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Prevalence of common respiratory viruses in children: insights from post-pandemic surveillance

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Abstract

Introduction The COVID-19 pandemic has significantly affected healthcare systems worldwide, impacting the occurrence and management of respiratory illnesses. This has also influenced respiratory infections' role in childhood mortality. Surveillance of common respiratory viruses in Ghana is limited, making it crucial to assess the prevalence of respiratory viral infections, particularly in children, in the post-pandemic era. This study provides data on the prevalence of respiratory viruses and the associated risk factors in symptomatic children aged 5 or younger in an urban paediatric hospital setting.

Methods The study was a cross-sectional study with a convenience sampling method, conducted in four health facilities: Asokwa Children's Hospital, HopeXchange Medical Centre, University Health Services-KNUST, and Kumasi South Hospital in Kumasi, Ghana, between August 2022 and June 2023. Recruitment was not done in parallel in each hospital. Oropharyngeal swabs were collected from 303 children ≤ 5 years old and screened by RT-qPCR for common respiratory viruses.

Results Out of the 303 patients enrolled in the study, 165 (54.4%) were male, and 122 (40.3%) were aged from 13 to 36 months. The median age of the patients was 19 months. The most common symptoms reported were cough (87.0%), runny nose (87.0%), and fever (72.0%). Respiratory viruses were detected in 100 (33.0%) of the samples, with 36 (12.0%) testing positive for Human metapneumovirus (HMPV), 27 (8.9%) for Respiratory syncytial virus (RSV), and 20 (6.6%) for Human Adenovirus (HAdV). In 8.0% of the cases, multiple viruses were detected, with HAdV being the most common (75.0%). Children under 6 months (AOR: 4.81, 95% CI: 1.20–24.60) had a higher risk of RSV detection compared to children aged 37 to 60 months. Furthermore, it was found that caregivers with tertiary education had higher odds of HMPV detection (AOR: 6.91, 95% CI: 1.71–47.3).

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Conclusion The detection of multiple viruses with a higher prevalence of HMPV and RSV in our study emphasises the need for a scaled-up and sustained surveillance of respiratory viruses in Ghana in the post-pandemic era. Such an establishment in respiratory virus surveillance systems in Ghana would help in the timely detection and education on viral seasonal patterns, which will inform public health responses.

Keywords Respiratory viruses, Children, Co-detection, Ghana

Introduction

Acute respiratory infections (ARIs) are important causes of illness worldwide, significantly burdening public health. They impact all age groups with a higher child mortality, especially in less developed countries [1]. Children in Sub-Saharan Africa are more than 15 times more likely to die before the age of five owing to ARIs [2]. ARIs in Ghana are part of the top 10 causes of hospital admissions and mortality in children under 5 years old [3].

Respiratory viruses account for a great percentage of ARIs. Respiratory viruses have been infecting humans for a long time and have evolved, leading to new strains and variants that cause different symptoms. The viruses that have been implicated as the etiological agents of ARIs include respiratory syncytial virus (RSV), influenza virus, human parainfluenza virus (HPIV), human rhinovirus (HRV), human coronaviruses (HCoV-229E, -NL63, -OC43, and -HKU1), human adenovirus (HAdV) and human metapneumovirus (HMPV) [4]. RSV has been reported as the leading cause of severe lower respiratory tract infections with a burden of hospitalizations, especially in children in developing countries [5–7]. Pneumonia due to human metapneumovirus has shown a higher risk of intensive care need in Moroccan children [8]. Influenza virus is also reported as contributing substantially to the burden of hospitalized febrile children in Ghana [9]. The recent coronavirus disease 2019 (COVID-19) pandemic, caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has further highlighted the role of respiratory viruses in ARIs.

The COVID-19 pandemic has profoundly reshaped the landscape of respiratory infections. During the pandemic, respiratory healthcare faced challenges, including disruptions to routine healthcare services, delays in immunization campaigns, and changes in healthcare-seeking patterns [10, 11]. These disruptions along with nonpharmaceutical interventions (e.g. nose masking and lockdowns) significantly influenced the prevalence and patterns of respiratory infections among children [12–14]. As the acute phase of the pandemic caused significant shifts in societal norms, public health initiatives, and healthcare use trends, the transition to the post-pandemic era provides new challenges for healthcare systems and policymakers.

