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A public health strategy for SARS-CoV-2, grounded in science, should guide Swiss schools through the coming winter

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As the world approaches the end of the second year of the COVID-19 pandemic, many countries have come to rely greatly on the safety afforded by vaccines, available to all aged 12 years and older, while relaxing other measures in the general population. In Switzerland, however, less than 60% of the population is fully vaccinated as of 1 October 2021 [1], considerably lagging behind other European countries. With the highly infectious Delta variant, and a still significant unvaccinated population, there is broad consensus that both pharmaceutical and nonpharmaceutical public health measures will remain relevant to limit further spread, especially during the coming winter. Of particular interest in this context are children below 12 years old, as no vaccine has been licensed for this age group yet.

A large increase in SARS-CoV-2 infections was observed in children in many countries recently, including in Switzerland [2]. Due to the progressive softening of measures following the mass vaccination campaign, and the increased contagiousness of the Delta variant, it is expected that the virus will continue to circulate rapidly in this population. There has been significant debate on how the educational system can remain functional, and how to minimise disruptions of children's well-being and learning, while at the same time ensuring that virus circulation remains low so as to protect children and the overall community. Public health and school authorities must make decisions as to which public health measures are appropriate and necessary to reach this goal, in spite of the imperfect evidence available to date.

The Swiss Society of Paediatrics (SSP) recently stated that mass testing, mandatory mask wearing, and quarantine orders in schools should be reduced to the "essential minimum" to ensure uninterrupted operation of schools [3]. Furthermore, they have argued for a harmonised Switzerland-wide strategy, and that vaccination in those >12 years old will help to mitigate the negative impact of the pandemic on children. We strongly support the call for a uniform public health strategy for educational institutions across Switzerland. Furthermore, we fully agree that vaccination uptake in the eligible population must be increased to protect the age groups not yet eligible for a vaccine.

However, we also believe that the primary goal of any public health strategy for schools should be to ensure undisturbed, but also safe, education for children. In contrast to the SSP's statements, we argue that a number of added public health measures should be considered "essential" in order to achieve this goal. In this paper, we respond to the statements made by the SSP by clarifying the current evidence on the epidemiology and burden of SARS-CoV-2 in children, and the expected benefits of school-based mitigation measures. We believe that the following points in the statement of the SSP require a critical scientific review. Statements that come directly from the SSP are highlighted in italics. Our arguments are also briefly summarised in the appendix.

Disease burden

"The Delta variant does not lead to more severe COVID-19 courses than previous variants. This statement is based on clinical experience over 2 months in Switzerland, data from the Federal Office of Public Health and published data from the US."

Data regarding the Delta variant and its effects on the severity of COVID-19 infections continue to emerge, making the statement above premature. To the best of our knowledge, only limited national data assessing the severity of the disease among children in Switzerland since the beginning of Delta circulation has been shared; nevertheless, several studies suggest that, at least among adults, Delta may lead to more severe outcomes than previous variants. A cohort study from Canada found that Delta "was associated with significant elevations in risk of hospitalisation, intensive care unit (ICU) admission, and death in younger and older adults", in comparison with non-variant infections [4]. The same study also found that "Delta VOC increased hospitalisation risk in children under 10 by a 2.5 factor (adjusted odds ratio, 95% confidence interval: 1.2 to 5.1) compared to non-VOC" [4] (VOC: variant of concern). In a UK study looking at all age groups, the results suggested that "patients with the Delta variant had approximately two times the risk of hospital admission compared with patients with the Alpha variant" [5].

Consequently, even if the risk of hospitalisation per exposure or infection still remains the same in children, the overall burden on the health system may be significantly higher since more people are getting infected with this more transmissible variant. The statement does, however, provide a reference to data from the US on children and adolescent hospitalisations associated with COVID-19 from March 2020 to August 2021 [6]. The cited study found that, although the proportions of hospitalised children and adolescents with severe disease did not show a statistically significant difference before and during the period of Delta predominance, an increase in the circulation of the highly transmissible Delta variant led to a nearly five-fold increase of COVID-19-associated hospitalisations among children and adolescents, and a nearly 10-fold increase in the age group 0–4 years, with one in four hospitalised children requiring ICU treatment [6]. The estimate of the proportion of hospitalised children who required invasive mechanical ventilation during the period of Delta predominance (9.8%) was higher than that earlier in the pandemic (6.1%), but the comparison of these proportions was based on a small number of children requiring invasive mechanical ventilation during the Delta period, and the difference was not statistically significant ($p = 0.06$).

