for cases hospitalised with each viral diagnosis: rotavirus, influenza, respiratory syncytial virus (RSV) and chickenpox; and corresponding distribution for the general population of Northern Stockholm as of 2013

|                      | Rotavirus (n = 1133) | Influenza (n = 387) | RSV (n = 1813) | Chickenpox (n = 112) | Northern Stockholm |
|----------------------|----------------------|---------------------|----------------|----------------------|-------------------|
| Age in years, median (IQR) | 1.2 (0.8–1.9) | 2.4 (0.9–6.3) | 0.4 (0.1–1.2) | 2.7 (1.1–4.6) |
| Season of birth for cases below 1 year (%) (n = 1869) | | | | | |
| Jan–Mar | 23.7 | 39.8 | 39.2 | 16.7 |
| Apr–June | 33.4 | 18.5 | 10.2 | 25.0 |
| July–Sep | 28.3 | 15.7 | 17.7 | 29.2 |
| Oct–Dec | 14.5 | 25.9 | 32.9 | 29.2 |
| Gender (male, %) | | | | | |
| 55.1 | 57.4 | 58.7 | 58.0 |
| Mother’s mean age at birth of child (n = 3438) | 32.0 | 31.6 | 32.6 | 32.4 | 32.1³ |
| Mother’s age group (%)⁴ | | | | | |
| <25 years | 7.3 | 10.2 | 6.9 | 6.3 | 6.3 |
| 25–34 years | 61.6 | 59.4 | 55.3 | 57.1 | 60.3 |
| 35+ years | 31.1 | 30.5 | 37.9 | 36.6 | 33.4 |
| Underlying chronic condition (%) | 6.1 | 20.4 | 6.7 | 8.9 |
| Born in Sweden (%) | 98.8 | 95.1 | 99.3 | 97.3 | 91.9 |
| Born outside Sweden | 1.2 | 4.9 | 0.7 | 8.1 |
| Born outside Sweden | 1.1 | 5.2 | 1.3 | 7.2 |
| Born in Sweden (%) | 100.0 | 97.1 | 99.4 | 96.7 | 96.6 |
| Born outside Sweden | 1.2 | 3.0 | 0.7 | 8.1 |
| Mother born in Sweden (%) (n = 3435) | 65.2 | 58.1 | 74.4 | 58.9 | 69.4 |
| Father born in Sweden (%) (n = 3257) | 66.7 | 58.9 | 74.3 | 59.6 | 70.3 |
| Birth country (%) | | | | | |
| Swedish-born⁵ | | | | | |
| Both parents Swedish-born | 55.5 | 45.7 | 61.9 | 48.2 | 59.0 |
| One parent Swedish-born | 17.1 | 21.2 | 19.6 | 18.8 | 16.2 |
| Both parents born outside Sweden | 26.1 | 28.2 | 17.8 | 30.4 | 16.7 |
| Born outside Sweden | 1.2 | 4.9 | 0.7 | 2.7 | 8.1 |
| Mother’s educational level (%) (n = 3351) | | | | | |
| ≤9 years | 12.0 | 18.8 | 10.8 | 19.6 | 7.3 |
| 10–12 years | 33.4 | 32.7 | 31.6 | 34.6 | 29.0 |
| >12 years | 54.6 | 48.5 | 57.5 | 45.8 | 63.7 |
| Father’s educational level (%) (n = 3302)⁶ | | | | | |
| ≤9 years | 13.7 | 17.6 | 11.1 | 18.9 | 10.1 |
| 10–12 years | 35.7 | 34.9 | 35.7 | 37.7 | 34.8 |
| >12 years | 50.6 | 47.6 | 53.2 | 43.4 | 55.1 |
| Mother’s income (n = 3432) | | | | | |
| Mean (MSEK) | 241.4 | 225.8 | 238.2 | 205.5 | 180.8–655.0⁷ |
| 1st Q (%) | 25.7 | 32.6 | 22.1 | 33.9 |
| 2nd Q (%) | 26.1 | 21.2 | 25.1 | 23.2 |
| 3rd Q (%) | 24.0 | 24.3 | 26.3 | 18.8 |
| 4th Q (%) | 24.2 | 21.9 | 26.5 | 24.1 |
| Father’s income (n = 3352) | | | | | |
| Mean (MSEK) | 257.5 | 243.0 | 254.0 | 230.0 |
| 1st Q (%) | 27.0 | 31.4 | 21.8 | 29.4 |
| 2nd Q (%) | 24.5 | 21.5 | 26.4 | 24.8 |

(Continues)
catchment area. Table 2 provides the odds ratios for the risk factors included in the regression analyses.