Despite the significant burden of respiratory viral infections among children in Ghana, there remains a paucity of comprehensive epidemiological data on circulating viruses with most studies skewed towards RSV and Influenza viruses. This study provides new insight into the changing dynamics of a broad spectrum of respiratory viruses among children in Ghana. The aim was to determine the prevalence of respiratory viruses and identify associated risk factors among symptomatic children aged 5 or younger in an urban paediatric hospital setting.

Methods

Study design and area

This cross-sectional study aimed at determining the prevalence of respiratory viruses in children was conducted from August 2022 to June 2023 at the following facilities in Kumasi, Ashanti region of Ghana: The University Hospital, KNUST, Asokwa Children's Hospital, Kumasi South Hospital, and HopeXchange Medical Centre. The KNUST hospital caters for about 150,000 people from over 30 surrounding communities. The Asokwa Children's Hospital, which solely focuses on the care and management of children younger than 12 years, attends to roughly 6,000 children every month. The Kumasi South Hospital has an outpatient department and a paediatric ward that attends to approximately 4000 children monthly. The HopeXchange Medical Centre is a private facility with a paediatric ward that caters to about 1,500 children every month.

Patient recruitment criteria

A convenience sampling method was used throughout the study thus based on the availability and willingness of participant at the time of presentation. Although this was a convenient sampling, recruitment was not done in parallel and at once in each hospital. Screening and recruitment were carried out five days per week (Monday to Friday) from 8:00 h – 17:00 h throughout the study period. All children attending to the outpatient units were assessed for eligibility and those presenting with signs and symptoms of acute respiratory infections as defined in the WHO Programme for the Control of Acute Respiratory Infections [15] were approached. The inclusion criteria were defined as individuals of age 5 years and below who presented with a suspected case of respiratory tract infection. In particular, patients presenting with cough or difficulty in breathing with or without fever [15] in combination with other symptoms and signs where present: rhinorrhoea, headache, loss of smell, nausea, vomiting, general weakness, loss of

appetite and diarrhoea. Among these, only those whose caregivers provided consent were enrolled in the study. Participant selection was done without consideration of ethnicity and gender. Patients were excluded if they were over five years old, unable or unwilling to participate, or if they had any chronic lung disease. At enrolment, clinical symptoms and exposure were assessed, and a clinical examination was conducted to measure weight, height, respiratory rate, and peripheral capillary oxygen saturation.

Data and sample collection

In calculating the sample size, we used an HRSV prevalence of 23% Obodai et al. in 2019 [16], among children with acute lower respiratory infections in Ghana. We chose to use this estimated as a proxy prevalence of respiratory viral infections due to the limited local publications. Based on this prevalence, the sample size was pre-determined to be 272 [$n = Z^2 \frac{p.q}{e^2}$, z = 1.96, $p = 0.23$, q = 0.77, e = 0.05]. The general demographics, including age, sex, and caregiver education, were recorded using a standardised questionnaire (see supplementary file). Clinical data were extracted from the paediatrician's folder. Clinical data included symptoms (cough, runny nose, headache, difficulty breathing, etc.) and diagnosis (upper respiratory tract infection (URTI), bronchiolitis, pneumonia). Overall, 303 oropharyngeal swabs were collected with flocked swabs (Copan Group, Brescia, Italy) and inserted into 1.5mL Eppendorf tubes (Eppendorf, Germany) containing 500 µl of viral transport medium (BioTeke Corporation Co., Ltd, China). The tubes were labelled with corresponding facility-specific identification numbers and transported on ice to the Kumasi Centre for Collaborative Research in Tropical Medicine (KCCR) for laboratory analysis.

Laboratory analysis

Nucleic acid extraction was done using the RADI PREP Swab and Stool DNA/RNA KIT (KH Medical Co., Ltd, Republic of Korea) according to the manufacturer's instructions. Samples were eluted in a 70 µl volume and SARS-CoV-2 viral RNA detection was performed using the RADI COVID-19 Detection Kit (KH Medical Co., Ltd, Republic of Korea) following the manufacturer's instructions. The Invitrogen SuperScript III One-step RT-PCR System was used for the detection of Flu A, Flu B, RSV, HPIV I-III, HRV and HMPV. For HAdV testing, the Qiagen 10X PCR buffer with Taq polymerase was used. Viral nucleic acid detection was done by real-time Polymerase Chain Reaction (PCR) using the LineGene 9600 Plus thermocycler (FQD-96 A, Bioer Technology, China). All samples with a threshold cycle (Ct) above 40 were considered negative. All samples with a threshold cycle (Ct) less than 40 were considered positive. Positive and negative controls were included in each PCR run for validation.

