








# Influence of epidemics and pandemics on paediatric ED use: a systematic review

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## ABSTRACT

**Objective** To assess the impact of epidemics and pandemics on the utilisation of paediatric emergency care services to provide health policy advice.

**Setting** Systematic review.

**Design** Searches were conducted of Medline, EMBASE, CINAHL, Scopus, Web of Science and the Cochrane Library for studies that reported on changes in paediatric emergency care utilisation during epidemics (as defined by the WHO).

**Patients** Children under 18 years.

**Interventions** National Institutes of Health quality assessment tool for observational cohort and cross-sectional studies was used.

**Main outcome measures** Changes in paediatric emergency care utilisation.

**Results** 131 articles were included within this review, 80% of which assessed the impact of COVID-19. Studies analysing COVID-19, SARS, Middle East respiratory syndrome (MERS) and Ebola found a reduction in paediatric emergency department (PED) visits, whereas studies reporting on H1N1, chikungunya virus and *Escherichia coli* outbreaks found an increase in PED visits. For COVID-19, there was a reduction of 63.86% (95% CI 60.40% to 67.31%) with a range of -16.5% to -89.4%. Synthesis of results suggests that the fear of the epidemic disease, from either contracting it or its potential adverse clinical outcomes, resulted in reductions and increases in PED utilisation, respectively.

**Conclusions** The scale and direction of effect of PED use depend on both the epidemic disease, the public health measures enforced and how these influence decision-making. Policy makers must be aware how fear of virus among the general public may influence their response to public health advice. There is large inequity in reporting of epidemic impact on PED use which needs to be addressed.

**Trial registration number** CRD42021242808.

## INTRODUCTION

The uncertainty surrounding the infectivity and mortality rates of COVID-19 meant many countries instituted restrictions on public freedoms to drive down community transmission. The use of strict lockdowns and 'stay-at-home' orders have been under scrutiny, especially as many of these

## WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ There have been five previous disease outbreaks, since 2005, which have been classified as a 'Public Health Emergency of International Concern' by WHO.
- ⇒ The evidence of their impact on emergency services for children has not been subject to a formalised review.

## WHAT THIS STUDY ADDS

- ⇒ This systematic review demonstrates that pandemics have significantly different impacts on paediatric emergency service utilisation depending on the epidemic/pandemic.
- ⇒ Differences in impact within and between countries may be related to the number of publications from that country and the length of time of their studies.
- ⇒ The reasons for changing emergency care utilisation are likely related to the public health response and parent/carer concern about the severity of the disease process.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

- ⇒ Policy makers must be aware how fear of viruses among the general public may influence their response to public health advice.
- ⇒ The inequality between low-middle and high-income countries in reporting the impact of emergency service utilisation for children must be recognised and addressed.

countries recorded drastic reductions in the utilisation of their emergency healthcare services by patients without COVID.<sup>1</sup> It has become clear that other than the rare complication of multisystem inflammatory syndrome in children,<sup>2</sup> SARS-CoV-2 infection in children is generally a mild disease.<sup>3</sup> However, there was also early evidence of low utilisation rates of emergency services among paediatric patients. Lazzarini *et al*<sup>4</sup> reported that, even though overall attendances were reduced, there were signs of delays in presentations, highlighting that 'parent's reported avoiding accessing hospital because of fear of infection with SARS-CoV-2'.



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There have been five previous disease outbreaks, since 2005, which have been classified as a 'Public Health Emergency of International Concern' by WHO.<sup>5</sup> The catalyst for this classification of the International Health Regulations in 2005 was the outbreak of SARS-CoV in 2003.<sup>6</sup>

The aim of this study was to conduct a systematic review of the literature from across the world on the impact pandemics and epidemics had on the utilisation of emergency care services by children.

## METHODS

This work is part of the EPISODES study, an international retrospective cohort study looking at the epidemiology, severity and outcomes of children presenting to emergency departments across Europe during the SARS-CoV-2 pandemic.<sup>7</sup>

This review has followed the guidance published within the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement.<sup>8</sup>

The predefined study characteristics and full search strategy are set out in the form of a 'PICO grid' in online supplemental appendix A, table A and, where possible, the search was limited to 'child < 18 years' and 'English language'. A senior academic librarian (information specialist) specialising in medical research reviewed the search strategy.

Two reviewers performed the title and abstract screening with any conflicts resolved by a third reviewer. Criteria for inclusion were original studies examining the access to emergency care services by children (< 18 years) during pandemics/epidemics as defined by WHO (<https://www.who.int/emergencies/diseases/en/>); studies of adults, 18 years and older were excluded.