There was a slight male predominance in cases admitted with all four diseases, ranging from 55.1% to 58.7% of cases, but the differences were not statistically significant in any of the groups. The age distribution of the cases was heavily skewed to the right (Figure 3). The median age of the RSV cases was lower (0.4 years), whereas the median ages of cases with influenza (2.4 years) and chickenpox (2.7 years) were higher than in rotavirus cases (1.2 years).

Children with RSV, influenza and chickenpox were all more likely to be admitted to the PICU than children with rotavirus, and the percentage in the PICU was highest for influenza cases (11.1%).

Several factors remained significant in the final multivariable models. The age differences between the groups, as described above, were similar after adjusting for the other factors. There were more children in the households of the influenza, RSV and chickenpox cases than the rotavirus cases. Both the influenza and RSV cases had underlying chronic conditions more frequently than the rotavirus cases. In addition, the mothers of the RSV cases were more likely to have been born in Sweden and their fathers were more likely to have an income in the higher quartiles than the rotavirus cases. The influenza cases were more likely to have single mothers than the rotavirus cases.

### Sensitivity analyses

When the multivariable analyses were restricted to the 2952 cases below 5 years of age, the results remained the same as in the main...
**TABLE 2** Association of demographic and socio-economic factors for cases hospitalised with influenza, respiratory syncytial virus (RSV) and chickenpox, compared to rotavirus cases in univariable and multivariable models using logistic regression