Statistical analysis

Data collected were entered into Microsoft Excel 2021, cleaned and exported to R programming language version 4.3.0 for analysis. Descriptive statistics were used to summarise the distribution of age, gender and respiratory viruses into tables. Contingency tables were used to stratify various socio-demographic variables against the detection of specific viruses (presence/absence). Variables that were significant at the level of $p \leq 0.05$ and others with $p \geq 0.05$ but deemed biologically relevant were subjected to multivariate binary logistic regression analysis. Risk factors were expressed as ratios with corresponding 95% CIs, were used to examine the association between age, caregiver education and gender. All statistical tests with p-values less than 0.05 were considered statistically significant. This is consistent with the significance levels used in previous studies on respiratory viruses [1, 17, 18].

Results

Patient characteristics

From August 2022 to June 2023, a total of 303 children aged 60 months and below were recruited in this study. Majority were males ($n = 165$, 54.4%) with the highest number within age group 13 to 36 months ($n = 122$, 40.3%), with a median age of 19 months. The study participants presented with more than one symptom, with the most predominant being cough ($n = 265$, 87.0%), rhinorrhoea ($n = 265$, 87.0%) and fever ($n = 219$, 72.0%). The least recorded symptoms were headache ($n = 102$, 34.0%) and vomiting ($n = 76$, 25.0%). Table 1 shows the characteristics of the study population.

Prevalence of respiratory viruses

Among the 303 samples tested, a respiratory virus was detected in 100 (33.0%, 95% CI: 27.7–38.3%) of the samples. The most prevalent virus was HMPV with 36 cases (12.0%, 95% CI: 8.2–15.5%), followed by RSV with 27 cases (8.9%, 95% CI: 5.7–12.1%), and then HAdV with 20 cases (6.6%, 95% CI: 3.8–9.4%). No HPIV-I was detected (See Table 2).

In Table 3, it is shown that out of the 100 samples that were positive for at least one respiratory virus, 92 (92.0%) had single viral detections and 8 (8.0%) had double viral detections.

Of the 8 samples that tested positive for two viruses, HAdV and HMPV were identified in 6 (75.0%) and 4 (50.0%) respectively. The combination of HAdV and HMPV co-detection was identified in 3 (37.5%) samples. SARS-CoV-2, HRV, Flu A, Flu B, PIV-II, PIV-III and RSV were each identified in single cases of co-detection.

Table 1 Characteristics of the study population

Variable	Number of participants (%)
Age (months)	
< 6	45 (14.8)
6–12	61 (20.1)
13–36	122(40.3)
37–60	75(24.8)
Gender	
Male	165 (54.4)
Female	138 (45.6)
Caregiver Education	
No formal education	57 (19.0)
JHS/Primary	42 (14.0)
SHS/Secondary	54 (18.0)
Tertiary	104 (34.0)
Symptoms	
Fever	219 (72.0)
Cough	265 (87.0)
Headache	102 (34.0)
Shortness of breath	122 (40.0)
Poor feeding	115 (38.0)
Vomiting	76 (25.0)
Rhinorrhoea	265 (87.0)
Loss of appetite	117 (39.0)

Table 2 Prevalence of respiratory viruses

Viral respiratory pathogen	Frequency	Prevalence (%)
SARS-CoV-2	3	1.0
HAdV	20	6.6
HRV	6	2.0
HPIV-I	0	0
HPIV-II	2	0.7
HPIV-III	2	0.7
FLU A	5	1.7
FLU B	7	2.3
HMPV	36	12.0
RSV	27	8.9

Circulation pattern of respiratory viruses

The number of samples that were positive for most viruses were generally low and unevenly distributed over the months within the period of the study as shown in Fig. 1. Respiratory viral detection was the highest in June with 34/56 (60.71%) samples positive for HMPV and 12/56 (21.43%) samples positive HAdV. No viruses were detected in the months of December and January. RSV was detected in the months August, September, November, May and June with a peak observed in October.

