

COVID-19 AND CHILDREN



REPORT OF A SPECIAL TASK FORCE
LED BY THE CHIEF SCIENCE ADVISOR OF CANADA

July 2020



Office of the Chief
Science Advisor of Canada

Bureau du conseiller
scientifique en chef du Canada

Canada 

TABLE OF CONTENT

EXECUTIVE SUMMARY	2
TASK FORCE MEMBERS	4
I. OBJECTIVE	5
Mandate	5
Methodology	5
II. CONTEXT AND STATE OF KNOWLEDGE	6
1. The role of children in the transmission of SARS-CoV-2	7
2. Disease presentation and risk factors in children	9
3. The impact of COVID-19 social measures on children and their families	11
III. FINDINGS	13
IV. ANALYSIS AND FUTURE CONSIDERATIONS	14
A. Children in daycares and schools	14
B. Addressing the challenges of COVID-19 in vulnerable children	16
V. CONCLUSION	17
REFERENCES	18

EXECUTIVE SUMMARY

For the past six months, the world has been dealing with an unprecedented pandemic caused by a new corona virus: SARS-CoV-2. Much has been learned since on the virus and the illness it causes, COVID-19, but many knowledge gaps persist on the prevalence, clinical presentation and transmission of COVID-19 in children. Children form a unique population that may have different infectivity and role in disease transmission compared to adults.

At the time of writing this report, fewer COVID-19 cases have been reported in children, possibly because they were less exposed due to the public health measures or because diagnostic testing strategies prioritized symptomatic individuals and their contacts. Nonetheless, there are emerging concerns that the health risks to children and their role in the transmission of the disease may have been overestimated while the impact of the social measures on their well-being may have been underevaluated.

The Chief Science Advisor (CSA) was asked by the Minister of Innovation, Science and Industry to provide guidance on the science concerning children as vectors for the spread of COVID-19. How the disease manifests in children and whether they contribute to its spread are important questions that directly impact school and daycare openings, health system preparedness and restarting the economy. To help answer the charge, the CSA convened a task force of leading scientists and clinical experts including practicing physicians with first hand knowledge of COVID-19 management in pediatric settings. This report is based on analysis of published research and observational data as well as information embedded in collective expertise.

The key task force findings are:

1. Children are susceptible to SARS-CoV-2 infection but the disease is generally milder in children than in older adults for reasons that have not yet been identified.
2. Younger children (up to 10 years of age) seem to have lower infection rates than older children. The reasons behind this age-dependent difference are not clear yet.
3. Younger children do not appear to be important vectors for COVID-19 transmission unlike their role in the transmission of the seasonal influenza.
4. It is not possible at present to establish the age cut-off when children's COVID-19 parameters (infectivity and transmission) become similar to those of adults.
5. Some public health measures aimed at limiting disease spread have unintended negative consequences on the development and wellbeing of children.
6. Many science gaps remain for fully understanding COVID-19 in children that should be urgently addressed through research and systematic data gathering.



In its analysis, the task force concluded that there is an urgency to fill the large knowledge gap on the pathophysiology of COVID-19 in children through focused research. All opportunities to collect better and broader data about COVID-19 in children should be leveraged, including prevalence studies and systematic observations in day camps, daycare facilities and schools. This will help document children's susceptibility to infection and confirm their role in

its transmission. At the same time, the direct and indirect impacts of the public health measures resulting from the pandemic on children require attention. In evaluating the appropriateness of measures that target children, from school to health interventions, risk assessment should take into account evolving science and include pediatric, infectious disease, educational and child development experts.



TASK FORCE MEMBERS

- Mona Nemer PhD, Chief Science Advisor **(Chair)**
- Susanne Benseler MD PhD, Alberta Children's Hospital, University of Calgary
- Christine Chambers PhD, Dalhousie University
- Dominique Cousineau MD, CHU Sainte-Justine, Université de Montréal
- Eyal Grunebaum MD, Hospital for Sick Children, University of Toronto
- Judith Hall MD, BC Children's Hospital, University of British Columbia
- Paul Kubes PhD, Cumming School of Medicine, University of Calgary
- Joanne Langley MD, Dalhousie University
- Ronald M. Laxer MD, Hospital for Sick Children, University of Toronto
- Amy Plint MD, Children's Hospital of Eastern Ontario, University of Ottawa
- Constantin Polychronakos MD, Montreal Children's Hospital, McGill University
- Caroline Quach MD, CHU Sainte-Justine, Université de Montréal
- Supriya Sharma MD, Health Canada

- Alexandre Bourque-Viens PhD, Office of the Chief Science Advisor **(support)**

I.OBJECTIVE

MANDATE

To review and assess the science concerning children as vectors for the spread of COVID-19.

METHODOLOGY

To evaluate the role of children as vectors for community transmission of COVID-19, the Chief Science Advisor (CSA) assembled a task force to consider the science with a special focus on the clinical and epidemiologic evidence with respect to what is known about COVID-19 infection rates, clinical presentation, transmission and disease course in children. Members of the task force are leading science and clinical experts in immunology and inflammation, child development, infectious disease in children as well as several pediatric specialties ranging from emergency medicine to rheumatology, hematology and genetics. Several of them are practicing physicians with first hand knowledge of COVID-19 management in pediatric settings.