To assess the quality of each study, the 'National Institutes of Health (NIH) quality assessment tool for observational cohort and cross-sectional studies'<sup>9</sup> was used. A single author (AG) reviewed all papers with the rest of the author group reviewing sections of the selected journals to confirm the answers to the NIH quality assessment tool. The lead author (DR) arbitrated on any differences in quality rating. Due to the heterogeneity between the included articles, meta-analysis could not be performed. Therefore, instead, a narrative analysis of the articles, split by epidemic disease being studied, was conducted.

We registered the protocol of our systematic review with PROSPERO ([www.crd.york.ac.uk/PROSPERO/](http://www.crd.york.ac.uk/PROSPERO/), published on 16 March 2021, protocol ID: CRD42021242808). The finalised protocol can be found in online supplemental appendix 2.

## RESULTS

The literature search produced a total of 9374 results; deduplication removed 1806 articles.

A total of 7568 articles were screened through the title and abstract review. There was unanimous decision to exclude 7169 of the articles and a further 198 articles with conflicting decisions were excluded by the third reviewer.

The 124 articles that were included after the full-text review were searched for additional potentially includable articles within their references. Seven previously not retrieved articles met the inclusion criteria and therefore 131 articles entered the data extraction phase and final analysis. A PRISMA flowchart summarising this process can be found in figure 1.

Of the 131 articles included for final analysis and review, 104 (79.4%) were publications related to the COVID-19 pandemic only<sup>110-112</sup>; 16 articles focused on H1N1 (113-128); 4 and 2 articles concerned SARS<sup>113-116</sup> and MERS,<sup>117 118</sup> respectively. One article<sup>119</sup> had data comparing the effect on children's healthcare utilisation for both the COVID-19 pandemic and SARS outbreak. The final four articles analysed the effect of the Ebola outbreak in Sierra Leone<sup>120</sup>; an outbreak of chikungunya virus in Jamaica in 2014<sup>121</sup>; a severe influenza outbreak in Israel in the 1999-2000 season;<sup>122</sup> and an *Escherichia coli* 0157:H7 outbreak in the USA in 1993.<sup>123</sup> Analysis of these papers can be found in the online supplemental appendix 3. A world map showing the distribution by country including all the articles can be found in figure 2. It highlights the USA (n=41), Italy (n=25) and the UK (n=9) as major publication countries while also showing the global spread of included articles. Using the World Bank Classification of Countries<sup>124</sup> shows that the majority of the included articles analysed the effect in 'higher income' countries (n=120 (91.6%)), with only 11 studies (8.4%) from 'upper middle-income countries (UMIC)' (n=6), 'lower middle-income countries (LMIC)' (n=4) and 'lower income' country (n=1).<sup>120</sup> Online supplemental appendix 4, table B show the

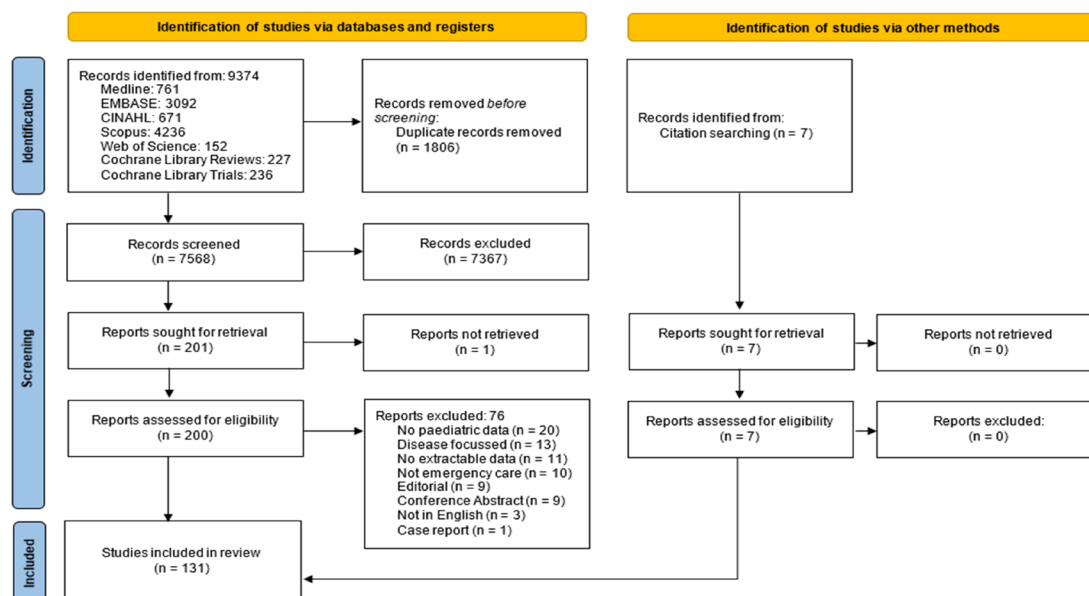
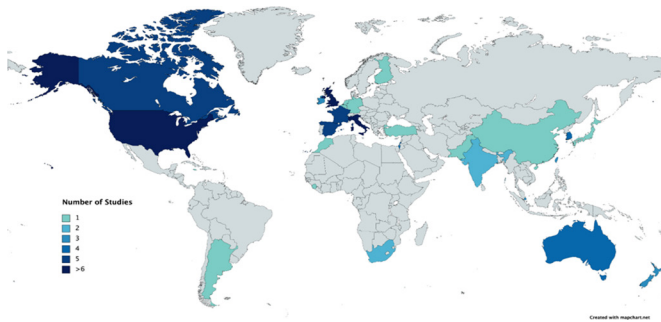


