







# Real-time effects of COVID-19 pandemic lockdown on pediatric respiratory patients

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## Abstract

**Objective:** A national lockdown was implemented in Israel to slow the viral spread of COVID-19. We assessed the real-time effects of the lockdown on disease expression and lifestyle modifications in pediatric patients with chronic respiratory disorders.

**Methods:** An anonymous electronic questionnaire was distributed during lockdown (March–May 2020) to caregivers of patients with chronic respiratory disorders. The primary outcome was change in disease expression and the secondary outcomes were changes in lifestyle and caregivers' emotional status.

**Results:** The clinical status of one-third of the 445 participating patients (age 0–18 years) reportedly improved, including decreased respiratory symptoms ( $n = 133$ , 33%), exacerbation frequency ( $n = 147$ , 35%), and use of reliever medications ( $n = 101$ , 27.4%). The condition of ~10% of the patients worsened. Clinical improvement was noted mostly in young patients <5 years ( $p = .001$ ), asthmatic patients ( $p = .033$ ), and patients with multiple underlying respiratory disorders ( $p = .015$ ). Patients whose condition significantly worsened were more likely to be >5 years ( $p < .001$ ), had increased screen time, decreased physical activity, and shorter sleep duration compared to their younger counterparts ( $p = .008$ , <.001, and .001, respectively). Caregivers' reports ( $n = 236$  [58%]) of their own anxiety levels and perceptions of the patients' elevated health risk were increased, regardless of the children's actual clinical status.

**Conclusion:** COVID-19 lockdown was associated with clinical improvement/stability for most of the surveyed children; however, their caregivers' anxiety level was heightened. An increased sedentary lifestyle was reported mostly in older children.

## KEYWORDS

anxiety, children, chronic respiratory disorders, COVID-19, lockdown, sedentary lifestyle

## 1 | INTRODUCTION

On December 31, 2019, the Wuhan Municipal Health Commission in Wuhan City, China reported a cluster of 27 pneumonia cases of unknown etiology.<sup>1</sup> The virus was soon identified as a novel virus and

named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) due to its resemblance to SARS-CoV.<sup>2</sup> The World Health Organization (WHO) called it coronavirus disease 2019 (COVID-19),<sup>3</sup> defining it as a pandemic by March 11, 2020, due to the massive global spread.<sup>4</sup> The rapid global rise of confirmed cases necessitated

**Abbreviations:** ABX, antibiotics; AD, atopic dermatitis; BD, bronchodilators; BE, bronchiectasis; BO, bronchiolitis obliterans; BPD, bronchopulmonary dysplasia; CF, cystic fibrosis; COVID-19, coronavirus disease 2019; CPT, chest physiotherapy; ICS, inhaled corticosteroids; NMD, neuromuscular disorder; SARS-CoV, severe acute respiratory syndrome corona virus; WHO, World Health Organization.

drastic measures to slow the spread of the virus, with the focus on “social distancing.” This measure is designed to reduce interactions between people in a broader community in which individuals may be infectious but have not yet been identified.<sup>5</sup>

In Israel, air trafficking restrictions and requirements for quarantine were applied toward the beginning of February, 2020,<sup>6</sup> ultimately leading to the closure of all educational institutions on March 15, 2020,<sup>7</sup> a move that affected more than 2.6 million students from preschoolers (3 years of age) to university students.<sup>8</sup> Workplaces were closed soon afterward. Israel's population was restricted to lockdown for approximately 2 months, with a step-down release of restrictions.<sup>9</sup> Education systems re-opened gradually from May 3, 2020.<sup>10</sup>

Although these measures and efforts are necessary, there is a lack of data on their impact on the physical and mental health of children. When children are out of school, they are physically less active,<sup>11</sup> experience shorter sleep durations,<sup>12</sup> and have much longer screen time. These sedentary lifestyle behaviors are also correlated to consumption of unfavorable diets,<sup>13</sup> resulting in weight gain and loss of cardiorespiratory fitness.<sup>14</sup> Such negative effects on health are likely to be worsened when children are confined to their homes without outdoor activities and interaction with peers during an outbreak.<sup>15</sup> Even fewer data are available with regard to the impact of COVID-19-related social restrictions on children with a chronic respiratory disorder.

The aim of the present study was to examine the real-time effects of the COVID-19 lockdown on disease expression in pediatric patients with a chronic respiratory disorder. In addition, we examined adherence to routine medical treatment, lifestyle changes, caregivers' emotional status, and utility of medical services during the lockdown.

## 2 | METHODS

### 2.1 | Subjects

Included were children and adolescents from the Pediatric Pulmonology Unit at the Dana-Dwek Children's Hospital, Tel Aviv Sourasky Medical Center with any one of various chronic respiratory disorders.

Questionnaires were answered by the caregivers of these children (hereafter referred to as patients). This study was approved by the local ethics committee (TLV-0222-20).