Scientific knowledge of COVID-19 has progressed at an unprecedented pace and much is still being learned about how the disease affects children. In assembling and evaluating existing science, the task force reviewed 1) the published literature and available international epidemiologic data up to July 10, 2020; 2) local

and country-wide epidemiologic data from public health authorities in Canada; and 3) unpublished data deriving from ongoing Canadian research projects. The evidence considered is included in the *Reference* section. The task force adopted an inclusive definition of children, i.e. individuals from 0 to 18 years of age. Recognizing that this group is not uniform, where relevant, expressions such as infants and youth are used to mean the very youngest and the older segment of the group respectively.

Task force observations and recommendations are based on consensus, weighing the assembled data as well as the information embedded in collective expertise.

The task force thanks several organisations that provided important data, in particular the Public Health Agency of Canada, the Institut national de la santé publique du Québec, the CIHR Institute of Human Development, Child and Youth Health and the Maternal Infant Child and Youth Research Network of Canada. Members of the task force gratefully recognize scientists and clinicians who shared unpublished data. In particular, Drs. Shaun Morris, Charlotte Moore Hepburn and Catherine Birken from the University of Toronto and The Hospital for Sick Children, and Dr. Fatima Kakkar from the Université de Montréal and CHU Sainte-Justine who provided highly relevant information from ongoing children and family cohort studies.

II. CONTEXT AND STATE OF KNOWLEDGE

In December 2019, a novel strain of coronavirus was identified in Wuhan, China, following a respiratory illness outbreak. This new virus is genetically related to the one that caused the severe acute respiratory syndrome (SARS) epidemic in 2003. The new virus was named SARS-CoV-2 and the illness it causes, COVID-19, rapidly spread into a pandemic. The common symptoms of COVID-19 are fever, dry cough, and fatigue. Most people will have mild symptoms while some may even remain asymptomatic. Most people (about 80%) recover from the disease without hospital admission. Around 20% of COVID-19 patients develop difficulty breathing and require hospitalization. Older people, and those with underlying medical problems like high blood pressure, heart and lung problems, diabetes, or cancer, appear to be at higher risk of developing serious illness (World Health Organization 2020). Possible long-term effects of COVID-19 in recovered individuals are presently unknown.

The health challenges of the COVID-19 pandemic have been unprecedented and so have been the measures taken to mitigate the spread of the virus. The impact of the public health measures put in place because of the pandemic has been significant on societies and their effects on child development need to be studied. At the time of writing there are emerging concerns that the health risks to children and their role in the transmission of the disease may have been overestimated while the impact of the social measures on their well being may have been under evaluated.

Little was known about SARS-CoV-2 at the onset of the pandemic. By analogy to other respiratory diseases such as influenza, COVID-19 was assumed to be highly contagious in children, which

led to school closures and physical distancing measures. Data collected over the past six months from different countries have provided better insight into the COVID-19 epidemiology, including in children where infections have been reported albeit at much lower rates than in adults. However, existing data in children must be interpreted with caution as they may underestimate infections in children hence disease prevalence, susceptibility, and infectiousness amongst children (Viner et al. 2020). Diagnostic testing for the SARS-CoV-2 virus largely prioritized symptomatic individuals and their contacts. This testing strategy could explain, at least in part, the paucity of data about COVID-19 in children given what we now know about the milder disease in children (Mehta et al. 2020).

Understanding COVID-19 in children and their role as a vector for the virus spread is important on many fronts. From a child health perspective, the disease may manifest itself differently than in adults and it is essential to clarify disease presentation and clinical course for the best approach for health care management and for preventing long-term sequelae. Similarly, it is critical to understand the risk factors for poor short- and long-term outcomes of COVID-19, especially given the recent evidence of Paediatric Inflammatory Multisystem Syndrome (PIMS) in some pediatric groups (Son 2020; Shulman 2020). Additionally, understanding the role of children in the spread of the disease is critical for adopting the appropriate public health measures to limit spread, such as closures of daycare, schools and playgrounds. Some of these measures can have significant unintended consequences on children's development. Of course, school and daycare closures also have ripple effects on the workforce and the workplace that can negatively affect the health and well-being of adults and children.

1. THE ROLE OF CHILDREN IN THE TRANSMISSION OF SARS-COV-2

Early observations suggest that children may be less likely than adults to become infected by SARS-CoV-2. However, it should be taken into account that throughout the pandemic access to virus testing had to be prioritized based on public health advice. For example, during the early phase of pandemic, the testing of symptomatic individuals was prioritized. Later, testing strategies across the country were broadened to include asymptomatic people and to target certain settings. In many places, children were tested only if they were known contacts of a case, a traveller, or being admitted to the hospital with respiratory symptoms. Therefore, the available data (described below) should be interpreted with caution as they may reflect the fact that children were less exposed to the virus during lockdowns or that they were tested less frequently for the reasons mentioned above.

A study of infection propagation in New York state households found a significant age gradient in COVID-19 prevalence that was 3 times higher in those ≥ 65 years as compared with those < 5 years (Rosenberg et al. 2020). A similar study in Guangzhou, China, indicates that, compared with the oldest age group (≥ 60 years), the risk of household infection was lower in the youngest (< 20 years) age group (Jing et al. 2020). Several other studies from Europe and Asia have also suggested differences amongst childhood age groups with respect to infection and transmission rates with young children being less likely to get infected and spread the virus (Fontanet, Grant, et al. 2020; Rajmil 2020; Nederlands National Institute for Public Health and the Environment 2020; Gudbjartsson et al. 2020). A recent larger study from South Korea of over 5000 index cases and their 59,000 contacts reaches the same

conclusion: namely that children younger than 10 years of age transmit the virus to others much less often than adults but older children (ages 10-19) can spread the virus just as much as adults (Park et al. 2020).