|                      | Univariable (n = 3125) |                      |                      | Multivariable (n = 3125) |                      |                      |
|----------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
|                      | Rotavirus              | Influenza              | RSV                    | Chickenpox             | Rotavirus              | Influenza              | RSV                    | Chickenpox             |
|                      | OR (95% CI)            | OR (95% CI)            | OR (95% CI)            | OR (95% CI)            | OR (95% CI)            | OR (95% CI)            | OR (95% CI)            | OR (95% CI)            |
| **Age**              |                        |                        |                        |                        |                        |                        |                        |                        |
| ref                  | 1.38 (1.30–1.46)       | 0.63 (0.58–0.68)       | 1.32 (1.22–1.44)       | 1.36 (1.28–1.44)       | 0.61 (0.56–0.66)       | 1.32 (1.22–1.43)       |                        |                        |
| Gender (male)        | ref                    | 1.13 (0.88–1.44)       | 1.15 (0.99–1.35)       | 1.20 (0.79–1.82)       | ref                    | 1.36 (1.28–1.44)       | 0.61 (0.56–0.66)       | 1.32 (1.22–1.43)       |
| Mother's age (at birth of child) |                        |                        |                        |                        |                        |                        |                        |                        |
| <25 years            | 1.40 (0.90–2.19)       | 0.93 (0.67–1.28)       | 0.92 (0.39–2.22)       |                        |                        |                        |                        |                        |
| 25–34 years          | ref                    | 1                      | 1                      | 1                      | ref                    | 1                      | 1                      | 1                      |
| 35+ years            | 1.02 (0.78–1.33)       | 1.36 (1.15–1.60)       | 1.22 (0.79–1.88)       | 1.36 (1.15–1.60)       | 1.22 (0.79–1.88)       |                        |                        |                        |
| Underlying chronic condition | ref                    | 4.14 (2.87–5.98)       | 1.13 (0.82–1.56)       | 1.57 (0.75–3.26)       | ref                    | 3.65 (2.43–5.48)       | 2.24 (1.53–3.26)       |                        |
| Born in Sweden       | ref                    | 0.22 (0.08–0.62)       | 1.89 (0.58–6.24)       | 0.19 (0.05–0.77)       | ref                    | 1.89 (0.58–6.24)       | 0.19 (0.05–0.77)       |                        |
| Mother born in Sweden| ref                    | 0.74 (0.58–0.96)       | 1.56 (1.31–1.86)       | 0.79 (0.52–1.20)       | ref                    | 0.79 (0.52–1.20)       | 0.79 (0.52–1.20)       | 1.53 (1.26–1.87)       |
| Father born in Sweden| ref                    | 0.72 (0.56–0.93)       | 1.46 (1.23–1.73)       | 0.79 (0.51–1.20)       | ref                    | 1.46 (1.23–1.73)       | 0.79 (0.51–1.20)       |                        |
| Mother's educational level |                        |                        |                        |                        |                        |                        |                        |                        |
| ≤9 years             | ref                    | 1                      | 1                      | 1                      | ref                    | 1                      | 1                      | 1                      |
| 10–12 years          | 0.58 (0.40–0.85)       | 0.97 (0.74–1.29)       | 0.65 (0.35–1.20)       | 0.58 (0.40–0.85)       | 0.97 (0.74–1.29)       | 0.65 (0.35–1.20)       |                        |                        |
| >12 years            | 0.53 (0.37–0.75)       | 1.11 (0.85–1.45)       | 0.52 (0.29–0.94)       | 0.53 (0.37–0.75)       | 1.11 (0.85–1.45)       | 0.52 (0.29–0.94)       |                        |                        |
| Father's educational level |                        |                        |                        |                        |                        |                        |                        |                        |
| ≤9 years             | ref                    | 1                      | 1                      | 1                      | ref                    | 1                      | 1                      | 1                      |
| 10–12 years          | 0.84 (0.57–1.22)       | 1.25 (0.96–1.62)       | 0.86 (0.47–1.56)       | 0.84 (0.57–1.22)       | 1.25 (0.96–1.62)       | 0.86 (0.47–1.56)       |                        |                        |
| >12 years            | 0.82 (0.57–1.17)       | 1.33 (1.04–1.71)       | 0.66 (0.36–1.18)       | 0.82 (0.57–1.17)       | 1.33 (1.04–1.71)       | 0.66 (0.36–1.18)       |                        |                        |
| Mother's income      | ref                    | 1                      | 1                      | 1                      | ref                    | 1                      | 1                      | 1                      |
| 1st Q                | 0.69 (0.49–0.98)       | 1.24 (0.98–1.56)       | 0.79 (0.45–1.38)       | 0.69 (0.49–0.98)       | 1.24 (0.98–1.56)       | 0.79 (0.45–1.38)       |                        |                        |
| 2nd Q                | 0.83 (0.59–1.16)       | 1.30 (1.04–1.63)       | 0.61 (0.34–1.11)       |                        | 0.83 (0.59–1.16)       | 1.30 (1.04–1.63)       | 0.61 (0.34–1.11)       |                        |
| 3rd Q                | 0.74 (0.53–1.04)       | 1.30 (1.04–1.64)       | 0.79 (0.45–1.37)       | 0.74 (0.53–1.04)       | 1.30 (1.04–1.64)       | 0.79 (0.45–1.37)       |                        |                        |
| 4th Q                | ref                    | 1                      | 1                      | 1                      | ref                    | 1                      | 1                      | 1                      |
| Father's income      | ref                    | 1                      | 1                      | 1                      | ref                    | 1                      | 1                      | 1                      |
| 1st Q                | 0.75 (0.53–1.06)       | 1.35 (1.08–1.69)       | 0.91 (0.51–1.60)       | 0.75 (0.53–1.06)       | 1.35 (1.08–1.69)       | 0.91 (0.51–1.60)       | 1.33 (1.04–1.70)       | 1.33 (1.04–1.70)       |
| 2nd Q                | 0.82 (0.58–1.14)       | 1.25 (1.00–1.56)       | 0.73 (0.40–1.31)       | 0.82 (0.58–1.14)       | 1.25 (1.00–1.56)       | 0.73 (0.40–1.31)       | 1.29 (1.00–1.66)       | 1.29 (1.00–1.66)       |
| 3rd Q                | 0.91 (0.65–1.29)       | 1.36 (1.08–1.70)       | 1.00 (0.57–1.74)       | 0.91 (0.65–1.29)       | 1.36 (1.08–1.70)       | 1.00 (0.57–1.74)       | 1.43 (1.11–1.85)       | 1.43 (1.11–1.85)       |
| 4th Q                | ref                    | 1                      | 1                      | 1                      | ref                    | 1                      | 1                      | 1                      |

(Continues)
analyses. However, there were no longer significant differences in relation to whether the mothers of influenza cases were single or cohabiting or to the income of fathers of RSV cases.