"The very rare PIMS-TS syndrome (roughly estimated 1:5000 to 1:10,000 infections) has not led to any deaths in Switzerland so far ..."

Currently, deaths due to the paediatric multisystem inflammatory syndrome associated with COVID-19 (PIMS-TS) have not yet been reported in Switzerland. Nonetheless, COVID-19 has already led to multiple deaths among children in other countries. Whereas acute SARS-CoV-2 infections remain generally mild among children, the absolute number of severe cases requiring hospitalisation and potentially experiencing long-term consequences increases as more children become infected. This was the case for the US, where 4461 PIMS-TS cases and 41 deaths meeting the PIMS-TS-related case definition were reported, as of 27 August 2021 [7]. The University Hospital of Geneva reported 20 PIMS-TS cases in an estimated 16,000 infections (around 0.1%) in spring 2021 [8]. Additionally, in July, the Swiss National COVID-19 Science Taskforce estimated that PIMS-TS occurs in around 1:2500 to 1:4000 infections [9]. Other respiratory viruses such as respiratory syncytial virus (RSV) or influenza are expected to circulate again this winter. Switzerland, like several other countries, has already reported an increase in RSV circulation recently with the relaxation of measures against COVID-19 [10]. Thus, paediatric units, especially paediatric ICUs, are likely to experience an additional burden through otherwise preventable COVID-19 cases.

Persistent symptoms (long COVID): The incidence and possible long-term consequences of long COVID are not addressed at all in the SSP statement. Currently, the incidence of long COVID, especially among children, remains unclear and varies according to definition and location. For example, a large study in the UK showed that 4.4% of children who tested positive for SARS-CoV-2 had symptoms for at least 28 days, and 1.8% had symptoms for at least 56 days [11]. A study from Switzerland showed that 3.7% of seropositive and 2.2% of seronegative school-aged children (median age 11 years) had symptoms beyond 12 weeks, although the sample size was small [12]. According to recent data from the UK, symptoms were similar in seropositive children (aged 2 to 11 years) and in a control group of children without infection (3.2% vs 4.1%) and overall, the proportion of persons who had symptoms for at least 12 weeks was lower in children than in adults [13]. However, neurocognitive symptoms such as attention and learning problems and memory deficits, which are frequent symptoms of long COVID in adults, were not assessed in the UK coronavirus infection survey.

Epidemiology

"The seroprevalence (natural contamination), which was already up to 40% before the start of the 4th wave, depending on the canton, will continue to increase rapidly."

As this statement is without reference, it is unclear what data support this estimate. The Ciao Corona study estimated that 19% of 2500 Zurich school children had antibodies as of July 2021 [14]. Data from the canton of Geneva, which was heavily impacted by COVID-19 in 2020, found a 20.8% seroprevalence in children <6 years old and 31.4% in 6–11 years old as of July 2021 [15]. Existing data therefore highlight that even in strongly affected areas around 70–80% of children remain seronegative, and thus likely still susceptible to infection and disease.

"The testing strategy in Switzerland since the beginning of the pandemic has been managed in a way that allows natural immunization in those under 6 years of age and (partially) in those 6–12 years of age."

The strategy to restrict testing in children under 12 years was first adopted in July 2020 [16]. Throughout the pandemic, the rationale for not testing children for SARS-CoV-2, even when symptomatic, has been justified by the SSP's assumption that only a small proportion of children would test positive and they rarely transmit SARS-CoV-2 [17]. However, regular testing in schools could play a key role in the early identification of cases and interruption of transmission chains, thereby reducing potential disruptions in the education of children and increasing transparency and trust in the population [18].

"Even for the Delta variant, the most important direction of transmission is from young adults to children, rather than vice versa, because the age-specific incidence maximum shifts downward with increasing wave duration. The most important transmission field remains the family and household."

