



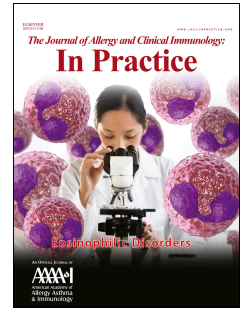
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The Unexpected Risks of COVID-19 on Asthma Control in Children

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36 Abstract

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38 Much is being learned about clinical outcomes for adult COVID-19 patients with underlying

39 chronic conditions, however, there is less coverage on how the COVID-19 pandemic impacts

40 the management of chronic medical conditions in children and youth, such as asthma. Asthma

41 is a common chronic medical condition in children that is uniquely susceptible to changes

42 brought upon by COVID-19. Sudden dramatic changes in the environment, medical practice,

43 and medication use have altered the asthma management landscape with potential impacts on

44 asthma outcomes. In this paper, we review how changes in transportation and travel patterns,

45 school attendance, physical activity, and time spent indoors, along with changes in healthcare

46 delivery since the start of the pandemic all play a contributing role in asthma control in children.

47 We review potentially important influences of asthma control in children during the COVID-19

48 pandemic worthy of further study.

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62 As the COVID-19 pandemic unfolds, we are learning about the multitude of ways, many
63 unforeseen, that response efforts to contain COVID-19 affect people's illnesses and chronic
64 diseases. While the risk of existing chronic disease on COVID-19 outcomes receives much
65 attention, less discussion has focused on the impact of societal changes resulting from the
66 COVID-19 pandemic on the course of specific chronic conditions. Changes in the environment,
67 medical practice, and medication management and use have rapidly altered the immediate
68 asthma management landscape with likely long-term impacts on asthma outcomes. Where
69 people spend time, daily habits, and travel patterns, have altered the natural environment in
70 ways that affect asthma. Changes in healthcare availability, delivery, and utilization have
71 important implications for asthma and other chronic conditions that require ongoing medical
72 attention. Finally, changes in medication management in asthma represent another important
73 COVID-19 related trend. Chronic asthma has particular vulnerabilities to the changes brought
74 on by COVID-19, with many shared pathways and risk factors, including air quality, the indoor
75 environment, physical activity, weight control, medication management, and healthcare delivery
76 (see Figure 1). Below, we review and postulate how significant changes in three domains,
77 environment, medical practice, and medication management, have altered asthma management
78 in the United States with likely longer-term implications for asthma outcomes.

79

80 Environmental changes: As different municipalities and states implement social distancing,
81 including stay-at-home orders, to control the COVID-19 pandemic, they impact many factors
82 that relate to asthma control, morbidity, and mortality. School cancellations mean that children
83 no longer have exposure to viruses from other schoolchildren that can cause upper respiratory
84 illnesses that may exacerbate asthma. Staying at home limits children's opportunities for
85 physical activity, known to be beneficial in asthma. Children now confined to small indoor
86 spaces, without access to school playgrounds or outdoor parks, lose use of spaces that are
87 conducive to physical activity. Children who actively commute to school by walking or bicycling

88 have also lost daily opportunity for physical activity. At the same time, remaining indoors means
89 children have greater exposure to indoor environments that can exacerbate asthma, including
90 secondary tobacco smoke exposure and indoor allergens including mold, mice, and roaches.

91

92 With fewer cars on the roads and children spending more time indoors, children will have less
93 exposure to outdoor air pollution. High concentrations of ambient air pollutants, primarily sulfur
94 dioxide, ozone, carbon monoxide, and particulates worsen asthma. During the summer 1996
95 Olympics, driving restrictions imposed in downtown Atlanta resulted in lower traffic volume with
96 an accompanying improvement in air quality, all associated with a decrease in emergency
97 department visits for childhood asthma.¹ Air quality has already improved since the start of the
98 COVID-19 pandemic,² and this improvement should contribute in a positive way to asthma.