Those for whom there was some technical inability of the caregivers to fill in the questionnaires were excluded.

Informed consent was obtained by the participant's agreement to enter the website and their willingness to fill in the online questionnaire.

### 2.2 | Data collection

Anonymous electronic questionnaires were distributed directly to caregivers of our patients during the lockdown between March and

May 2020 by short message services (Supporting Information, Appendix A—questionnaire). The information that was extracted from the questionnaires included the following: age, sex, respiratory disorder (e.g., asthma, bronchiectasis, etc.), comorbidities (e.g., sequelae of prematurity, allergy, atopic dermatitis [AD], etc.), routine medical treatment (e.g., inhaled corticosteroids [ICS], long- or short-acting bronchodilators [BD], etc.), prior hospitalizations due to respiratory conditions, pulmonologist follow-up visits frequency during the last 1 year. The caregivers' perspectives of changes in clinical status during the lockdown (improved, unchanged, or worsened) were determined by three questions: (1) respiratory symptoms (e.g., cough, rhinorrhea, shortness of breath, etc.); (2) frequency of exacerbation of respiratory symptoms, and (3) use of reliever medications (e.g., inhaled BD). Changes in adherence to routine treatment and rate of utilization of medical services (decreased, unchanged, or increased), as well as caregiver anxiety levels and perception of an elevated risk for their child, were also evaluated. Additional variables included number of residents in the home, adherence to lockdown (not at all, minimally, satisfactorily, and entirely), and lifestyle changes, including the amount of leisure screen time, physical activity, diet, and sleep duration. The primary outcome was change in the patients' disease expression during the lockdown, and the secondary outcomes were changes in the caregivers' emotional status and in the patients' lifestyle.

### 2.3 | Statistical analyses

The patients' demographics were assessed with descriptive statistics. Pearson's  $\chi^2$  test or Fisher's exact test was performed to assess associations between changes in clinical status during lockdown, lockdown variables, and caregiver's perspective. Continuous variables are displayed as means (standard deviation [SD]), and the results were compared by a Student's *t*-test. Statistical analysis was performed with IBM SPSS statistics 25.

## 3 | RESULTS

A total of 445 caregivers completed the questionnaire (response rate: 32%). The mean ( $\pm$ SD) age of patients was 6.2 years (4.7) with a range of 0–18 years. Patients included 276 (62%) males and 169 (38%) females. Most of the patients ( $n = 368$ , 82%) had a single respiratory disorder, the most common of which were asthma (291, 65%), recurrent pneumonia ( $n = 96$ , 21.5%), followed by bronchopulmonary dysplasia (BPD;  $n = 32$ , 7.2%).

More preschool patients (younger than 5 years of age) had BPD (77.4% vs. 22.6%  $p = .002$ ) and recurrent pneumonia (65.6% vs. 33.4%  $p = .001$ ) compared to older patients, whereas respiratory manifestations of neuromuscular disease were more prevalent in patients older than 5 years (71.4% vs. 28.6%  $p = .016$ ). There was no age difference in the prevalence of asthma. Comorbidities were reported in 234 (52.5%) patients, the most common of which were

allergic disorders (e.g., allergic rhinitis, allergic conjunctivitis, aeroallergens sensitivity, and food allergies) and AD with a similar prevalence ( $n = 69$ , 15.5% and  $n = 70$ , 15.7% respectively), developmental delay ( $n = 60$ , 13.5%), and sequelae of prematurity ( $n = 54$ , 12%).

Routine medical treatment was prescribed for 283 (63.5%) patients. ICS ( $n = 217$ , 48.7%), short- or long-acting BD ( $n = 138$ , 31%), and Montelukast ( $n = 46$ , 10.3%) were the most prevalent medications. Routine pulmonologist follow-up visits in the last year were reported for 358 (80.3%) patients, and prior hospitalizations due to respiratory disorders for 202 (45.5%) patients (of which, about one half had a single hospitalization). The background characteristics of patients are listed in Table 1.

Almost all (98%) of the caregivers reported high adherence to lockdown policies (satisfactorily,  $n = 109$  [24%] patients and entirely,  $n = 331$  [74%] patients). More than one-third of the study population lived in 4-person households ( $n = 167$ , 37.4%), and the rest consisted of  $\leq 3$ - or  $\geq 5$ -person households ( $n = 105$ , 23.5% and  $n = 174$ , 39% respectively).

Screen time during the lockdown increased among 344 of the responders (79.3%) and decreased in only 7 (1.6%). Physical activity decreased in 236 (53.9%) patients and sleep duration decreased in 155 (35%) patients. Healthier eating habits were reported for 143 (32.6%) patients and less healthy eating habits were reported for 73 (16.6%) patients.

Selected lockdown variables are listed in Table 2.