Since the opening of schools in Switzerland, several cantons have had very large surges of cases in children that do not correspond to surges in adults. It is highly unlikely that the majority of these children acquired their infection outside schools when a large number of children belonging to the same class or school test positive in a very short time frame. In the meanwhile, more than half of the adult population in Switzerland is fully vaccinated. Although vaccine break-through infections do occur, infections are far less common among vaccinated than among unvaccinated persons [19]. If transmission mostly occurred from adults to children, we would expect that case numbers in children would decrease with increasing adult vaccination rates, rather than increase, as we have observed.

Furthermore, data from the UK found that young people aged 2–16 years are more likely to be the first case in their household, even before the predominance of more transmissible SARS-CoV-2 variants. The study clearly states that, "children can transmit within households as well as in educational settings" [20], and accumulating evidence is consistent with increased transmission occurring amongst school children. No such study data are yet available in Switzerland, and by deliberately choosing not to test children or only testing sporadically, important epidemiological data on SARS-CoV-2 infection is missed.

Protective measures

The SSP statement is in disagreement with many other international academies of paediatricians as well as other large health agencies (e.g., the World Health Organization [WHO], the US Centers for Disease Control and Prevention [CDC]) concerning preventive measures in educational institutions. For example, the American Academy of Pediatrics strongly advocates for protection measures in children and schools [21].

Protective measures such as regular testing, mask use, use of natural ventilation and high-efficiency particulate airfilters (HEPA filters) and vaccination of teachers, are well known to be very effective without being invasive [22, 23]. It also has been shown in epidemiological studies that although in-person schooling is associated with increased household COVID-19 risk, this additional risk is eliminated with sufficient school-based mitigation measures [24].

The first trial results on vaccination in children aged 5 to 11 years were released by Pfizer recently [25]. The results show that the vaccine is safe, well tolerated and that it causes a robust neutralising antibody response. More data on children aged 2 to 5 years and 6 months to 2 years of age are expected by the fourth quarter of this year. Many parents and children are eagerly awaiting the approval of the vaccine for younger children, and a free circulation of the virus will increase the risk of infection just before a protective vaccine will most probably become available.

"Masking mandates should be questioned, especially in primary schools; mask mandates will not influence the course of the pandemic in a relevant way".

Several national and international recommendations on masks mandates in children exist, although the minimum age for mask use differs between them. According to the WHO, masks can be safely used on children above the age of 5 years [26], while the US CDC recommends masks for children above the age of 2 years in schools [27]. They also suggest masking people aged ≥2 years in indoor public spaces and child care centres as critical measures to reduce disease burden. Similarly, the Italian paediatric society recommends masks in children [28], which are currently required in Italy above the age of 6. In France, masks were compulsory for children aged 6 years and older in schools up to 17 June 2021, and now mask use depends on the epidemiological situation in the area [29]. Recent data from the CDC concludes that counties without school mask requirements experienced larger increases in paediatric COVID-19 case rates compared with counties that had school mask requirements [30]. Masking of children and teachers in addition to other mitigation measures was found to be associated with a significant risk reduction for COVID-19 in schools in the US [24].

"The effect of air filtration systems in schools has been little studied and is not a priority for pandemic control."

There is little debate on whether improvements in indoor air quality can lead to reductions in respiratory pathogen risk, including SARS-CoV-2. Simple ventilation measures in classrooms promote low CO_2 values and thus well-being, attention and performance [22, 31]. A study in US schools found that SARS-CoV-2 "incidence was 37% lower in schools that required teachers and staff members to use masks and 39% lower in schools that improved ventilation" [30]. Similarly, a modelling study showed that combined interventions (natural ventilation, masks and HEPA filtration) were most effective, leading to a ≥30-fold decrease in the cumulative dose of viruses absorbed by exposed occupants in a classroom [22].

"Quarantine measures should be used flexibly and with a sense of proportion. In the case of repetitive testing, they should be omitted altogether and class quarantines should only be imposed in the case of several cases (e.g. three per class within a few days)."