In Canada, the reported incidence of COVID-19 in children is relatively low compared to other age groups. Based on data collected up to June 9th, out of the 96,318 cases of COVID-19 reported in Canada, 6.7% ($n=6,444/96,318$) are under 20 years of age whereas they represent 22% of the population. Older children (10-19 years of age) account for 62% of the reported cases under 20 years of age (Public Health Agency of Canada 2020b).

As noted above, lower testing rates, higher rate of asymptomatics or mildly symptomatic individuals and lower exposure (e.g. due to school closure) could affect these values (Viner et al. 2020). For instance, in Stockholm, where schools remained open, Sweden Public Health Agency data suggest only slightly lower infection rates in children under 19 years of age compared to adults based on antibody testing; in total, 4.7% of samples from the age group 0-19 years were positive for 64 years and 2.7% in the 65-95 years age group (Folkhälsomyndigheten 2020). These results may



however be skewed by differences in the immune response to the virus between the various groups which have not yet been studied.

Given the preceding and in the absence of rigorous prevalence studies, it is difficult to ascertain whether children are less likely to get infected than adults. However, the existing data suggest that children may not be major transmitters of SARS-CoV-2 (Isaacs et al. 2020; Park et al. 2020). Findings from a systematic review of household clusters of COVID-19 found that 3/31 (10%) were due to a child index case, and a population-based school contact tracing study found minimal transmission by child or teacher index cases (Viner et al. 2020). In the Netherlands, separate data from primary care and household studies suggest SARS-CoV-2 is mainly spread between adults and from adult family members to children (Netherlands National Institute for Public Health and the Environment 2020). The retrospective study of a large cluster of COVID-19 cases in Northern France, led by Institut Pasteur researchers and based on surveys and serology

testing, observed very different transmission dynamics operating in high schools and primary schools. In high schools, secondary transmission was observed and the probability of finding antibodies in 15-17 year olds (students) was similar to finding them in their teachers (Fontanet, Tondeur, et al. 2020). In primary schools there was no evidence of secondary transmission from children in the school setting (Fontanet, Grant, et al. 2020). These findings are consistent with the large study from South Korea (Park et al. 2020).

Information obtained by the task force on daycare infections during the peak of the pandemic in Quebec and Ontario (mid-March to June 11) suggest that children can infect others, including peers and staff, but that outbreaks can be kept small with strategic infection control measures that allow for interactions between children and with adult caretakers, that are as normal as possible. Observations are summarized in the following vignette.

DAYCARE INFORMATION FROM ONTARIO AND QUEBEC UP TO JUNE 11

Ontario

Up to June 11, daycare only served essential workers in Ontario. Ottawa saw no outbreak. Toronto reported one outbreak where 15 staff and 7 children were infected. In that case, COVID-19 was likely introduced into the centre by staff although it is not possible to rule out other infection sources.

Quebec

In addition to daycare services for essential workers, progressive reopening of daycare across Quebec started May 11, except for the greater Montréal and Joliette areas, which reopened June 1st.

- Infection was reported in 63 daycares, 81% (51/63) declared a single case.
- Outbreaks occurred in 12 daycares: 10 in Centres de la Petite Enfance (CPE) and 2 in home care settings.
- On average, the 10 CPE outbreaks included 2.5 cases. The largest outbreak involved 4 cases.

Conclusion

The data indicate that the measures in place were effective at controlling outbreaks.

2. DISEASE PRESENTATION AND RISK FACTORS IN CHILDREN

Data available so far, including hospitalization and fatalities, suggest that COVID-19 is generally a much milder disease in children than in adults, with the notable exception of the pediatric inflammatory multisystem syndrome (PIMS) discussed later.

Systematic reviews of the clinical presentation of SARS-CoV-2 infection in children are summarized in Table 1.

Table 1 — Summary of common COVID-19 symptoms in children and adults.

	CHILDREN			ADULTS
	(Liguoro et al. 2020)	(Mantovani et al. 2020)	(Ma et al. 2020)	(Public Health Agency of Canada 2020c)
Severity				
Asymptomatic	15.1 %	n/a	42%	n/a
Mild or moderate	80.4%	79 %	n/a	81%
Severe	2%	4%	3%	14%
Critical	0.7%	n/a	n/a	5%
Symptoms	N=1016	N=2855	N=486	
Fever	51.6%	47%	46%	44-91%
Cough	47.3%	37%	42%	57-74%
Sore throat	17.9%	n/a	n/a	11-13%
Runny nose	7.7%	2%	12%	<10%
Dyspnea	7.7%	1%	n/a	31-63%
Diarrhea	9.7%	4%	10%	5-24%
Vomiting	7.3%	n/a	8%	5-19%
Fatigue	10.6%	n/a	8%	31-70%
Loss of appetite	n/a	n/a	n/a	39-84%
Loss of smell and /or taste	n/a	n/a	n/a	54-88%

Studies reviewed by Liguoro et al include a majority of children from Italy and the US. Studies reviewed by other authors include a majority of Chinese children. For more information readers should refer to original publications. With regard to the severity of the COVID-19, a severe disease generally would require hospitalization and an acute disease would require mechanical ventilation.