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.<sup>8</sup>



**Figure 2** World map showing density of publications by country.

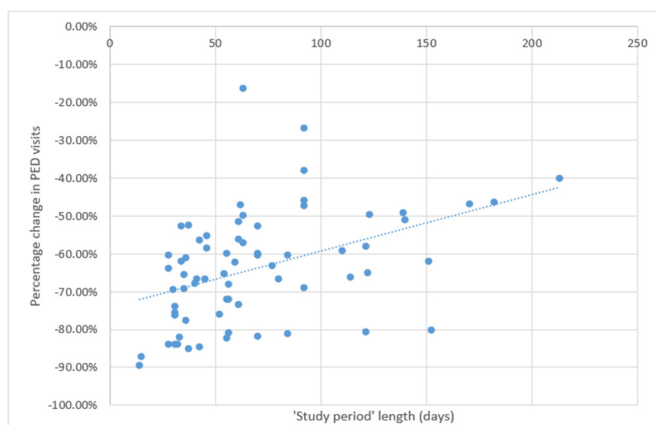
study characteristics of the included studies and online supplemental appendix 5, table C show the completed NIH assessment tool for each article.

### COVID-19

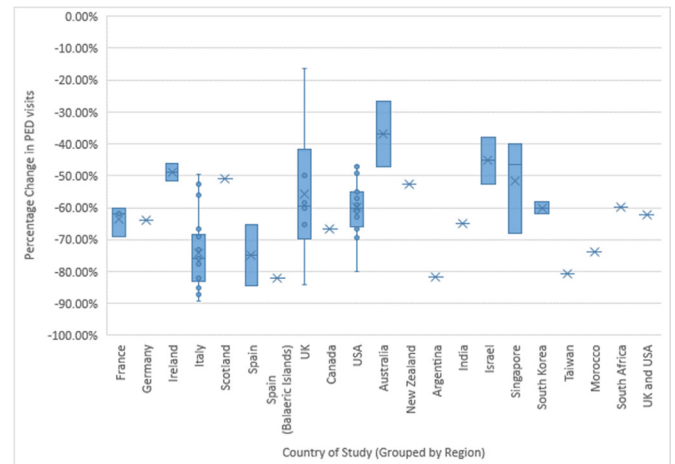
SARS-CoV-2/COVID-19 was the disease of focus within 105 articles. The majority were published by countries most affected by the disease during the first wave of the pandemic. Most publications were from higher income or upper middle-income countries, with only four papers published from lower middle-income countries: India,<sup>43 92</sup> Morocco<sup>28</sup> and Pakistan.<sup>79</sup>

Initial analysis found that 69 out of 105 (66%) provided quantifiable data for a change in general paediatric emergency department (PED) visits. Collectively, they included about 14 million individual visits, across the various COVID-19 study periods and previous year(s) data (online supplemental table 1). Acknowledging various methodologies were used in studies to compare the observed values with the predicted number for the corresponding time periods, the mean percentage change in PED visits across the 69 included articles was a reduction of 63.86% (95% CI 60.40% to 67.31%) with a range of -16.5% to -89.4.