Risk factors associated with respiratory viral detection

The factors age and caregiver education were subjected to multivariate binary logistic regression based on a p-value of less than 0.05 at the univariate analysis, however gender was included due to prior evidence [19] as risk factor for respiratory infections. The risk factor analysis was limited to HMPV, RSV, and HAdV due to the low prevalence of other respiratory viruses. According to the multivariate binary logistic regression analysis of the risk factors, children younger than 6 months (AOR: 4.81, 95% CI: 1.20–24.60, p-value = 0.036) had higher odds of RSV detection when compared to children aged 37 to 60 months. It is evident from Table 4 that children with caregivers who had completed tertiary education (AOR: 6.91, 95% CI: 1.71–47.30, p-value = 0.017) were more likely to test positive for HMPV compared to those with caregivers who had no formal education. The clinical risk factors evaluation in Table 5 showed that children presenting with headache (AOR: 3.95, 95% CI: 1.35–12.60, p-value = 0.015) had higher odds of testing positive for HAdV compared to children without headache. In addition, children who presented with shortness of breath (AOR: 0.33, 95% CI: 0.13–1.02, p-value = 0.014) had lower odds of testing positive for HMPV compared to children without shortness of breath.

Table 3 Single and double virus detections made during the study period

Virus	Number of samples (%)	SARS-CoV-2	HAdV	HRV	HPIV-II	HPIV-III	FLU A	FLU B	HMPV	RSV
SARS-CoV-2		**2**	1	0	0	0	0	0	0	0
HAdV		-	**14**	0	0	0	1	1	3	1
HRV		-	-	**6**	0	0	0	0	0	0
HPIV-II		-	-	-	**1**	1	0	0	0	0
HPIV-III		-	-	-	-	**1**	0	0	0	0
FLU A		-	-	-	-	**-**	**4**	0	0	0
FLU B		-	-	-	-	**-**	-	**6**	1	0
HMPV		-	-	-	-	-	**-**	**-**	**32**	0
RSV		-	-	-	-	-	-	-	-	**26**
SINGLE DETECTION	**92 (92.0)**	2	14	6	1	1	4	6	32	26
DOUBLE DETECTION	**8 (8.0)**	1	6	0	1	1	1	1	4	1
TOTAL	**100 (100.0)**	**3**	**20**	**6**	**2**	**2**	**5**	**7**	**36**	**27**