In Canada, hospital admissions were less likely to occur among those under 20 years of age (Public Health Agency of Canada 2020b), up to June 9th.

- Children accounted for 1% of known COVID-19 hospitalization¹ (n=95), whereas they represent 22% of the population.
- Only 1.5% of infected children were hospitalized (95/6,444 cases).
- No death from SARS-CoV-2 infection occurred among those under 20 years of age.

Within the pediatric group, a higher prevalence of COVID-19 and higher hospitalization rates were observed in children under the age of one. A meta-analysis concludes that infants and newborns were more vulnerable to a severe COVID-19 disease than older children (observed generally with sepsis) but morbidity and mortality were low (Raba et al. 2020). The greater number of cases in infants under 1 year may also be due to more testing and the general greater precaution with that age group.

With respect to complications, about a month after the peak of COVID-19 cases in some regions, a small number of children presented Kawasaki-like symptoms including persistent fever, systemic hyper inflammation, multi-organ involvement, abdominal pain and gastrointestinal symptoms, cardiogenic shock and myocardial dysfunction (Verdoni et al. 2020; Riphagen et al. 2020). While the majority of patients tested negative for the virus, most tested positive for antibodies to the virus, suggesting that the syndrome may have resulted from an abnormal immune reaction to the virus (Shulman 2020). The Canadian Pediatric Surveillance Program (2020) observed a significant number of PIMS cases in Canadian provinces with the highest proportion of COVID-19 cases, i.e. Ontario, Quebec and Alberta. At present, it is unclear which patients might progress to PIMS and a better understanding of the cellular mechanisms triggered by SARS-CoV-2 is needed. A number of factors may affect the risk of developing severe forms of COVID-19 or delayed complications including ethnicity, genetic and epigenetic factors, co-morbidities, prenatal history, subclinical birth defects as well as socio-economic determinants.

1. A portion of children were admitted with severe COVID-19 symptoms, another portion was admitted because psychiatry or residential institutions could not keep COVID-19 positive cases even with mild or no symptoms.

3. THE IMPACT OF COVID-19 SOCIAL MEASURES ON CHILDREN AND THEIR FAMILIES

In response to the seriousness of the global pandemic, multiple broad based public health measures were put in place, including school closures, online distance learning, home confinement and physical distancing. With the evolving knowledge of SARS-CoV-2, several groups have started reviewing both the risks and benefits of the measures as well as their unintended consequences. In particular, several health professionals are studying whether some public health measures may have had unintended negative consequences on the pediatric population.

Pediatricians have been publicly highlighting the risks of isolation and closing of schools on children (Association des pédiatres du Québec 2020; Royal College of Paediatrics

and Child Health 2020; Masonbrink and Hurley 2020). Some of these risks are outlined in a recent analysis published in the Canadian Medical Association Journal:

“Although severe COVID-19 seems to be rare in children and young people, this demographic group will likely experience a high burden of indirect physical, social and mental health effects related to reduced non-urgent care and general pandemic control measures. We owe it to our children and young people to proactively measure the indirect effects of the COVID-19 pandemic on their health and take steps to mitigate the collateral damage.”(Chanchlani, Buchanan, and Gill 2020)



Children from vulnerable populations and those with disabilities may be more affected by the social measures. Mandated social isolation may increase adverse childhood experiences such as maltreatment, poverty and food insecurity. Recent refugees, marginalized families and those in Indigenous communities, who already suffer from difficult housing conditions, financial strain and food insecurity may be at increased risk (Chanchlani, Buchanan, and Gill 2020). Of note, in addition to their key role in learning and child development, schools also help compensate for food insecurity, lack of cognitive stimulation and to detect and report child abuse and neglect. Home schooling can contribute to amplifying social inequities, as it requires access to technology and family support that may not be available to all. Additional consequences of not reopening schools could include parental exhaustion and childhood obesity due to a sedentary lifestyle. Of note, school and daycare closures have had well documented disproportionate impacts on women including their participation in the workforce (United Nations Entity for Gender Equality and the Empowerment of Women (UN Women) and United Nations Secretariat 2020).

Collective trauma events have short- and long-term implications including post-traumatic stress, anxiety and behavioral disorders. Children in poverty are particularly vulnerable because of underlying psychosocial stressors (e.g., home

instability) and developmental and behavioral disorders (Masonbrink and Hurley 2020). The task force was provided preliminary results from the *TARGet Kids! COVID-19 Study of Children and Families* practice-based cohort in Greater Toronto Area, Kingston, and Montreal, which suggest a widespread increase of distress in children (average age 5) compared with pre-COVID-19 (C. Birken, unpublished results).

Children with chronic health problems (cancer, diabetes, etc.) have also suffered from a lack of access to the healthcare system. Protecting newborns from the risk of COVID-19 exposure in a hospital setting required prioritization of medical procedures, which in some cases could have resulted in some newborns not receiving physical exams they usually get in the first days of life because of quick discharge from hospitals after childbirth. A general delay in regular immunization programs has been noted, which could result in the resurgence of certain infectious diseases. The National Advisory Committee on Immunization issued guidance on continuity of immunization programs during the COVID-19 pandemic (Public Health Agency of Canada 2020a) but data are required to assess the situation in Canada. USA data suggest that vaccine doses administered to children decreased by >50% after the March 13 declaration of a national emergency (Chanchlani, Buchanan, and Gill 2020).