Figure 3 shows the value for percentage change in PED visits and the number of days included in the study period. There is a suggestion that smaller study periods show a greater reduction, likely due to studies with shorter study periods focussing on the 'lockdown' period in their respective countries. The difference between countries may also be explained, in part, by the number of papers published in that particular country (figure 4).



**Figure 3** Scatterplot of percentage change in paediatric emergency department (PED) visits by the length in days of the 'study period'. This plot includes data from 69 articles analysing COVID-19 that provided quantitative data for PED visits.



**Figure 4** Box and whisker plot showing percentage change in paediatric emergency department (PED) visits by the country of study, grouped by region. This plot includes data from 69 articles analysing COVID-19 that provided quantitative data for PED visits.

Summary data for surgical patients, mental health, diabetes care, specialist healthcare utilisation and qualitative papers can be found in online supplemental appendices 6 and 7, tables D–F with additional analysis into these papers.

Online supplemental appendix 8, table G show the summary data for articles analysing the impact of COVID-19 on PED visits, but it was not possible to retrieve quantitative data from the authors.

Themes were extracted of potential reasons for the reduction in PED visits discussed within the COVID-19 articles (the breakdown by article can be found in online supplemental appendix 4, table B and a summary in online supplemental appendix 9, table H). Twenty-seven papers found no supporting evidence to determine the potential cause for the reduction in visits and, of the remaining 78 papers, the most common reason (n=52, 66.7%) alluded to by the authors was the 'fear of contracting the virus', closely followed by the impact of 'social distancing/lockdown measures' (n=49, 62.8%).

### Influenza A/H1N1 (2009 pandemic)

Sixteen articles that analysed the H1N1 pandemic in 2009/2010 met the inclusion criteria for this review. All were published in higher income countries (11/16 in the USA). The years of publications range from 2009 to 2015, with the most published in 2011 (n=6). Eleven<sup>125–135</sup> of the articles provided data for PED visits for both a period of time during the pandemic and a control period prior to the outbreak. Five<sup>136–140</sup> did not provide quantifiable data; however, two<sup>136 137</sup> still provided a percentage change for PED visits and Codish *et al*<sup>139</sup> analysed the effect of mass media on public behaviour.

During the H1N1 pandemic period, there was a surge in paediatric utilisation of emergency care (summary data can be found in online supplemental appendix 10, table I). The range of values for percentage increase found within the articles is 10.6%–180%.

Sills *et al*<sup>131</sup> postulated multiple reasons for the observed increase in PED visits: parents' fear of adverse outcomes, the perception of less primary care access, inappropriate referrals and advice from the media not being accurate. Codish *et al*<sup>139</sup> found a significant association between mass media coverage of the H1N1 pandemic in Israel and the number of PED visits.

### Severe acute respiratory syndrome (SARS)

There were four articles that analysed the SARS epidemic and each showed a significant reduction in PED visits, ranging from a 36.1% to a 47% reduction. South Korea was the only country to publish articles looking at the 2015 MERS outbreak that met the inclusion criteria for this review. Summary data for SARS articles, as well as MERS articles and the four articles analysing the other epidemic diseases, can be found in online supplemental appendix 11.

Potential reasons for the reductions in PED visits during the SARS epidemic were postulated as a fear of SARS transmission,<sup>113 114</sup> the influence of media coverage with phrases such as ‘killer pneumonia’<sup>113</sup> or public health department advice, in this case, to stay at home when exhibiting SARS-like symptoms.<sup>116</sup>

### DISCUSSION

The evidence presented within this systematic review shows that pandemics/epidemics can result in changes in emergency care utilisation both directly (ie, the causative organism results in ill health and a need to present to emergency services) and indirectly (attendance to emergency care may be reduced because of fear of catching a disease from other patients) dependent on the specific epidemic disease.

A critical finding was the disproportionate nature of research in this area both in relation to the country of research and the epidemic/pandemic. The proportion of articles addressing the effects of COVID-19 was large, accounting for 80% of the articles, with a significant proportion of these being from high-income countries. Fontelo and Liu<sup>141</sup> reviewed recent publication trends from countries and found 30 countries generated 94.6% of all publications and 98.1% of publications in core clinical journals worldwide. Of further note is that for COVID-19, two papers published in India,<sup>43 92</sup> one published in Pakistan<sup>79</sup> and another in Morocco<sup>28</sup> all show similar changes in healthcare utilisation to the rest of the included articles, implying that the observed indirect effects of the COVID-19 pandemic were not less severe, nor magnified in high-income countries. However, this assertion is severely limited by the fact that it only draws on evidence from 4 of 105 papers and only 2 of these papers provide data for general ED visits: Raman and Madhusudan<sup>43</sup> and Mekaoui *et al.*<sup>28</sup> This disparity of evidence between high-income and low-middle-income countries has implications for the extension of early research findings from future pandemics, as it cannot be assumed that low-income and middle-income countries’ emergency service utilisation will be similar to early reports from high-income countries. Of particular significance is the very small amount of information available for diseases such as Ebola and chikungunya.