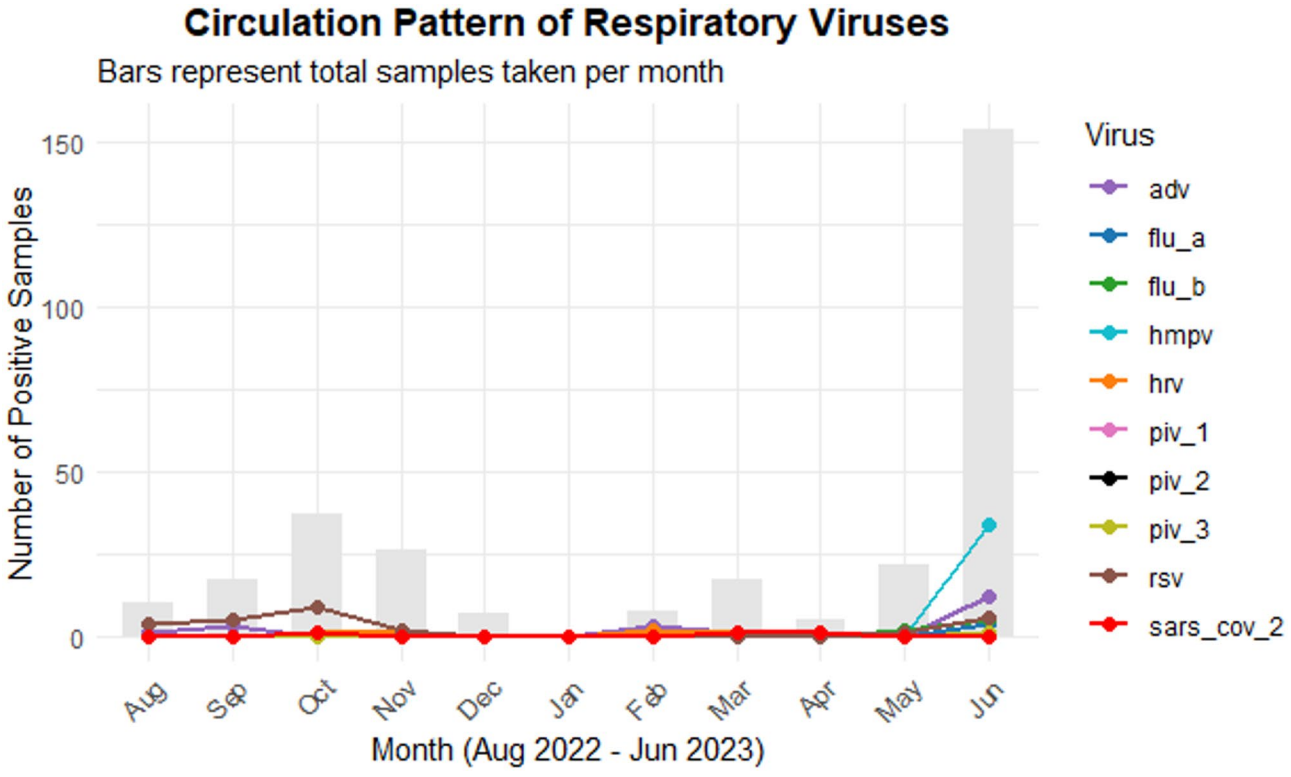


Fig. 1 Seasonal variation of the respiratory viruses detected among study participants

Discussion

The present study emphasized the prevalence of various respiratory viruses including RSV, Flu A, Flu B, HPIV I, II, III, HAdV, SARS-CoV-2, HRV, and HMPV among children exhibiting respiratory symptoms and signs. The overall prevalence recorded among the study participants was 33.0%.

Previous studies from Ghana, prior to the COVID-19 pandemic, have reported varying estimates of prevalence of respiratory viruses from 12.5 to 73.0% among the paediatric population [1, 17, 18, 20]. From those studies, relatively higher viral prevalence has been observed among hospitalized cases with more severe symptoms than cases recruited in the outpatient department (OPD), as was done in the present study [1, 17, 18, 20].

In other parts of Africa, higher viral prevalence was reported in Burkina Faso (85.0%), Kenya (68.0%) and Cameroon (65.0%) [21–23]. Generally, variations in prevalence of respiratory viruses can be attributed to a number of reasons, including the panel of viral agents tested, the duration of the study, climatic conditions and enrolment criteria [24]. The recruitment of outpatients and daytime sampling in the present study could account for the relatively lower viral prevalence in comparison with previously published studies that recruited hospitalized patients.

HMPV was the most predominant virus, identified in 12.0% of the recruited participants. Approximately 90.0% of the HMPV cases were detected in one site during a three-week period, leading to a higher prevalence compared to previous reports in Ghana [1, 17, 18]. This increase may have been caused by an undetected HMPV outbreak, driven by nosocomial infections which is an existing significant public health concern, especially among paediatric patients [25]. The absence of viral testing in Ghanaian healthcare facilities further complicates the detection of such outbreaks. Recent studies since the decline of SARS-CoV-2 cases have also reported high prevalence of HMPV in Myanmar (13.0%), USA (12.6%) and Nepal (13.3%) [5, 26, 27].

RSV, which has been implicated as a major cause of ARI in children, was identified in 8.9% of the study population. The aggressive implementation of non-pharmaceutical interventions (NPIs) during the COVID-19 pandemic led to a significant decline in RSV cases among young children globally, as reported in South Africa (4.1%), the United Kingdom (0.1%) and Canada (0.05%) [12, 13, 28]. However, with the gradual relaxation of NPIs, countries like Egypt (20.9%) and China (21.7%) witnessed a resurgence in RSV cases, particularly among young children [29, 30].