III. FINDINGS

The task force was mandated to provide guidance on the science concerning children as vectors for the spread of COVID-19. How the disease manifests in children and whether they contribute to its spread are important questions that directly impact school and daycare openings, health system preparedness and the restarting of the economy. After less than six months of research, knowledge of the virus that causes COVID-19 has dramatically progressed. Nonetheless, many gaps remain with respect to the transmission of the virus, the variable biological responses to it and the genetic and environmental factors that affect the disease outcome. With respect to children, the epidemiologic data from different studies and jurisdictions are not always similarly collected and aggregated and furthermore, COVID-19 testing guidelines are not always specified at the time of data collection. Notwithstanding these gaps, the available evidence indicates that:

1.

Children are susceptible to SARS-CoV-2 infection but the disease is generally milder in children than in older adults.

2.

Younger children (up to 10 years old) seem to have lower infection rates than older children. The reasons behind this age-dependent difference is not clear yet. It may be behavioural or physiologic.

3.

Younger children do not appear to be important vectors for COVID-19 transmission unlike their role in the transmission of the seasonal flu. The reasons for this are not clear but may reflect the mild/asymptomatic nature of the disease in children.

4.

It is not possible at present to establish more precisely the age cut-off when children's COVID-19 parameters (infectivity and transmission) become similar to those of adults.

IV. ANALYSIS AND FUTURE CONSIDERATIONS

With no effective therapy available to prevent or treat the disease, jurisdictions in Canada and around the world have used the precautionary principle in dealing with the uncertainties surrounding COVID-19. Multiple measures were applied simultaneously, making it difficult to dissect each of their individual effectiveness. Some of these public health measures can have adverse or unintended consequences on the physical and mental wellbeing of children; others exacerbate inequities and may have long lasting negative effects on a whole generation. Limited access to primary and secondary health care, parental fear of seeking health care, daycare and school closures as well as parental unemployment and financial instability, exacerbate health and educational inequalities especially in vulnerable communities. Home confinement also increases the risk of exposure to adverse childhood experiences including physical and mental abuse as well as malnutrition.

The knowledge gained over the past six months should help better evaluate the gains but also the risks of different public health measures and ensure that appropriate and measured responses are in place to preserve children and societal wellbeing. The coming months present important opportunities to continue bridging the knowledge gaps and accumulating valuable epidemiologic and research data on COVID-19 in children. With this in mind the following areas of considerations are presented:

A. CHILDREN IN DAYCARES AND SCHOOLS

Safe reopening of daycares and primary schools with appropriate monitoring should be prioritized. Evidence so far suggests that children have a low risk of serious complications and mortality from COVID-19. Young children seem to have low transmission rates but there is insufficient evidence on the role of older children in the spread of the disease.



The psychosocial consequences of school and daycare closures may outweigh the health benefits to children directly and indirectly by, for example, impacting the employment situation of the parent(s). Decisions on school reopening need to weigh public health, education as well as other social and community risks. A number of experts are issuing recommendations on how to re-open activities for children while mitigating the most important risks (SickKids 2020; Sharfstein and Morpew 2020). Daycare and primary schools in Quebec have shown that practices such as keeping children and education personnel in “bubbles” and limiting contact between classes can allow for some quasi-normal educational interactions while mitigating the risks of large outbreaks. A recent Consensus Study Report from the US National Academy of Sciences also provides valuable recommendations for safely reopening and operating schools (National Academies of Sciences 2020).

Research that improves understanding of the COVID-19 epidemiology in children should be encouraged.

There is an urgency to clarify the scientific evidence on the lower prevalence of COVID-19 in children during the pandemic and to verify whether older children have indeed different infection and transmission rates than younger ones. This will require, among other, well-designed rigorous studies to monitor transmission dynamics in children by observing them and their parents as they return to normal activities during the summer and fall months.

Suggested areas of attention include:

1. Research

- **Undertaking of COVID-19 serological studies in pediatric populations by researchers and academics through the Canadian Immunity Task Force to improve understanding of infection prevalence in children.**
- **Clinical and biomedical research aimed at understanding the basis for differences**

in virus infection and transmission as well as research into the benefit and impact of confinement, physical distancing and other infection control measures on children.

2. Monitoring

- **Collaborative efforts between community, researchers and public health authorities to closely monitor, test, and analyze SARS-CoV-2 propagation in summer camps, daycares and schools should be established and data collection should be harmonized and include personal as well as environmental (e.g., exposure conditions and precautionary measures in place) parameters.**

3. Care and ongoing risk assessment

- **Resources to address physical and emotional needs of children should be accessible in schools and health care and community settings.**
- **To ensure that measured approaches are implemented, health (public, infection, epidemiology, pediatrics), education, and psychosocial experts should participate in risk assessment exercises at all government levels.**

4. Communication

- **Clear, evidence-backed communications by health authorities to communities, health and educational professionals on the role of children in disease transmission are essential. Public information on the markedly reduced risk of acute severe infections in children, as well as the benefits and impacts of infection prevention and control measures on children should be easily accessible using appropriate tools and products tailored to different communities and stakeholders.**

B. ADDRESSING THE CHALLENGES OF COVID-19 IN VULNERABLE CHILDREN

Children are unlikely to suffer from the COVID-19 associated morbidities and mortalities seen in older adults for reasons that remain unclear. Nonetheless, some children experience serious complications not seen in adults while others are more severely affected by the public health measures associated with the pandemic.