Over the course of the pandemic, quarantine of contacts of cases has been very effective in containing virus spread. Quarantines in the form of lock-downs may create enormous societal, economic and health damage. However, frequent testing and quarantines of exposed individuals have the potential to decrease virus spread within institutions and limit the size of outbreaks [32]. Thus, testing will ultimately lead to fewer children needing isolation or quarantine. Furthermore, adopting additional measures to prevent infections in educational settings, as well as vaccination of all eligible age groups, will further decrease the spread of SARS-CoV-2. Thus, implementing clear and uniform public health measures, which mitigate SARS-CoV-2 circulation in children, will reduce not only morbidity and mortality, but also pandemic-related secondary harm.

Conclusions

We strongly advocate use of meaningful public health measures in schools to reduce disruptions in the education of children and protect those populations that are not yet eligible for a vaccine. Possible measures have been briefly summarised by the Swiss National COVID-19 Science Task Force [33] and also internationally (WHO, CDC) [26, 27] and *The Lancet* [23]. Adopting the precautionary principle will also prevent potential unknown negative long-term health consequences. By implementing the known effective measures, both vulnerable children, adults and the whole healthcare system will be safer. Protecting children is not only a moral imperative, but will also help us to control the epidemic situation and ensure continuous education during the coming winter.

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Competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflicts of interest were disclosed.

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Appendix

Table S1

Statements by SSP	Counter-arguments
"The Delta variant does not lead to more severe COVID-19 courses than previous variants. This statement is based on clinical experience over 2 months in Switzerland, data from the Federal Office of Public Health and published data from the USA."	No data provided for Switzerland
	Data on children still limited and based on small sample sizes
	Data on adults shows more severe disease and increased hospitalisation risk
	Hospitalisations for children increased with Delta circulation 5–10 fold in US
	Opposite conclusions by the authors whose work is cited by SSP
"The very rare PIMS-TS syndrome (roughly estimated 1:5,000 to 1:10,000 infections) has not led to any deaths in Switzerland so far ..."	COVID19 and PIMS-TS-related deaths have been reported in children in other countries
	Swiss Science Taskforce estimated that PIMS-TS occurs in around 1:2500 to 1:4000 infections
	PIMS-TS may strain paediatric units with co-circulation of other viruses
Long COVID and possible long-term consequences not mentioned	Incidence of long COVID, especially in children, is still unclear
	Varies according to definition and location but it should certainly not be ignored
"The seroprevalence (natural contamination), which was already up to 40% before the start of the 4th wave, depending on the canton, will continue to increase rapidly."	No verifiable data source for this seroprevalence
	Recent data available for children in Switzerland range between 19% and 31%
	70–80% of children are still susceptible to primary infection
"The testing strategy in Switzerland since the beginning of the pandemic has been managed in a way to allow transmission in those under 6 years of age and (partially) in those 612 years of age."	Rationale for this testing strategy was communicated as children being rarely infected and rarely transmitting the virus in July 2020
	Testing increases transparency and trust in the population
"Even for the Delta variant, the most important direction of transmission is from young adults to children, rather than vice versa, because the age-specific incidence maximum shifts downward with increasing wave duration. The most important transmission field remains the family and household."	In Switzerland surge in paediatric cases after school openings does not correspond to adult incidences
	Many concurrent infections in schools make it unlikely that all children infected outside schools
	Accumulating evidence of transmission by children in school and household settings
	Increasing vaccination rates in adults do not correlate with decreased infections in children
"Masking mandates should be questioned, especially in primary schools; mask mandates will not influence the course of the pandemic in a relevant way."	Masks can be safely used in children according to WHO and the US Centers for Disease Control and Prevention (CDC)
	The US recommends masks for all individuals above the age of 2 in schools
	Recent data suggest that mandatory masks slow down the spread of SARS-CoV-2 in children
"The effect of air filtration systems in schools has been little studied and is not a priority for pandemic control."	Implementation of air filters are unlikely to affect the well-being of children and they are very cheap compared with the costs of a severe disease and school closures.
	Many studies exist on effectiveness of air filtration
"Quarantine measures should be used flexibly and with a sense of proportion. In the case of repetitive testing, they should be omitted altogether and class quarantines should only be imposed in the case of several cases (e.g. three per class within a few days)."	Letting the virus spread could potentially contribute to large outbreaks that may demand school-wide closures, thereby involving a larger number of children.
	Adopting additional measures will decrease the spread of SARS-CoV-2 and thus also disruptions by quarantine