About one-third of the caregivers reported improvement in the patients' clinical status as assessed by frequency of respiratory symptoms, frequency of respiratory exacerbations, and use of reliever medications ( $n = 133$ , 33%,  $n = 147$ , 35.5%, and  $n = 101$ , 27.4% patients, respectively). Worsening of those three parameters was reported in only 42 (10.4%), 35 (8.5%), and 45 (12.2%) patients, respectively. The respiratory condition of most of the patients remained stable (unchanged; Tables 3 and 4).

Cofactors that were associated with improved clinical status were younger age  $< 5$  years ( $p = .001$ ), diagnosis of asthma ( $p = .033$ ), asthma with allergy ( $p = .044$ ), presence of multiple respiratory disorders ( $p = .015$ ), and entire adherence to lockdown ( $p = .005$ ). The number of residents living at home, comorbidities, compliance to routine treatment, frequency of pulmonologist follow-up visits, and the number of prior hospitalizations were not associated with changes in clinical status during the lockdown. Worsening of the clinical status during the lockdown was more prominent in patients  $> 5$  years of age ( $p < .001$ ). Compared to their younger counterparts, these older patients also experienced increased screen time, decreased physical activity, and shorter sleep duration ( $p = .008$ ,  $< .001$ , and  $< .001$ , respectively). Most of the caregivers reported similar degrees of adherence to routine medical treatment as in ordinary times ( $n = 238$ , 71%), while 67 (20.1%) caregivers reported increased adherence and 29 (8.7%) reported decreased adherence. The caregivers reported increased adherence for patients who had asthma ( $p = .043$ ) or asthma and allergy ( $p = .04$ ), and who were treated routinely with ICS ( $p = .003$ ) or Montelukast ( $p = .027$ ). Decreased

adherence was recorded for the patients who had comorbidities ( $p = .039$ ).

Adherence was significantly correlated with increased anxiety ( $p = .024$ ), but not with clinical improvement or increased medical services utilization.

The caregivers' anxiety levels and perception of risk for their child's (patient's) health were increased in 236 (58%) and 300 (72.8%) caregivers, respectively. Only 30 (7.4%) and 17 (4.1%) caregivers reported being less anxious and concerned, respectively. Caregivers reported themselves as being more anxious and/or perceiving an increased risk for the patients when additional variables were present, including sequelae of prematurity ( $p = .021$ ), BPD ( $p = .049$ ), frequent pulmonologist follow-up visits ( $p = .002$ ), prior hospitalizations ( $p = .006$ ), and routine medical treatment ( $p = .031$ ), and when more than one underlying respiratory disorder was present ( $p < .001$ ).

The utilization of medical services during the lockdown was increased in 88 (25.7%) patients and decreased in 57 (16.7%). Means of medical services utilizations included phone (118, 26.5%), on-line consultations (52, 11.5%), e-mail (31, 7%), primary care checkup (19, 4.3%) and emergency room visits (13, 2.9%). Hospitalization was required for four (0.9%) patients. There was increased utilization of medical services by caregivers who felt more anxious during the lockdown compared to those who did not feel more anxious (by telephone  $p < .001$  or by online services  $p = .024$ ). The caregivers' perspectives and adherence to routine treatment during the lockdown are listed in Table 5.

## 4 | DISCUSSION

Enforcement of lockdown was shown to be an effective measure to reduce SARS-CoV-2 transmission.<sup>16,17</sup> The effects of the lockdown in the pediatric population are just now emerging, but little is known about its effects on children with chronic respiratory diseases.<sup>18</sup> We conducted this survey to provide more real-time information on these issues.

The results of this study showed that COVID-19 lockdown was associated with significant clinical improvement in about one-third of our studied children with a respiratory disorder. The caregivers' level of anxiety and perceived increased risk for the patients' health was significantly higher, as were lifestyle changes for the worse among the older patients.

The clinical improvement shown in our study, mainly in the asthmatic patients, may have resulted from two key factors: fewer exposure variables and increased adherence to routine treatment. Exposure to pathogens and inhaled irritants is a common cause of morbidity in people with respiratory diseases.<sup>19,20</sup> One of the most common triggers for exacerbations in asthma is viral respiratory diseases<sup>19,21</sup>; thus, the limitation of any viral spread caused by a lockdown might have played a major role. Furthermore, the fact that clinical improvement was more pronounced in children  $< 5$  years, emphasizes, decreased pathogenic exposure due to lack of close