When we removed the 114 influenza cases admitted in 2009 and the 128 rotavirus cases admitted in 2014 from the main analysis, the results remained almost the same, with a few exceptions. The association of influenza case mothers being single was no longer significant. The RSV case mothers, not the fathers as in the main analysis, had higher income levels than the rotavirus case mothers. In addition, children with influenza were more frequently born abroad than children with rotavirus were.

Only 174 children were admitted to the PICU, as the numbers were small the analysis had little power to detect any differences. However, a logistic regression that had PICU as outcome found that the viral diagnosis and underlying chronic condition were significant determinants.

Parental education had the most missing values (4.4%). During the data management, we found that 86.6% of the parents with missing information on education were born outside Sweden. A post hoc sensitivity analysis, which was not adjusted for parental educational level, was carried out on a complete case count of 3230 cases. The results were very similar to those from the main analysis.

### 3.2 The northern Stockholm population

Table 1 presents the corresponding distribution of demographic and socio-economic factors among the population of northern Stockholm.

### 4 DISCUSSION

This linkage study of registers and clinical data looked at differences in demographic and socio-economic factors between cases...
admitted to the largest paediatric hospital in Stockholm due to four common viral diseases: rotavirus, influenza, RSV and chickenpox. As anticipated, we found differences in the ages between the case groups. We also found that there were more children in the household of influenza, RSV and chickenpox cases than rotavirus cases. Cases with influenza and RSV were more likely to have underlying chronic conditions than rotavirus cases. Finally, mothers of children with RSV were more frequently born in Sweden than mothers of children with rotavirus. Other clear-cut socio-economic differences were not as robust across the sensitivity analyses.

The main limitation of this study was that we did not have individual data on the source population. As all the case groups stemmed from the same source population, this was not an issue when we compared the four groups to each other. However, we could not explore, and compare, the risk factors in the four groups to children who were not admitted and their parents. We included a wide set of demographic and socio-economic factors. However, we did not have data on some potentially confounding factors. These included preterm birth, which is an established risk factor for RSV,12 but did not influence admissions for rotavirus or influenza in our study population.9,18 We selected rotavirus cases as the reference group, a priori. We did not investigate their representativeness of the source population. However, our analyses confirmed our hypothesis that their demographic characteristics did not suggest either pronounced high or low socio-economic status.

The main strength of the study was that we could draw on the high-quality Swedish population registers, which meant we could link individual demographic and socio-economic data to clinical data for the more than 3000 cases. The differences we found between the case groups are likely to reflect well-known differences in epidemiology and transmission patterns between these viruses. As mentioned, age differences between the four groups were anticipated and were robustly confirmed by our analyses. The presence of more children in the household for all case groups, compared to rotavirus, was also robust across sensitivity analyses. Even if RSV and rotavirus infect children early in life (Figure 3), they differ in many ways. RSV causes a symptomatic infection during the first months of life. Rotavirus usually causes symptomatic infections when babies are 6–18 months of age, and they experience milder symptoms if they contract the virus during the first months of life. This mild infection provides future protection, similarly to the oral rotavirus vaccine. Previous studies have shown that RSV cases had older siblings,13,14 whereas rotavirus was more likely to affect the firstborn child.18 We support these findings by showing that RSV cases tended to live with more children than rotavirus cases. We also found an association between more children in the household and chickenpox cases. One likely explanation is that the intensity of exposure was associated with the severity of disease. In other words, there was a higher risk following an infection in the household.20 Influenza strikes at all ages through life. Young children face a higher risk for influenza if there are more children in the household and older children are more likely to get influenza if they have underlying risk factors.9