This systematic review shows that for the COVID-19 pandemic, the 2015 MERS outbreak, the 2003 SARS pandemic, the 2014 Ebola outbreak and the 1999–2000 influenza outbreak in Israel, there were significant decreases in paediatric utilisation of emergency care services. These decreases were most noticeable throughout the COVID-19 pandemic, with evidence showing that the institution of lockdowns and home confinements coincided with a sudden drop in PED visits.<sup>10 11 13 76</sup>

Low acuity attendances to emergency services occur commonly in high-income countries.<sup>142 143</sup> Our review generally found either a larger reduction in lower acuity paediatric patients compared with those requiring more urgent care, resulting in a proportional increase in higher acuity paediatric patients,<sup>35 36 41 43 56 102</sup> or no change in the overall proportion,<sup>64 66 73</sup> despite overall reduced numbers. Individual studies with specific triage detail<sup>34</sup> have shown a large decrease in absolute numbers for non-urgent (Emergency Severity Index (ESI) 4 or 5) but a proportional increase in urgent

(ESI 3) visits or a large proportional and significant absolute increase in resuscitation/emergency consultations. The overall inference is that, particularly in high-income countries, a significant proportion of attendances in non-epidemic times do not need emergency care, but it is possible some children attended at a later stage of their illness during epidemics/pandemics. There are insufficient data to demonstrate whether this occurs in low-middle income countries as well.

The impact of epidemics on health seeking behaviour when emergency care is required was mixed in our review. Lynn *et al.*<sup>103</sup> found a delayed presentation was a suspected causative factor in nine deaths. Increases in severe diabetic ketoacidosis<sup>74 75 91 92</sup> and complicated acute appendicitis presentations<sup>86 144</sup> are examples of this. However, Chong *et al.*<sup>35</sup> did not observe a large deferred increase in ‘priority 1 (most ill)’ cases in the early post-lockdown period and Roland *et al.*<sup>105</sup> noted a ‘low rate of reported delays’ at 3.8% (n=51) and, of these, the admission rate was also low at 11.8% (n=6).

This review highlights the need for reflection on the structure of emergency services post-pandemic. Policy makers need to urgently consider how the public can address minor illness and injury at home, or at least more locally, rather than seeking emergency care services as clearly many children were managed without healthcare intervention during pandemics. Our data highlight that public reactions could change according to their perception of risk related to that pandemic (eg, COVID-19 vs H1N1). The increase in visits to the PED during the H1N1 pandemic may then have been a result of the higher mortality and parental fears of adverse outcomes.<sup>145 137</sup> This suggests policy makers and health authorities may need to provide the public ‘personalised and periodically updated communication’ as opposed to generic advice and be aware messaging can reassure or scare the public.

The vast majority of the articles included within this review had a retrospective observational methodology which brings with it inherent limitations. Many of the articles analysed the effect at a single hospital/city, which may not allow their data to be generalised, but the large amount of studies from many countries included in this review improve on this limitation. Some studies also had no or very few cases of the epidemic disease at the hospital or in the region, which may have been a cause behind differing changes in PED visits between studies, making comparisons difficult. It is noted that the pandemic still continues and so the final impact on attendances is not certain with further analysis of trends greater than 1–2 years needed. Finally, redeployment of staff did occur during the COVID-19 pandemic but the impact of this was not directly measured in the papers we reviewed. Nor did they take into account other system changes, such as the development or closure of primary care services which also may have had an impact on attendances.

### CONCLUSION

We found that PED attendances may increase or decrease during these pandemics and epidemics, the reasons being multifactorial, and ultimately individual experiences and behaviours will influence parent/patient decision-making during these periods of public health crisis. As public health messaging can impact on public behaviours, governing bodies and public health departments must be aware how fear of viruses among the general public may influence their response to public health advice. We have found inequity in the research on epidemic diseases affecting children’s presentations to emergency care and this should be a worldwide health policy focus.

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