**TABLE 1** Background characteristics of the study patients (*n* = 445)

Characteristic	<i>n</i> (%)	Patients < 5 years, <sup>a</sup> <i>n</i> (%)	Patients > 5 years, <sup>a</sup> <i>n</i> (%)
Sex			
Male	276 (62)	127 (59.1)	140 (66.4)
Female	169 (38)	88 (40.9)	71 (33.6)
Underlying respiratory disorder			
Asthma	290 (65)	132 (61.4)	147 (69.7)
Male	195 (67.2)	95 (32.8)	
Female			
Recurrent pneumonia	96 (21.5)	59 (65.6)	31 (34.4)
BPD	32 (7.2)	24 (77.4)	7 (22.6)
Other <sup>b</sup>	44 (9.9)	12 (5.6)	12 (5.6)
Respiratory manifestations of NMD			
BE/BO	24 (5.4)	13 (6)	9 (4.3)
Chronic cough	12 (2.7)	5 (2.3)	6 (2.8)
Perinatal respiratory morbidity <sup>c</sup>	6 (1.3)	6 (2.8)	0 (0)
Comorbidities			
Allergy <sup>d</sup>	234 (52.5)	118 (57.3)	88 (42.7)
AD	69 (15.5)	13 (20.6)	50 (79.3)
AD	70 (15.7)	26 (40)	40 (60)
Developmental delay and neurological morbidity <sup>e</sup>	60 (13.5)	31 (54.4)	26 (45.6)
Prematurity	54 (12)	39 (72.2)	15 (27.8)
GI disorders <sup>f</sup>	21 (4.7)	7 (33.3)	14 (66.7)
Cardiovascular disorders <sup>g</sup>	12 (2.7)	6 (50)	6 (50)
Miscellaneous disorders <sup>h</sup>	12 (2.7)	6 (33.3)	14 (66.7)
Routine medical treatment			
ICS	283 (63.5)	78 (50.3)	77 (49.7)
ICS	217 (48.7)	115 (55.3)	93 (44.7)
Long- or short-acting BD	138 (31)	73 (55.3)	59 (44.7)
Montelukast	46 (10.3)	28 (62.2)	17 (37.8)
CPT	44 (10)	11(26.8)	30 (73.2)
Anti-allergic medications <sup>i</sup>	26 (5.8)	5 (19.2)	21 (80.8)
Prophylactic ABX	22 (5)	8 (38.1)	13 (61.9)
Pulmonologist follow-up visits in the last year			
1–2	358 (80.3)	180 (51.6)	169 (48.4)
1–2	171 (47)	74 (44.6)	92 (55.4)
3–4	132 (36.5)	65 (51.6)	61 (48.4)
5–6	60 (16.5)	41 (71.9)	16 (28.1)
Prior hospitalizations			
1	202 (45.5)	106 (58.9)	74 (41.1)
1	98 (51.3)	54 (58.1)	39 (41.9)
2	43 (22.5)	23 (56.1)	18 (43.9)
3	24 (12.6)	13 (56.5)	10 (43.5)
≥4	26 (13.6)	16 (69.6)	7 (30.4)

Abbreviations: AD, atopic dermatitis; ABX, antibiotics; BD, bronchodilators; BE, bronchiectasis; BO, bronchiolitis obliterans; BPD, bronchopulmonary dysplasia; CPT, chest physiotherapy; GI, gastrointestinal; ICS, inhaled corticosteroids; NMD, neuromuscular disorder.

<sup>a</sup>For 20 patients, the correct birth date was not available; therefore, they were excluded from analysis.

<sup>b</sup>Other—primary ciliary dyskinesia, neuroendocrine hyperplasia of infancy, pneumothorax, and atelectasis.

<sup>c</sup>Perinatal respiratory morbidity—pneumothorax and laryngomalacia.

<sup>d</sup>Allergy—allergic rhinitis, allergic conjunctivitis, aeroallergens sensitivity, and food allergies.

<sup>e</sup>Neurological disorders—attention deficit disorder and trisomy.

<sup>f</sup>GI disorders—celiac disease, inflammatory bowel disease, and failure to thrive.

<sup>g</sup>Cardiovascular disorders—congenital heart disease.

<sup>h</sup>Miscellaneous disorders—familial Mediterranean fever and thalassemia.

<sup>i</sup>Anti-allergic medications—antihistamines and intranasal steroids.

**TABLE 2** Lockdown variables

Variable	Increased, n (%)	Unchanged, n (%)	Decreased, n (%)
Screen time	344 (79.3)	83 (19.1)	7 (1.6)
Physical activity	85 (19.4)	117 (26.7)	236 (53.9)
Sleep duration	59 (13.4)	227 (51.1)	155 (35.1)
Healthier eating habits	143 (32.6)	227 (50.8)	73 (16.6)

contact, as a major factor for clinical improvement seen in our study. Another well-known trigger for asthma exacerbation is air pollution.<sup>22,23</sup> During the COVID-19 lockdown in Israel, as in many parts of the world, there was a reduction in air pollution, mostly with regard to NO<sub>2</sub> emission, which might be related to slowing down of factories activity and drop of transport utilities, which would serve to at least partially explain the clinical improvement in our cohort.<sup>18,24,25</sup>