Emerging reports of rare but severe forms of the disease including cases of PIMS or Kawasaki-like disease in COVID-19 infected children is of particular concern and require attention. As severe forms of COVID-19 in children are better understood, including their risk factors and how to prevent them or effectively treat them, clinical care of at-risk children will be improved. Furthermore, the longer term effects of contracting COVID-19 are presently unknown. Delayed organ damage is observed in other childhood diseases. The long-term effects of the SARS-CoV-2 infection need to be monitored in children. Research findings on these questions will help update clinical guidance including for PIMS associated with SARS-CoV-2 (American College of Rheumatology 2020).

On the other hand, current public health measures to prevent COVID-19 spread may disproportionately affect some children putting them at greater risk for psychosocial impact or further widening socio-economic disparities. For example, school closures risk exacerbating the incidence of school drop-out, which already disproportionately affects certain groups. Online learning may not be accessible to everyone and may be particularly challenging to some groups including those with special needs or from vulnerable communities.

The likelihood of living with COVID-19 for the coming months requires that we continuously endeavour to minimize its short- and long-term impacts on children. This in turn necessitates more focused research into understanding the disease in children and better data collection. COVID-19 pathophysiology may be different in children and

it may be further affected by ethnicity, gender, and other unknown factors. Answering questions such as why children seem to be less susceptible to the illness or why COVID-19 has a different presentation in children would provide fundamental answers to some of the mysteries of COVID-19. Coordination of data and research (e.g. by leveraging existing cohorts or establishing a pediatric COVID-19 network) will accelerate discovery and its translation into better child care and development.

Areas of attention include:

1. Research

- **Supporting studies aimed at understanding COVID-19 in children, including the immune response to the virus, the impact, if any, of other immunizations or infections (such as seasonal flu and the common cold) and other unique pediatric aspects of COVID-19.**
- **Clarifying the relationship of PIMS to SARS-CoV-2 and identifying the risk factors for more severe disease presentation or outcome in children.**

2. Monitoring and care

- **Funding for the development of a national cohort of children with confirmed COVID-19 for long-term follow up and monitoring of physical and mental health outcomes.**
- **Establishing, through rigorous studies and surveys, the direct and indirect impacts of the pandemic on children, including those with chronic health problems, with learning or physical disabilities, with behavioural disorders or from vulnerable communities.**
- **Developing practical approaches to identify and protect most at-risk children from severe acute or delayed respiratory and Inflammatory Multisystem syndromes. This could include prioritizing rapid antibody testing in emergency rooms.**

V. CONCLUSION

Few studies so far have focused on COVID-19 in children and some of the epidemiological data collected may reflect diagnostic strategies that prioritized symptomatic individuals. Nonetheless, the bulk of existing data suggests that SARS-CoV-2 infection and transmission in children is different from seasonal influenza. Children are susceptible to COVID-19 infection but the disease appears to be milder in children than in adults and so far, many show mild to no symptoms. Early evidence indicates that younger children appear to contribute less to disease spread than older children and adults; however, this needs to be studied further. On the other hand, certain public health measures put in place to limit the spread of COVID-19 and protect children from COVID-19 exposure, such as school closures, may have unintended consequences on the development and psychophysical health of children.

In the months ahead, as we learn to live with COVID-19, we need to fill the many persisting knowledge gaps on the pathophysiology of COVID-19 in children. There may be an urgency

to leverage all opportunities to learn more about children and COVID-19. For instance, performing systematic observations in day camps, daycares and schools to confirm the role of children in transmission, or leveraging existing longitudinal cohorts to assess the direct and indirect impacts of COVID-19 while learning more about its prevalence in children as part of the Canadian Immunity Task Force efforts.

At the same time, there are decisions to make that can bear long-lasting impacts on the health and well-being of children. In evaluating the appropriateness of measures that target children, risk assessment should take into account evolving science and include pediatric, infectious disease, educational and child development experts.

REFERENCES

As the report is being finalized the evidence base continues to grow. Recent additions such as the following two reviews from McMaster University's National Collaborating Centre for Methods and Tools are consistent with this report's findings.

Rapid evidence reviews: *"What is the specific role of daycares and schools in COVID-19 transmission?"* and *"What is known about the impact of the COVID-19 pandemic on families with children?"* <https://www.nccmt.ca/knowledge-repositories/covid-19-rapid-evidence-service>

