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Review

Challenges of COVID-19 in children in low- and middle-income countries

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Educational Aims

The reader will come appreciate:

- Children in LMICs develop predominantly mild disease or asymptomatic infection similar to that in high income countries.
- The indirect effects of the pandemic on child health are substantial in LMICs, including increasing poverty levels, disrupted schooling, lack of access to school feeding schemes, reduced access to health facilities and interruptions in vaccination and other child health programs.
- In many LMICs inability to implement effective public health measures such as social distancing, hand hygiene, identification and isolation of infected people and universal use of masks, impact on transmission.
- Health systems in LMICs are under-resourced; diversion of resources to adults' services in the pandemic may further compromise child health.

ARTICLE INFO

Keywords:

COVID
 Low-middle income countries
 Child
 Indirect effects
 Resource allocation

ABSTRACT

As the coronavirus pandemic extends to low and middle income countries (LMICs), there are growing concerns about the risk of coronavirus disease (COVID-19) in populations with high prevalence of comorbidities, the impact on health and economies more broadly and the capacity of existing health systems to manage the additional burden of COVID-19. The direct effects of COVID are less of a concern in children, who seem to be largely asymptomatic or to develop mild illness as occurs in high income countries; however children in LMICs constitute a high proportion of the population and may have a high prevalence of risk factors for severe lower respiratory infection such as HIV or malnutrition. Further diversion of resources from child health to address the pandemic among adults may further impact on care for children. Poor living conditions in LMICs including lack of sanitation, running water and overcrowding may facilitate transmission of SARS-CoV-2. The indirect effects of the pandemic on child health are of considerable concern, including increasing poverty levels, disrupted schooling, lack of access to school feeding schemes, reduced access to health facilities and interruptions in vaccination and other child health programs. Further challenges in LMICs include the inability to implement effective public health measures such as social distancing, hand hygiene, timely identification of infected people with self-isolation and universal use of masks. Lack of adequate personal protective equipment, especially N95 masks is a key concern for health care worker protection. While continued schooling is crucial for children in LMICs, provision of safe environments is especially challenging in overcrowded resource constrained schools. The current crisis is a harsh reminder of the global inequity in health in LMICs. The pandemic highlights

Abbreviations: COVID-19, Coronavirus disease 2019; ICU, intensive care unit; HIC, high income country; LMICs, low- and middle-income country; LRTI, lower respiratory tract infection; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; TB, tuberculosis; WHO, World Health Organisation.

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<https://doi.org/10.1016/j.prrv.2020.06.016>

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key challenges to the provision of health in LMICs, but also provides opportunities to strengthen child health broadly in such settings.

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INTRODUCTION

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) emerged in China in December 2019 and has spread to most countries, infecting millions of people and causing over 400,000 deaths [1]. As of May 2020, high-income countries (HICs) reported twice as many cases as low- and middle-income countries (LMICs) [1,2]. This may be due to lags in spread to LMICs and lack of testing capacity. Recently expanded testing capacity has revealed fast rising numbers in several LMICs, although there are noticeable differences in transmission between nations [3–5]. For example in South America, the incidence of new infections is higher in Chile, Peru, Brazil and Ecuador while Argentina, Uruguay and Paraguay have much fewer cases [4]. Although Brazil has the second highest number of cases worldwide, there is a seven fold difference in incidence between the southern and northern regions of the country as at the beginning of June 2020 [6].

As the pandemic extends to LMICs, there are growing concerns about the risks of severe coronavirus disease 2019 (COVID-19) in populations with high prevalence of comorbidities, the impact on health and economies more broadly and the capacity of existing health systems to manage the additional burden of COVID-19 [7,8]. Furthermore, in countries where other infectious diseases such as malaria, cholera, chikungunya and dengue are prevalent, it is impossible to predict interactions among these infections and SARS-CoV-2. Table 1 provides a summary of COVID-19 cases and deaths for a few LMICs and country specific health indicator data.

Children in LMICs seem to predominantly develop mild disease or be asymptomatic, a pattern that is similar to that in high income countries (HICs). However, children in LMICs may be more vulnerable for several reasons. Firstly, children constitute a greater proportion of the population, comprising up to 60% of the population in some LMICs [11]. Secondly, risk factors for severe lower respiratory tract infection (LRTI) such as malnutrition, exposure to smoke or air pollution, incomplete immunisation and HIV are more prevalent in children in LMICs [12]. Indeed, the burden of LRTIs globally is heavily skewed towards LMICs, with most deaths occurring in these settings [13]. Thirdly, the burden of infectious diseases such as tuberculosis is much higher in LMICs and little is known about co-infections with SARS-CoV-2. However, prior infection with other pathogens including endemic coronaviruses or universal BCG vaccination, may possibly protect children against severe disease through development of trained or specific immunity [14,15]. Fourthly, health systems in LMICs are under-resourced and weaker than in high-income-countries (HICs). With the burden of adult COVID disease, diversion of resources away from child services may further compromise child health. Furthermore, although COVID-19 is a respiratory disease, it is likely transmissible by faecal-oral contamination; stool samples remain positive for an average of 11 days after respiratory swabs turn negative [16]. In some LMIC settings, particularly in Africa and Latin-America, water scarcity and poor sanitation are important issues that may promote transmission of SARS-CoV-2 (Table 1) [17]. Importantly the *indirect* effects of the pandemic, including increasing poverty, adult illness and school closures with negative impact on school feeding schemes may be substantial, with major negative effects on child health and wellbeing.