Another potential parameter for respiratory disease exacerbation is aeroallergen exposure. The COVID-19 pandemic emerged in Israel in early spring, a time period characterized by increased exposure to aeroallergens, a risk factor for allergic asthma exacerbations.<sup>26,27</sup> Avoidance of outdoor activities might explain the beneficial effect observed in asthmatic patients with allergies in our cohort. The clinical improvement documented among our patients supports the findings reported by Krivec et al.<sup>18</sup> from Slovenia, who described a >70% decrease in pediatric asthma admission rates and a >50% decrease in respiratory tract infection admissions in the months of March and April 2020, compared to the same period in previous 3 years. Of interest and similar to the data observed in Israel,<sup>25</sup> there was also a substantial air quality improvement in Slovenia at that time.<sup>18</sup>

As younger, pre-school children were more likely to improve in our cohort, we may assume that reduced viral exposure played a greater role in clinical improvement than exposure to aero-allergens. Adherence to treatment is known as being another major factor in controlling respiratory diseases.<sup>28</sup> The COVID-19 lockdown in our study population was associated with increased adherence to routine treatment. More parental time with the patients due to home-schooling and working from home may be responsible for the increased adherence. Telemedicine may be another potential factor for increased adherence to treatment,<sup>29</sup> yet current evidence supporting its effect on adherence, especially in asthmatic children, are conflicting.<sup>30</sup> Improved adherence during the COVID-19 pandemic has already been reported in adults with asthma and chronic obstructive pulmonary disease.<sup>31</sup>

In our study, factors that were correlated with clinical improvement were younger age, presence of asthma, and allergy.

Reduced exposure to pollutants inhaled irritants and pathogens could have been especially beneficial for them. Moreover, since many of the caregivers reported maintaining the lockdown to the maximum, there was little exposure if any. Patients who improved were also likely to suffer from more than a single respiratory disorder. These patients often need several supporting treatments and medications, therefore a tighter adherence to treatments would have clearly benefited them.

A recent opinion study by Gupta et al.<sup>32</sup> has suggested that huge reductions in asthma attacks during the lockdown are probably the result of behavioral changes. Those authors mention several lessons to be implemented for future asthma management in general, such as more rigorous prevention of viral transmission among children, efforts to reduce global air pollution, and increased emphasis on telemedicine monitoring. Our study lends strong support to these ideas.

The minority of patients in our study whose condition worsened during the lockdown were more likely to be older children. They also were the ones who reported a more sedentary lifestyle, including increased screen time, decreased physical activity, and decreased sleep duration. The associations between obesity, nutritional changes, sedentary lifestyle and the development of asthmatic symptoms as well as poor asthma control are well known,<sup>33,34</sup> and such changes in lifestyle during COVID-19 are emerging.<sup>35</sup> Our study also showed worrisome numbers of caregivers with heightened anxiety and increased concern for their child's health. These findings were not dependent upon the level of stability or improvement in clinical status that had been found in the majority of our patients. Increments in anxiety and risk perception were significantly greater in the caregivers of premature infants, children with BPD or multiple respiratory disorders, and those who had a history of hospitalizations. The greater the anxiety, the greater was the utilization of the medical services. Even in non-pandemic conditions, numerous studies have described increased caregiver anxiety in conditions such as asthma,<sup>36</sup> cystic fibrosis (CF),<sup>37</sup> prematurity, and BPD,<sup>38,39</sup> as well as in situations where hospitalization due to respiratory illness is required.<sup>40</sup> Adding a complex, unknown situation of a global pandemic to these conditions may impose a profound effect on caregivers.

**TABLE 3** Description of clinical status during lockdown

Variable	Improved, n (%)	Unchanged, n (%)	Worsened, n (%)
Respiratory symptoms	133 (29.8)	228 (51.1)	42 (10.4)
Exacerbation frequency (stability)	147 (35.5)	232 (56)	35 (8.5)
Need for reliever medications	101 (27.4)	222 (49.8)	45 (12.2)

**TABLE 4** Description of clinical status during lockdown adjusted to age cut<sup>a</sup>

Variable	Improved, n (%)		Unchanged, n (%)		Worsened, n (%)	
	Patients < 5 years, n (%)	Patients > 5 years, n (%)	Patients < 5 years, n (%)	Patients > 5 years, n (%)	Patients < 5 years, n (%)	Patients > 5 years, n (%)
Respiratory symptoms	76 (38.4)	54 (28.7)	111 (56.1)	104 (55.3)	11 (5.6)	30 (16)
Exacerbation frequency (stability)	90 (43.9)	53 (27.6)	108 (52.7)	111 (57.8)	7 (3.4)	28 (14.6)
Need for reliever medications	59 (32.4)	41 (23.7)	110 (60.4)	101 (58.4)	13 (7.1)	31 (17.9)

<sup>a</sup>For 20 patients, the correct birth date was not available; therefore, they were excluded from analysis.