99

100 Medical Care: Dramatic changes in healthcare delivery during the COVID-19 pandemic will also
101 impact asthma management and control. Many medical practices in the United States, including
102 primary care and pulmonology practices, have limited office visits to urgent patient needs and
103 have largely moved to telehealth visit formats. These changes have decreased visit volumes in
104 the immediate term, however, the availability of telehealth offers new opportunities for access to
105 care, although some changes exacerbate disparities in access to care. The impact on longer-
106 term access to medical providers as the COVID-19 pandemic continues remains unknown and
107 merits careful monitoring. In Boston, we have seen a sharp decrease in asthma-related
108 emergency department visits since the beginning of the pandemic. At Massachusetts General
109 Hospital, while the number of hospital admissions for COVID-19 gradually increased through
110 March and April, reaching over one thousand confirmed positive patients by the first week of
111 May 2020, the hospital saw a corresponding decline in the usual volume of pediatric asthma-
112 related ED visits (see Table 1). This sharp decrease may reflect families avoiding healthcare
113 institutions for fear of contracting COVID-19, structural contributing factors based on healthcare

114 provider recommendations, or early evidence of improved asthma control or beneficial
115 environmental shifts such as improved air quality. Fewer encounters and less use in emergent
116 situations may affect asthma control and outcomes.

117

118 Medication management: COVID-19 also likely impacts medication prescriptions and
119 adherence. Parents of children with asthma may have heightened concerns about asthma
120 control during a respiratory illness pandemic, potentially increasing medication adherence in
121 their children.³ Parents may be both more likely to fill prescriptions as well as more vigilant that
122 children take their medications regularly as prescribed. While increased medication adherence
123 may improve asthma control, altered prescribed medication regimens may also contribute, but
124 in the opposite direction. Preliminary data suggest that corticosteroid use may delay viral
125 clearance⁴ and be associated with increased mortality in patients infected with COVID-19,⁵ and
126 some medical providers have moved to limit the use of corticosteroids, both systemic use for
127 acute exacerbations as well as inhaled corticosteroids for maintenance therapy. How this
128 change in treatment will impact asthma outcomes remains unknown, however, they may well
129 contribute to decreased asthma control and an increase in acute asthma exacerbations and
130 asthma severity.

131

132 While many of these contributing factors are common and ubiquitous across the United States,
133 they likely vary depending on where a child lives and a family's socioeconomic status. Shifts in
134 air quality may have greater consequence in large urban areas, like New York City and Boston,
135 where COVID-19 hot spots have been reported. Variation in governmental stay-at-home orders
136 will directly impact many of the risk factors listed above, including physical activity and exposure
137 to indoor and outdoor air quality. Accordingly, the impact of COVID-19 on asthma control and
138 outcomes will likely vary from state to state and especially by municipality within states. The
139 associations of asthma prevalence and severity with socioeconomic status, especially income

140 and racial variations, are well described, as well as in asthma management.⁶ The COVID-19
141 pandemic may exacerbate these disparities from variations in exposure to risk factors in the
142 home environment. Lower income children in urban environments have more limited access to
143 safe spaces for physical activity. Their families may have unstable housing with a greater risk of
144 exposure to indoor allergens like mold, rodent, roaches, and tobacco smoke. Low-income
145 children are more likely to live with adults who have ongoing contact with outside populations
146 due to financial stressors or instability. Adults in low-income households are more likely to be
147 essential workers and to take public transportation to work, increasing their exposure risk to
148 COVID-19 infected persons. Children with asthma living in households where one or more adult
149 is infected with COVID-19, face increased risk for medical and psychosocial complications.
150 While children appear to suffer a lower burden of illness with COVID-19 infection, children are
151 at-risk for developing rare but severe complications including a multisystem inflammatory
152 syndrome unique to children.⁷ It is unclear whether underlying conditions such as asthma place
153 children at greater risk for these rare outcomes. Even in households with infected adults where
154 children do not contract COVID-19, there may be heightened emotional distress that may
155 worsen the child's asthma symptoms. As we approach the warmer spring and summer months,
156 financial complications, where infected low-income adults are unable to work and may not have
157 sufficient finances to pay utility bills, including air conditioning, may in turn impact indoor air
158 quality and children's asthma control.