- o American College of Rheumatology. 2020. "Clinical Guidance for Pediatric Patients with Multisystem Inflammatory Syndrome in Children (MIS-C) Associated with SARS-CoV-2 and Hyperinflammation in COVID-19."
- o Association des pédiatres du Québec. 2020. "Position de l'Association Des PédiatresDuQuébecSurLeDéconfinement Des Enfants Québécois En Contexte de Pandémie de COVID-19." <https://pediatres.ca/wp-content/uploads/2020/04/Position-de-IAPQ-D%C3%A9confinement-des-enfants-qu%C3%A9b%C3%A9cois-Lettre-aux-m%C3%A9dias-2020-04-23.pdf>.
- o Canadian Pediatric Surveillance Program. 2020. "Public Health Alert: Acute Inflammatory Illness in Children Temporally Linked to COVID-19." https://www.cpsp.cps.ca/uploads/private/CPSP_Public_Health_Alert_Acute_inflammatory_illness_and_COVID-19.pdf.
- o Chanchlani, Neil, Francine Buchanan, and Peter J. Gill. 2020. "Addressing the Indirect Effects of COVID-19 on the Health of Children and Young People." *CMAJ*, June. <https://doi.org/10.1503/cmaj.201008>.
- o Folkhälsomyndigheten. 2020. "Första resultaten från pågående undersökning av antikroppar för covid-19-virus — Folkhälsomyndigheten." May 20, 2020. <http://www.folkhalsomyndigheten.se/nyheter-och-press/nyhetsarkiv/2020/maj/forsta-resultaten-fran-pagaende-undersokning-av-antikroppar-for-covid-19-virus/>.
- o Fontanet, Arnaud, Rebecca Grant, Laura Tondeur, Yoann Madec, Ludivine Grzelak, Isabelle Cailleau, Marie-Noelle Ungeheuer, et al. 2020. "SARS-CoV-2 Infection in Primary Schools in Northern France: A Retrospective Cohort Study in an Area of High Transmission." *MedRxiv*, June, 2020.06.25.20140178. <https://doi.org/10.1101/2020.06.25.20140178>.
- o Fontanet, Arnaud, Laura Tondeur, Yoann Madec, Rebecca Grant, Camille Besombes, Nathalie Jolly, Sandrine Fernandes Pellerin, et al. 2020. "Cluster of COVID-19 in Northern France: A Retrospective Closed Cohort Study." *MedRxiv*, April, 2020.04.18.20071134. <https://doi.org/10.1101/2020.04.18.20071134>.
- o Gudbjartsson, Daniel F., Agnar Helgason, Hakon Jonsson, Olafur T. Magnusson, Pall Melsted, Gudmundur L. Norddahl, Jona Saemundsdottir, et al. 2020. "Spread of SARS-CoV-2 in the Icelandic Population." *New England Journal of Medicine* 382 (24): 2302–15. <https://doi.org/10.1056/NEJMoa2006100>.
- o Isaacs, David, Philip Britton, Annaleise Howard-Jones, Alison Kesson, Ameneh Khatami, Ben Marais, Claire Nayda, and Alexander Outhred. 2020. "To What Extent Do Children Transmit SARS-CoV-2 Virus?" *Journal of Paediatrics and Child Health* 56 (6): 978–79. <https://doi.org/10.1111/jpc.14937>.

- o Jing, Qin-Long, Ming-Jin Liu, Zhou-Bin Zhang, Li-Qun Fang, Jun Yuan, An-Ran Zhang, Natalie E. Dean, et al. 2020. "Household Secondary Attack Rate of COVID-19 and Associated Determinants in Guangzhou, China: A Retrospective Cohort Study." *The Lancet Infectious Diseases* 0 (0). [https://doi.org/10.1016/S1473-3099\(20\)30471-0](https://doi.org/10.1016/S1473-3099(20)30471-0).
- o Liguoro, Ilaria, Chiara Pilotto, Margherita Bonanni, Maria Elena Ferrari, Anna Pusioli, Agostino Nocerino, Enrico Vidal, and Paola Cogo. 2020. "SARS-CoV-2 Infection in Children and Newborns: A Systematic Review." *European Journal of Pediatrics*, May, 1–18. <https://doi.org/10.1007/s00431-020-03684-7>.
- o Ma, Xuefeng, Shousheng Liu, Lizhen Chen, Likun Zhuang, Jie Zhang, and Yongning Xin. 2020. "The Clinical Characteristics of Pediatric Inpatients with SARS-CoV-2 Infection: A Meta-Analysis and Systematic Review." *Journal of Medical Virology* n/a (n/a): 1–7. <https://doi.org/10.1002/jmv.26208>.
- o Mantovani, Alessandro, Elisabetta Rinaldi, Chiara Zusi, Giorgia Beatrice, Marco Deganello Saccomani, and Andrea Dalbeni. 2020. "Coronavirus Disease 2019 (COVID-19) in Children and/or Adolescents: A Meta-Analysis." *Pediatric Research*, June, 1–5. <https://doi.org/10.1038/s41390-020-1015-2>.
- o Masonbrink, Abbey R., and Emily Hurley. 2020. "Advocating for Children During the COVID-19 School Closures." *Pediatrics*, June. <https://doi.org/10.1542/peds.2020-1440>.
- o Mehta, Nisha S., Oliver T. Mytton, Edward W. S. Mullins, Tom A. Fowler, Catherine L. Falconer, Orla B. Murphy, Claudia Langenberg, Wikum J. P. Jayatunga, Danielle H. Eddy, and Jonathan S. Nguyen-Van-Tam. 2020. "SARS-CoV-2 (COVID-19): What Do We Know about Children? A Systematic Review." *Clinical Infectious Diseases*. <https://doi.org/10.1093/cid/ciaa556>.
- o National Academies of Sciences, Engineering. 2020. "Reopening K-12 Schools During the COVID-19 Pandemic: Prioritizing Health, Equity, and Communities." <https://doi.org/10.17226/25858>.
- o Netherlands National Institute for Public Health and the Environment. 2020. "Children and COVID-19 | RIVM." 2020. <https://www.rivm.nl/en/novel-coronavirus-covid-19/children-and-covid-19>.
- o Park, Young Joon, Young June Choe, Ok Park, Shin Young Park, Young-Man Kim, Jieun Kim, Sanghui Kweon, et al. 2020. "Contact Tracing during Coronavirus Disease Outbreak, South Korea, 2020." *Emerging Infectious Diseases* 26 (10). <https://doi.org/10.3201/eid2610.201315>.
- o Public Health Agency of Canada. 2020a. "COVID-19: Continuity of Immunization Programs during the Pandemic: Interim Guidance." <https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/interim-guidance-immunization-programs-during-covid-19-pandemic.html>.
- o Public Health Agency of Canada. 2020b. "Epidemiologic Summary of COVID-19 in Children and Youth: Special Compilation for Task Force."
- o Public Health Agency of Canada. 2020c. "COVID-19 Signs, Symptoms and Severity of Disease: A Clinician Guide." Guidance. Aem. June 29, 2020. <https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/guidance-documents/signs-symptoms-severity.html>.
- o Raba, Ali Ahmed, Anis Abobaker, Ismail Suliman Elgenaidi, and Ahmed Daoud. 2020. "Novel Coronavirus Infection (COVID-19) in Children Younger Than One