**TABLE 5** Caregiver perspectives and adherence to routine treatment

Variable	Increased, n (%)	Unchanged, n (%)	Decreased, n (%)
Anxiety	236 (58)	141 (34.6)	30 (7.4)
Risk perception	300 (72.8)	95 (23.1)	17 (4.1)
Adherence to routine treatment	67 (20.1)	238 (71.3)	29 (8.7)

Evidence of the psychological implications of the COVID-19 pandemic in both children and caregivers are emerging. Xie et al.<sup>41</sup> reported depressive and anxiety symptoms in about 20% of 1784 students in Hubei province. Sismanlar Eyuboglu et al.<sup>42</sup> reported increased anxiety levels among mothers in children with CF, which were similar to those of mothers of healthy children during the COVID-19 pandemic, further supporting our study results that the actual clinical status of patients did not alter the psychosocial impact of the pandemic on their caregivers.

Some limitations to our study bear to be mentioned. Although questionnaires were delivered in “real-time” during the lockdown, the clinical, psychological, and lifestyle implications of confinement were subjectively assessed by caregivers. The interpretation of these findings may be limited due to several factors, including lack of employment of validated psychosocial questionnaires (e.g., anxiety and/or depression scales), absence of objective measurements of treatment adherence (e.g., prescription refilling), and lack of inquiry regarding COVID-19 status during the lockdown.

It is possible that future lockdowns might be needed in the absence of definitive treatment or vaccination for COVID-19. Our study results can lead to a more focused approach for children with chronic respiratory disorders and their caregivers during pandemics, including encouraging a healthier lifestyle among children and adolescents during lockdowns, innovative physician-guided therapy, and help for patients and caregivers coping with anxiety.

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This study was approved by the local ethics committee (TLV-0222-20).

#### CONFLICT OF INTERESTS

The authors declare that there are no conflict of interests.

#### AUTHOR CONTRIBUTIONS

Michal Cahal conceptualized and designed the study, designed the data collection instruments and methodology, coordinated and supervised data collection and investigation, carried out data curation and formal analysis as well as written, reviewed, and revised the manuscript. Israel Amirav conceptualized and designed the study, designed the data collection instruments and methodology, coordinated and supervised data collection and investigation, carried

out data curation and formal analysis as well as reviewed and revised the manuscript. Nir Diamant took part in study investigation, data collection and analysis as well as reviewed and revised the manuscript. Moria Be'er took part in study investigation, data collection, and analysis as well as reviewed and revised the manuscript. Omri Besor took part in study investigation, carried out data curation and formal analysis as well as reviewed and revised the manuscript. Moran Lavie conceptualized and designed the study, designed the data collection instruments and methodology, coordinated and supervised data collection and investigation, carried out data curation and formal analysis as well as written, reviewed, and revised the manuscript.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author on reasonable request.