The finding from this study emphasizes the importance of routine testing in enhancing the management of

Table 4 Risk factors associated with respiratory viruses in the study population

	OR (95% CI)						AOR (95% CI)					
Variable	**RSV**	***p*-value**	**HMPV**	***p*-value**	**HAdV**	***p*-value**	**RSV**	***p*-value**	**HMPV**	***p*-value**	**HAdV**	***p*-value**
Age group												
37–60	Ref		Ref		Ref		Ref		Ref		Ref	
<6	6.00 (1.68–28.30)	**0.010**	0.60 (0.13–2.20)	0.500	0.53 (0.08–2.44)	0.500	4.81 (1.20–24.60)	**0.036**	0.79 (0.16–3.11)	0.700	0.55 (0.07–2.71)	0.500
6–12	2.14 (0.50–10.80)	0.300	0.91 (0.29–2.78)	0.900	0.59 (0.12–2.36)	0.500	2.21 (0.48–11.90)	0.300	0.96 (0.29–3.06)	0.900	0.60 (0.12–2.48)	0.500
13–36	2.14 (0.63–9.8)	0.300	1.54 (0.66–3.93)	0.300	0.92 (0.32–2.84)	0.900	2.27 (0.64–10.70)	0.200	1.39 (0.57–3.62)	0.500	0.91 (0.31–2.86)	0.900
Gender												
Female	Ref		Ref		Ref		Ref		Ref		Ref	
Male	0.46 (0.20–1.02)	0.062	0.82 (0.40–1.65)	0.600	0.83 (0.33–2.07)	0.700	0.46 (0.19–1.05)	0.069	0.89 (0.41–1.96)	0.800	0.83 (0.31–2.18)	0.700
Caregiver Education												
No education	Ref		Ref		Ref		Ref		Ref		Ref	
JHS/Primary	0.44 (0.11–1.40)	0.200	0.67 (0.03–7.23)	0.700	1.38 (0.25–7.83)	0.700	-		0.90 (0.04–10.50)	0.900	1.00 (0.15–6.48)	0.900
SHS /Secondary	-		7.03 (1.77-47.00)	**0.014**	1.06 (0.19–5.95)	0.900	-		6.91 (1.60–48.50)	**0.020**	0.98 (0.16–5.94)	0.900
Tertiary	0.21 (0.06–0.62)		6.55 (1.81-42.00)	**0.014**	1.91 (0.56–8.81)	0.300	-		6.91 (1.71–47.30)	**0.017**	2.27 (0.59)	0.300

Table 5 Clinical symptoms associated with respiratory viruses in the study population

			OR (95% CI)						AOR (95% CI)			
Variable	**RSV**	***p*-value**	**HMPV**	***p*-value**	**HAdV**	***p*-value**	**RSV**	***p*-value**	**HMPV**	***p*-value**	**HAdV**	***p*-value**
Clinical Symptom												
Fever												
No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	1.38 (0.57–3.87)	0.500	0.86 (0.40–1.65)	0.700	1.16 (0.43–3.67)	0.800	1.68 (0.64–5.08)	0.300	0.88 (0.37–2.15)	0.800	0.83 (0.26–2.88)	0.700
Cough												
No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	-		2.65 (0.76–16.8)	0.200	0.55 (0.19–1.99)	0.300	-		2.77 (0.65–20.5)	0.200	0.48 (0.15–1.86)	0.200
Headache												
No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	0.54 (0.19–1.30)	0.200	0.85 (0.39–1.77)	0.700	3.22 (1.29–8.47)	**0.014**	0.75 (0.25–2.01)	0.600	1.12 (0.46–2.65)	0.800	3.95 (1.35–12.6)	**0.015**
Shortness of breath												
No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	1.02 (0.45–2.27)	0.900	0.38 (0.16–0.84)	**0.022**	0.79 (0.29–1.98)	0.600	1.07 (0.45–2.50)	0.900	0.33 (0.13–1.02)	**0.014**	0.76 (0.26–2.06)	0.600
Rhinorrhoea												
No	Ref		Ref		Ref		Ref	0.400	Ref		Ref	
Yes	1.87 (0.53-12.00)	0.400	0.44 (0.19–1.12)	0.067	-		1.98 (0.54–12.90)		0.36 (0.13–0.77)	0.055	-	
Poor feeding												
No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	0.80 (0.33–1.81)	0.600	0.43 (0.18–0.93)	**0.043**	1.37 (0.53–3.41)	0.500	0.81 (0.32–1.94)	0.600	0.39 (0.15–0.97)	0.052	1.07 (0.38–2.94)	0.900
Vomiting												
No	Ref		Ref		Ref		Ref		Ref		Ref	
Yes	0.84 (0.30–2.05)	0.700	0.34 (0.10–0.89)	**0.048**	2.11 (0.80–5.31)	0.120	0.81 (0.27–2.11)	0.700	0.55 (0.15–1.64)	0.300	2.13 (0.75–5.84)	0.140