159

160 These COVID-19 changes in the environment, in medical practice, and medication management
161 will likely have major impact on childhood asthma, with many already manifesting. These
162 several risk factors will often work in opposite directions at the same time. With the pandemic
163 natural experiment absent a control group, it is difficult to foretell the ultimate impacts these
164 broad societal changes will have on childhood asthma. Despite these difficulties, this paper
165 aims to start by identifying key changes in some of the underlying associated risk factors to help

166 the scientific community learn from the pandemic, better guide management of pediatric
167 asthma, and indicate research questions that merit study during these unprecedented times.
168 The exact relationship and impact of the many contributing risk factors will be difficult to
169 measure. Many of the potential influences we highlight in this paper are not typically collected in
170 datasets available for study. Data on some key variables which could help understand the
171 changes and impacts of the COVID-19 pandemic on asthma control are available, including
172 pharmacy claims data, health care utilization measures including asthma-related ED visits and
173 hospitalizations, air quality data, and school closure dates. Innovative studies that combine
174 these disparate datasets will be important to help the scientific community more broadly
175 understand the pandemic's full impact.

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219 Figure 1 Legend: Potentially Important Influences on Asthma Control During the COVID-19

220 Pandemic Worthy of Investigation.

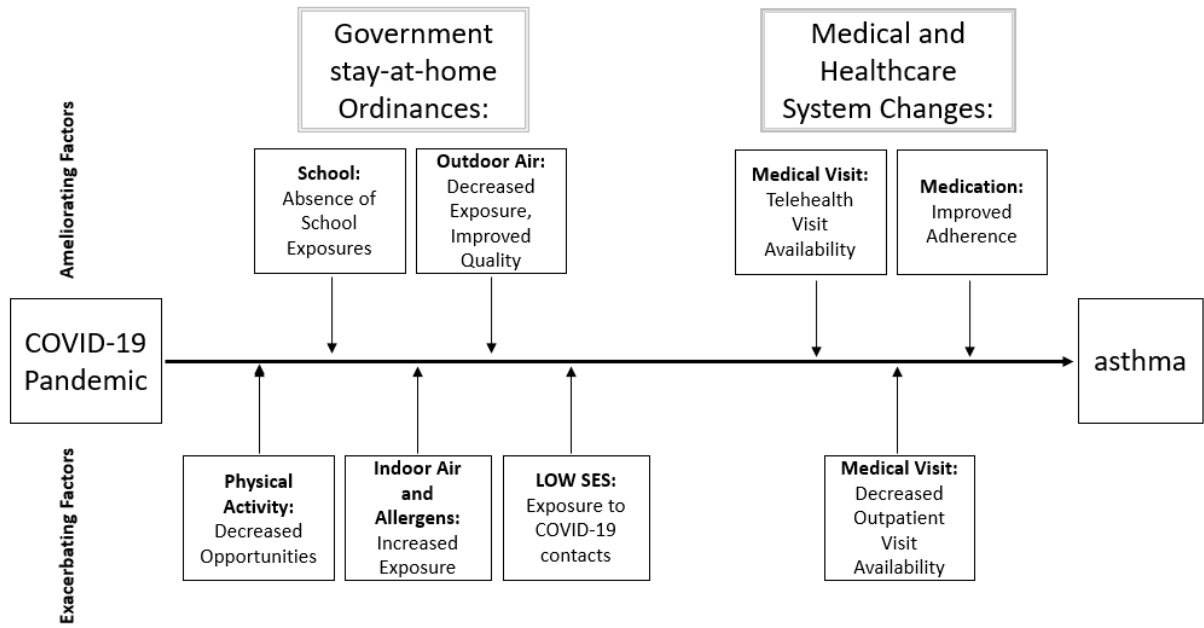
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Table 1: Change in Volume of Pediatric Asthma Emergency Department Visits During the COVID-19 Pandemic.

Timeframe	2019	2020	% Difference
January	77	82	6.5%
February	87	80	-8.0%
March	98	60	-38.8%
April	92	14	-84.8%

* Includes patients under 20 years of age with a J45 ICD-10 primary or secondary asthma diagnosis code. The average monthly number of asthma visits in 2019 was 69 patients.



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