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## REFERENCES

1. The 2019-nCoV Outbreak Joint Field Epidemiology Investigation Team, Li Q. An outbreak of NCIP (2019-nCoV) infection in China—Wuhan, Hubei Province, 2019–2020. *China CDC Wkly.* 2020;2(5):79–80. <https://doi.org/10.46234/ccdcw2020.022>
2. Zhou P, Yang XL, Wang XG, et al. A pneumonia outbreak associated with a new coronavirus of probable bat origin. *Nature.* 2020;579(7798):270–273. <https://doi.org/10.1038/s41586-020-2012-7>
3. Naming the Coronavirus Disease (COVID-19) and the Virus that Causes It. [https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-\(covid-2019\)-and-the-virus-that-causes-it](https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/naming-the-coronavirus-disease-(covid-2019)-and-the-virus-that-causes-it). Accessed May 11, 2020.
4. WHO Timeline – COVID-19. <https://www.who.int/news-room/detail/27-04-who-timeline-covid-19>. Accessed May 11, 2020.
5. Wilder-Smith A, Freedman DO. Isolation, quarantine, social distancing and community containment: pivotal role for old-style public health measures in the novel coronavirus (2019-nCoV) outbreak. *J Travel Med.* 2020;27(2):1–4. <https://doi.org/10.1093/jtm/taaa020>
6. Ongoing Efforts to Protect Against the Coronavirus, Ministry of Health. [https://www.health.gov.il/English/News\\_and\\_Events/Spokespersons\\_Messages/Pages/0202\\_3.aspx](https://www.health.gov.il/English/News_and_Events/Spokespersons_Messages/Pages/0202_3.aspx). Accessed May 21, 2020.
7. Updated Guidelines, Ministry of Health. [https://www.health.gov.il/English/News\\_and\\_Events/Spokespersons\\_Messages/Pages/1503\\_01.aspx](https://www.health.gov.il/English/News_and_Events/Spokespersons_Messages/Pages/1503_01.aspx). Accessed May 21, 2020.
8. State of Israel, Ministry of Education, Director of Economics and budgets. Facts and Figures years 2018–2019, page 4:1–33.
9. A Series of Relief Measures to the Emergency Regulations, Ministry of Health. [https://www.gov.il/en/departments/news/0405\\_02](https://www.gov.il/en/departments/news/0405_02). Accessed May 21, 2020.
10. Education System Instructions – COVID-19. <https://parents.education.gov.il/prhnet/parents/healthy-lifestyle/korona>. Accessed July 7, 2020.
11. McCue MC, Marlatt KL, Sirard J. Examination of changes in youth diet and physical activity over the Summer Vacation Period. *Internet J Allied Health Sci Pract.* 2013;11(1). <https://nsuworks.nova.edu/ijahsp/vol11/iss1/8/>. Accessed May 22, 2020.
12. Nixon GM, Thompson JMD, Han DY, et al. Short sleep duration in middle childhood: risk factors and consequences. *Sleep.* 2008;31(1):71–78. <https://doi.org/10.1093/sleep/31.1.71>
13. Fletcher EA, McNaughton SA, Crawford D, et al. Associations between sedentary behaviours and dietary intakes among adolescents. *Public Health Nutr.* 2018;21(6):1115–1122. <https://doi.org/10.1017/S136898001700372X>
14. Brazendale K, Beets MW, Turner-McGrievy GM, Kaczynski AT, Pate RR, Weaver RG. Children's obesogenic behaviors during summer versus school: a within-person comparison. *J Sch Health.* 2018;88(12):886–892. <https://doi.org/10.1111/josh.12699>
15. Wang G, Zhang Y, Zhao J, Zhang J, Jiang F. Mitigate the effects of home confinement on children during the COVID-19 outbreak. *Lancet.* 2020;395(10228):945–947. [https://doi.org/10.1016/S0140-6736\(20\)30547-X](https://doi.org/10.1016/S0140-6736(20)30547-X)
16. Lau H, Khosrawipour V, Kocbach P, et al. The positive impact of lockdown in Wuhan on containing the COVID-19 outbreak in China. *J Travel Med.* 2020;2020:1–7. <https://doi.org/10.1093/jtm/taaa037>
17. Hamzelou J. World in lockdown. *New Sci.* 2020;245(3275):7. [https://doi.org/10.1016/s0262-4079\(20\)30611-4](https://doi.org/10.1016/s0262-4079(20)30611-4)
18. Krivec U, Kofol Seliger A, Tursic J. COVID-19 lockdown dropped the rate of paediatric asthma admissions. *Arch Dis Child.* 2020;0(0):138540–138810. <https://doi.org/10.1136/archdischild-2020-319522>
19. Thumerelle C, Deschildre A, Bouquillon C, et al. Role of viruses and atypical bacteria in exacerbations of asthma in hospitalized children: a prospective study in the Nord-Pas de Calais region (France). *Pediatr Pulmonol.* 2003;35(2):75–82. <https://doi.org/10.1002/ppul.10191>
20. Samoli E, Nastos PT, Paliatsos AG, Katsouyanni K, Priftis KN. Acute effects of air pollution on pediatric asthma exacerbation: evidence of association and effect modification. *Environ Res.* 2011;111(3):418–424. <https://doi.org/10.1016/j.envres.2011.01.014>
21. Jartti T, Gern JE. Role of viral infections in the development and exacerbation of asthma in children. *J Allergy Clin Immunol.* 2017;140(4):895–906. <https://doi.org/10.1016/j.jaci.2017.08.003>
22. Ko FWS, Tam W, Wong TW, et al. Effects of air pollution on asthma hospitalization rates in different age groups in Hong Kong. *Clin Exp Allergy.* 2007;37(9):1312–1319. <https://doi.org/10.1111/j.1365-2222.2007.02791.x>
23. Wang AX, Chen X, Song CB, et al. Association between fine particulate matter and asthma hospital outpatient visits in Hangzhou. *Huanjing Kexue/Environ Sci.* 2018;39(10):4457–4462. <https://doi.org/10.13227/j.hjkk.201712090>
24. Wang Q, Su M. A preliminary assessment of the impact of COVID-19 on environment – a case study of China. *Sci Total Environ.* 2020;728:138915. <https://doi.org/10.1016/j.scitotenv.2020.138915>
25. State of Israel, Ministry of Environmental Protection, Department of Air Quality and Climate Change. Air Pollution Changes in Israel During COVID-19 due to Reduction Economical Activity 23/03/20. 2020;2020.
26. Tosca MA, Ruffoni S, Canonica GW, Ciprandi G. Asthma exacerbation in children: relationship among pollens, weather, and air pollution. *Allergol Immunopathol.* 2014;42(4):362–368. <https://doi.org/10.1016/j.aller.2013.02.006>
27. Osborne NJ, Alcock I, Wheeler BW, et al. Pollen exposure and hospitalization due to asthma exacerbations: daily time series in a European city. *Int J Biometeorol.* 2017;61(10):1837–1848. <https://doi.org/10.1007/s00484-017-1369-2>
28. Basharat S, Jabeen U, Zeeshan F, Bano I, Bari A, Rathore AW. Adherence to asthma treatment and their association with asthma control in children. *J Pak Med Assoc.* 2018;68(5):725–728. <http://www.ncbi.nlm.nih.gov/pubmed/29885170>. Accessed June 21, 2020.
29. Chan DS, Callahan CW, Hatch-Pigott VB, et al. Internet-based home monitoring and education of children with asthma is comparable to