RSV-related respiratory infections in young children. The prevalence of HAdV (6.6%), HRV (2.0%), Flu A (1.7%), and Flu B (2.3%) in the present study was lower than previous studies conducted pre-COVID-19 pandemic among Ghanaian children [9, 17, 18, 20]. Apart from Influenza, which is under routine surveillance in Ghana, respiratory viruses are not routinely sought for in Ghanaian healthcare facilities [9]. The relatively lower prevalence still, however, highlights the circulation of these viruses among the paediatric population. A major implication of the failure to detect them is a possible increase in antimicrobial resistance as antibiotics are often prescribed to treat apparent respiratory infections [31].

Young children have been reported to be less often infected by SARS-CoV-2 when compared to adults [32]. Our study found a similarly low prevalence (1.0%) as reported among children (0.4%) during the peak of the COVID-19 pandemic in Ghana [33]. Comparisons with studies from other parts of the world revealed that regardless of the clinical profile, SARS-CoV-2 prevalence remains low among children [34–36]. HPIV-II and HPIV-III were both detected in 0.7% of the study group with no detection (0%) for HPIV-I. This was lower than previous reports in Ghana [18, 20, 37] and other African countries like Cameroon and Niger [23, 24]. It is possible there may have been low viral activity of HPIV since there was no year-round sampling. Generally, the limited diagnostic capacity of healthcare facilities to detect respiratory viruses increases the risk of infected children unknowingly transmitting these viruses to others in daycare, schools and households. Consequently, this adds more burden to the constrained healthcare system in Ghana.

HMPV and HAdV accounted for 3 (37.5%) of the 8 co-detections observed in this study. Single cases of co-detection were observed for the HAdV and RSV, HAdV and SARS-CoV-2, HAdV and flu A, HMPV and flu B, and HPIV-II and HPIV-III. Literature on viral co-detection in respiratory illness among children shows conflicting results. Some studies [38, 39] suggest worse outcomes and longer hospital stays, whereas others [40, 41] found no association between viral co-detection and illness severity. Our study however, did not determine the association between viral co-detection and its impact on health, as only outpatients were recruited.

The circulation pattern of respiratory viruses has been reported to be affected by changes in weather conditions [20]. Our findings showed that the circulation of RSV peaked in October, which falls within the rainy season from April to October in Ghana. Some studies conducted in Ghana and other African countries have previously reported RSV to have high seasonal activity in October [20, 37, 42, 43]. The detection of RSV in the rainy season could be due to overcrowding because of the inclination of people to stay indoors. Although most HMPV positive cases were detected in June, its seasonality could not be determined because of the few positive cases in the other months. However, HMPV has previously been reported to predominantly circulate during the rainy season in other tropical countries [44, 45]. HAdV circulation was also observed in the rainy season with a peak in June. HAdV has been reported to show no distinct seasonality but circulates all year round or sporadically [46, 47]. The observation in our study could be due to the high number of samples collected in June. The true estimation of the seasonal variation of respiratory viruses in the study may have been impacted by the uneven number of samples taken across the months.

We identified age as a risk factor for RSV detection in our study. Children aged younger than 6 months (AOR: 4.81, 95% CI: 1.20–24.60) had higher odds of testing positive for RSV when compared to those aged from 37 to 60 months. This is consistent with other studies that identified a higher risk of RSV infection among children less than 6 months than other age groups [48, 49]. Children younger than six months are biologically more vulnerable to ARIs due to the ongoing development of their immune system and lungs, leaving them with insufficient immunity when exposed to infections [50].