We found that influenza cases were more likely to have underlying chronic conditions in both the univariable and multivariable analyses and the same was true for RSV cases in the multivariable analyses. This was more pronounced with increasing age for RSV: 3.8% of those below 2 years of age had chronic conditions and 31% of cases over that age. We previously showed that RSV infections are increasingly diagnosed in older children with medical risk factors, partly due to multiple-agent PCR tests.12 The proportion of chickenpox cases with a chronic condition was also high, but as the case numbers were low, we could not establish this statistically. Children with influenza, RSV or chickenpox were more likely to be admitted to the PICU than rotavirus cases. Having an underlying chronic condition was an important predictor for intensive care. This underlines that hospital admissions of cases with underlying medical risk factors are not a matter of lower thresholds for admission, but higher risks of severe disease when affected by these infections.

Swedish parents receive generous benefit payments, so-called parental leave, for up to 16 months. Children may start day care from 1 year of age and most children (89%) start between their first and second birthdays, according to Statistics Sweden. This is when they will first be exposed to many paediatric infections, unless they have older siblings. That may explain some of the transmission patterns for the four diseases described above.

When we explored differences in clear-cut socio-economic factors, they were not as robust as for the factors described above and the absolute numerical differences were sometimes small (Table 1). However, there was a distinct pattern of differences between case groups in univariable analyses, where some associations remained after adjusting for other factors in some sensitivity analyses, but not in others. Compared to rotavirus cases, RSV cases were more likely to have Swedish-born, older mothers and cohabiting parents (non-significant) with higher disposable income. Influenza cases were more likely to be born and have parents born abroad, have mothers with lower educational levels and disposable income (non-significant) and being single parents. Although the analyses for chickenpox cases generated fewer statistically significant results, they had features similar to influenza cases (Table 2).

Our findings imply a difference in socio-economic factors between case groups, namely suggesting an association between influenza and chickenpox cases to factors related to lower socio-economic status and an association between RSV cases and higher socio-economic status. Rotavirus cases fell in between. These findings were somewhat compatible to what has been described in the literature. These differences were so small they could not be robustly confirmed. Yet, we studied a large group of children, which meant we had the power to detect small differences. This indicates that the differences between groups were almost negligible in a high-income country like Sweden.

Child health care is mostly free in Sweden, and 99% of children are registered with a child health centre. These provide regular check-ups and a trusted contact in the healthcare system.21 This could be one reason why the socio-economic factors we studied only had a limited influence on admissions.

Overall, paediatric hospital admissions for infectious diseases have been shown to be associated with factors such as low levels
of maternal education, low family income and single mothers. It could be that the entire group in our study of hospitalised children differed from the general population in terms of demography and socio-economic status. We could not carry out an adjusted analysis to investigate this. However, when we compared the parents of our cases to the register data for parents in the catchment area, our case group did not stand out overall in terms of factors associated cases to the register data for parents in the catchment area, our case group did not stand out overall in terms of factors associated factors associated with lower socio-economy (Table 1). Differences between the case groups and the general population could be explained by differences in a number of factors. These include the risk of contracting the disease or the risk of severe disease. They also include seeking health care too often or too late and the admitting doctor’s perception of the parents’ ability to care for the child or understand instructions.

5 | CONCLUSION

This linkage study of registers and clinical data explored the differences in demographic and socio-economic factors between children admitted to hospital with four common viral diseases. It included more than 3000 children admitted to Astrid Lindgren Children’s Hospital in Stockholm in 2009–2014 with rotavirus, influenza, respiratory syncytial virus or chickenpox. There were differences with regard to the children’s ages, underlying chronic conditions and the number of children in the household. These differences could be explained by the epidemiology and transmission patterns of the four diseases. The differences in clear-cut socio-economic terms were less robust and were probably less pronounced in this high-income setting with subsidised health care. However, further studies are warranted to explore these differences and the reasons behind them. Furthermore, it does not seem appropriate to group children with different infectious diseases together when exploring socio-economic determinants for admission or severe disease.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

ORCID

Katarina Widgren https://orcid.org/0000-0002-5713-0071
Rutger Bennet https://orcid.org/0000-0003-0105-1865
Johan Giesecke https://orcid.org/0000-0001-6107-4204

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