- ideal office-based care: results of a 1-year asthma in-home monitoring trial. *Pediatrics*. 2007;119(3):569-578. <https://doi.org/10.1542/peds.2006-1884>
30. Jung Y, Kim J, Park DA. Effectiveness of telemonitoring intervention in children and adolescents with asthma: a systematic review and meta-analysis. *J Korean Acad Nurs*. 2018;48(4):389-406. <https://doi.org/10.4040/jkan.2018.48.4.389>
31. Kaye L, Theye B, Smeenk I, Gondalia R, Barrett MA, Stempel DA. Changes in medication adherence among patients with asthma and COPD during the COVID-19 pandemic. *J Allergy Clin Immunol Pract*. 2020;8:2384-2385. <https://doi.org/10.1016/j.jaip.2020.04.053>
32. Gupta A, Bush A, Nagakumar P. Asthma in children during the COVID-19 pandemic: lessons from lockdown and future directions for management. *Lancet Respir Med*. 2020;2600(20):19-20. [https://doi.org/10.1016/s2213-2600\(20\)30278-2](https://doi.org/10.1016/s2213-2600(20)30278-2)
33. Arvaniti F, Priftis KN, Papadimitriou A, et al. Salty-snack eating, television or video-game viewing, and asthma symptoms among 10- to 12-year-old children: the PANACEA study. *J Am Diet Assoc*. 2011; 111(2):251-257. <https://doi.org/10.1016/j.jada.2010.10.051>
34. Reimberg MM, Pachi JRS, Scalco RS, et al. Patients with asthma have reduced functional capacity and sedentary behavior. *J Pediatr*. 2020;96(1):53-59. <https://doi.org/10.1016/j.jpeds.2018.07.011>
35. Pietrobelli A, Pecoraro L, Ferruzzi A, et al. Effects of COVID-19 lockdown on lifestyle behaviors in children with obesity living in Verona, Italy: a longitudinal study. *Obesity*. 2020;28(8):1382-1385. <https://doi.org/10.1002/oby.22861>
36. Sicouri G, Sharpe L, Hudson JL, et al. Parent-child interactions in children with asthma and anxiety. *Behav Res Ther*. 2017;97:242-251. <https://doi.org/10.1016/j.brat.2017.08.010>
37. Yilmaz O, Sogut A, Gulle S, Can D, Ertan P, Yuksel H. Sleep quality and depression-anxiety in mothers of children with two chronic respiratory diseases: asthma and cystic fibrosis. *J Cyst Fibros*. 2008; 7(6):495-500. <https://doi.org/10.1016/j.jcf.2008.05.002>
38. Lee JY, Lee JH, Yeon GM, Jung YJ. Parental anxiety regarding premature infants and factors affecting parental concern. *J Spec Pediatr Nurs*. 2019;24(4). <https://doi.org/10.1111/jspn.12266>
39. Zanardo V, Freato F. Home oxygen therapy in infants with bronchopulmonary dysplasia: assessment of parental anxiety. *Early Hum Dev*. 2001;65(1):39-46. [https://doi.org/10.1016/S0378-3782\(01\)00190-6](https://doi.org/10.1016/S0378-3782(01)00190-6)
40. Leidy NK. The impact of severe respiratory syncytial virus on the child, caregiver, and family during hospitalization and recovery. *Pediatrics*. 2005;115(6):1536-1546. <https://doi.org/10.1542/peds.2004-1149>
41. Xie X, Xue Q, Zhou Y, et al. Mental health status among children in home confinement during the coronavirus disease 2019 outbreak in Hubei Province, China. *JAMA Pediatr*. 2020;7:18-20. <https://doi.org/10.1001/jamapediatrics.2020.1619>
42. Pınar Senkalfa B, Sismanlar Eyuboglu T, Aslan AT, et al. Effect of the COVID-19 pandemic on anxiety among children with cystic fibrosis and their mothers. *Pediatr Pulmonol*. 2020;55(8):2128-2134. <https://doi.org/10.1002/ppul.24900>

### SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

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