Our study identified secondary and tertiary level of caregiver education as risk factors for HMPV detection. Children whose caregivers had attained secondary (AOR: 6.91, 95% CI: 1.60–48.50) and tertiary (AOR: 6.91, 95% CI: 1.71–47.30) education had higher odds of HMPV detection when compared to those with caregivers of no formal education. This association may have been confounded or mediated by socioeconomic factors like healthcare-seeking behaviour and day-care attendance which were not explicitly controlled for in our analysis. This was in contrast to findings by Ujunwa in Nigeria and Tazinya in Cameroon, who suggested that no formal education among caregivers led to poor hygienic practices in homes. This was reported to increase the risk of respiratory viral detection among children [51, 52]. A possible explanation for our finding could be that caregivers with higher education may enrol children in crowded day-care settings and kindergartens. This could potentially increase the risk of respiratory virus transmission, such as HMPV. We identified headache as a clinical risk factor for HAdV detection in our study. Children with headaches (AOR: 3.95, 95% CI: 1.35–12.60) had higher odds of testing positive for HAdV than those without headaches. This aligns with a study in Senegal linking HAdV detection to headaches in children with respiratory illness [53]. In infants, headaches have been associated with adenoviral pharyngitis. Symptoms of common cold such as sneezing and sinus inflammation induced by HAdV can contribute to headache sensations [54, 55]. Children with shortness of breath (AOR: 0.33, 95% CI: 0.13–1.02) in

our study had lower odds of testing positive for HMPV, contrary to previous studies associating dyspnoea with HMPV infection [56–58]. The discrepancy might be due to potential non-viral causes, like *Streptococcus pneumoniae* or *Haemophilus influenzae*, which were not assessed in this study but are known to cause bacterial pneumonia with similar symptoms [59].

Our study has some limitations: While a hospital-based sampling approach allowed for the efficient collection of data within the scope of the study, the reported prevalence of respiratory viruses may not reflect the true prevalence in the general population. The use of hospital-based data may limit the generalizability of our findings. We could not also rule out possible nosocomial infections that could arise from prolonged period of hospitalization. The recruitment of these subjects could introduce some level of bias. Follow-ups were not conducted to determine causality associated with the various viral infections. There were wide confidence intervals observed for some associations, including age and RSV detection and caregiver education and HMPV detection, which may have been due to small sample size in certain subgroups and variability in data. This may reduce the precision of our estimates. While the findings suggest strong associations, they should be interpreted cautiously because of the wide confidence intervals. Larger sample sizes in future studies could provide more robust subgroup analysis for more precise estimates.

Conclusion

The results of our study indicate that HMPV, the most common respiratory virus, may have a more significant impact on the cause of respiratory illness in Ghanaian children than previously believed. The increased scientific and public awareness of the burden of respiratory infections by the COVID-19 pandemic provides a good opportunity to make advances towards reducing the spread of common respiratory viruses. Further studies, including longitudinal follow-ups, should be conducted in other geographical locations in the country to elucidate the viral prevalence patterns and provide a comprehensive overview of the respiratory virome in the Ghanaian paediatric population.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12879-025-11201-0.

Supplementary Material 1

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Author contributions
MO and AAS designed the research; CAG and JAA performed laboratory tests and acquired data; CAG, JAA and HKA analysed and interpreted the data; CAG and JAA wrote the original manuscript; MO and AAS revised the manuscript. All authors reviewed the manuscript.

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Data availability
Raw data that support the findings of this study have been deposited in the Open Science Framework with the digital object identifier (DOI) 10.17605/OSF.IO/QW2HU.No new sequences were generated in this study.

Declarations

Ethics approval and consent to participate
The protocols used for the study were reviewed and approved by the Ghana Health Service Ethics Review Committee (GHS-ERC: 007/05/22) and informed consent was obtained from the caregivers/guardians of all the participants by signature or thumb-print in accordance with the ethical principles of the Declaration of Helsinki [60].

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Abbreviations
AOR Adjusted odds ratio.
ARIs: Acute Respiratory infections.
CI: Confidence Interval.
COVID-19: Coronavirus Disease 2019.
Ct: Cycle threshold.
GHS-ERC: Ghana Health Service Ethics Review Committee.
HAdV: Human Adenovirus.
HMPV: Human Metapneumovirus.
HPIV: Human Parainfluenza virus.
HRV: Human Rhinovirus.
KCCR: Kumasi Centre for Collaborative Research in Tropical Medicine.
NPIs: Non-Pharmaceutical Interventions.
OPD: Outpatient department.
PCR: Polymerase Chain Reaction.
RSV: Respiratory Syncytial Virus.
SARS-CoV-2: Severe Acute Respiratory Syndrome Coronavirus 2.
URTI: Upper Respiratory Tract Infection.

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