- Year: A Systematic Review of Symptoms, Management and Outcomes.” *Acta Paediatrica* n/a (n/a). <https://doi.org/10.1111/apa.15422>.
- o Rajmil, Luis. 2020. “Role of Children in the Transmission of the COVID-19 Pandemic: A Rapid Scoping Review.” *BMJ Paediatrics Open* 4 (1): e000722. <https://doi.org/10.1136/bmjpo-2020-000722>.
 - o Riphagen, Shelley, Xabier Gomez, Carmen Gonzalez-Martinez, Nick Wilkinson, and Paraskevi Theocharis. 2020. “Hyperinflammatory Shock in Children during COVID-19 Pandemic.” *The Lancet* 395 (10237): 1607–8. [https://doi.org/10.1016/S0140-6736\(20\)31094-1](https://doi.org/10.1016/S0140-6736(20)31094-1).
 - o Rosenberg, Eli S, Elizabeth M Dufort, Debra S Blog, Eric W Hall, Dina Hoefer, Bryon P Backenson, Alison T Muse, et al. 2020. “COVID-19 Testing, Epidemic Features, Hospital Outcomes, and Household Prevalence, New York State—March 2020.” *Clinical Infectious Diseases: An Official Publication of the Infectious Diseases Society of America*, May. <https://doi.org/10.1093/cid/ciaa549>.
 - o Royal College of Paediatrics and Child Health. 2020. “Open Letter from UK Paediatricians about the Return of Children to Schools.” https://www.rcpch.ac.uk/sites/default/files/2020-06/open_letter_re_schools_reopening_2020-06-17.pdf.
 - o Sharfstein, Joshua M., and Christopher C. Morpew. 2020. “The Urgency and Challenge of Opening K-12 Schools in the Fall of 2020.” *JAMA*, June. <https://doi.org/10.1001/jama.2020.10175>.
 - o Shulman, Stanford T. 2020. “Pediatric Coronavirus Disease-2019—Associated Multisystem Inflammatory Syndrome.” *Journal of the Pediatric Infectious Diseases Society*. <https://doi.org/10.1093/jpids/piaa062>.
 - o SickKids. 2020. “COVID19: Recommendations for School Reopening.” http://www.sickkids.ca/PDFs/About-SickKids/81407-COVID19-Recommendations-for-School-Reopening-SickKids.pdf?fbclid=IwAR2B4R_I12KCP_sL28DTPczO6DQg4okn1T1fjrid_qLjExmHB2PJB3asEMI.
 - o Son, Mary Beth F. 2020. “Pediatric Inflammatory Syndrome Temporally Related to Covid-19.” *BMJ* 369 (June). <https://doi.org/10.1136/bmj.m2123>.
 - o United Nations Entity for Gender Equality and the Empowerment of Women (UN Women), and United Nations Secretariat. 2020. “Policy Brief: The Impact of COVID-19 on Women.” <https://www.un.org/sexualviolenceinconflict/wp-content/uploads/2020/06/report/policy-brief-the-impact-of-covid-19-on-women/policy-brief-the-impact-of-covid-19-on-women-en-1.pdf>.
 - o Verdoni, Lucio, Angelo Mazza, Annalisa Gervasoni, Laura Martelli, Maurizio Ruggeri, Matteo Ciuffreda, Ezio Bonanomi, and Lorenzo D’Antiga. 2020. “An Outbreak of Severe Kawasaki-like Disease at the Italian Epicentre of the SARS-CoV-2 Epidemic: An Observational Cohort Study.” *The Lancet* 395 (10239): 1771–78. [https://doi.org/10.1016/S0140-6736\(20\)31103-X](https://doi.org/10.1016/S0140-6736(20)31103-X).
 - o Viner, Russell M., Oliver T. Mytton, Chris Bonell, G. J. Melendez-Torres, Joseph L. Ward, Lee Hudson, Claire Waddington, et al. 2020. “Susceptibility to and Transmission of COVID-19 amongst Children and Adolescents Compared with Adults: A Systematic Review and Meta-Analysis.” *MedRxiv*, May, 2020.05.20.20108126. <https://doi.org/10.1101/2020.05.20.20108126>.
 - o World Health Organization. 2020. “Q&A on Coronaviruses (COVID-19).” 2020. <https://www.who.int/news-room/q-a-detail/q-a-coronaviruses>.



Report prepared by the Office of the Chief Science Advisor of Canada (also available in French) / July 2020.

science@canada.ca