Public health interventions including hand hygiene, social distancing, universal wearing of masks, identification and isolation of infected people and tracing of contacts are effective to contain transmission and mitigate the epidemic [18,19]. However, many of these measures are difficult or impossible to institute in poorer LMICs where for example running water may not be easily accessed or people live in very crowded conditions.

CHILDHOOD COVID DISEASE IN LMICs

In LMICs most reported COVID-19 cases have occurred in adults, with much fewer cases in children [3,20]. In Kenya, 3.0% of the 2600 confirmed COVID-19 cases are children <10 years of age, and only 1% of deaths among confirmed cases have occurred in children [21]. In South Africa, less than 2% of positive cases are in children, with few requiring hospitalisation and even fewer requiring intensive care [22]. In Chile 3.8% of confirmed cases are below 10 years [23]. Similarly, in the south of Brazil, 2% of cases fall in this age group [6,24]. Interestingly in Argentina where the incidence is still low, the proportion of infections among children under 10 years is the highest in the region (6.9%) [25]. COVID does not appear to be especially severe even in children with underlying comorbidities, similar to what has reported for children from HICs. Although children in LMICs have a much higher burden of severe LRTIs in general as compared to adults, this pattern is not apparent with COVID [26,27].

THE INDIRECT EFFECTS OF COVID ON CHILD HEALTH IN LMICs

While COVID does not appear to directly severely affect many children in LMICs, the indirect effects of the pandemic are of great concern [28]. Firstly, downscaling or closure of regular child and maternal health preventive and other services may compromise immunisation, antenatal and nutritional programs, and result in higher morbidity and mortality from other diseases such as tuberculosis (TB). Several African countries have initiated dusk to dawn curfews and local travel restrictions as part of social distancing measures. These measures further reduce access to health care especially among low income groups, leading to potential increases in morbidity or mortality among vulnerable groups most in need of health care including young children and pregnant women [29]. Reduced access to care, poverty and fear of being infected with COVID at health care facilities, may lead to delays in seeking care for sick children, resulting in more severe illness at presentation and lower uptake of effective preventive interventions such as childhood vaccination [30].

Secondly, diversion of resources to adult services further compromises the ability to care for children. Health care workers are increasingly being seconded to adult services and health budgets that are already inadequate for child health needs, are being shifted to managing the COVID epidemic. Thirdly, closure of schools directly affects child learning, child mental health and the ability of parents to work. In LMICs, children may not have equitable access to distance learning; indeed, the poorest children are least able to access internet learning resources [31]. In addition, child nutrition may be further compromised, as many children from poor communities in LMICs rely on school feeding schemes for daily sustenance [32]. Lastly, lockdowns with resulting wide-

Table 1
Summary of COVID-19 and health indicator data for selected low- and middle-income countries.

Country	Region	COVID indicators				Health system indicators				Water, sanitation and hygiene indicators		
		No of cases as at 13 June 2020	No. of deaths as at 13 June 2020	Case fatality rate	Human development index	Antiretroviral therapy coverage among people living with HIV	Effective tuberculosis treatment coverage	Antenatal care coverage (4 visits)	Measles vaccine second dose coverage	Population with at least basic access to drinking water	Population using basic sanitation services	Population with basic hygiene facilities
Low income country												
Haiti	Latin America & Caribbean	3941	61	2%	0.503	58%	60%	67%	38%	65%	35%	23%
Nepal	South Asia	5062	16	0%	0.579	56%	64%	69%	69%	89%	62%	48%
Sierra Leone	Sub-Saharan Africa	1103	51	5%	0.438	41%	55%	78%	55%	61%	16%	19%
Syrian Arab Republic	Middle East & North Africa	164	6	4%	0.549	20%	73%	64%	54%	97%	91%	71%
Tajikistan	Europe & Central Asia	4902	49	1%	0.656	46%	71%	64%	97%	81%	97%	73%
Lower middle-income country												
Bangladesh	South Asia	81,523	1095	1%	0.614	22%	58%	37%	93%	97%	48%	35%
Djibouti	Middle East & North Africa	4441	38	1%	0.495	30%	68%	26%	81%	76%	64%	
Kenya	Sub-Saharan Africa	3305	96	3%	0.579	68%	39%	10%	45%	59%	29%	25%
Nicaragua	Latin America & Caribbean	1655	55	3%	0.651	53%	70%	88%	95%	82%	74%	
Philippines	East Asia & Pacific	24,787	1052	4%	0.712	44%	53%	87%	40%	94%	77%	78%
Ukraine	Europe & Central Asia	30,506	880	3%	0.750	52%	56%	87%	90%	94%	96%	
Upper middle-income country												
Armenia	Europe & Central Asia	16,004	264	2%	0.760	53%	63%	96%	96%	99%	94%	94%
Brazil	Latin America & Caribbean	802,828	40,919	5%	0.761	66%	62%	91%	69%	98%	88%	
Iran (Islamic Republic of)	Middle East & North Africa	182,545	8659	5%	0.797	20%	70%	94%	98%	95%	88%	
Mexico	Latin America & Caribbean	133,974	15,944	12%	0.767	70%	64%	94%	99%	99%	91%	88%
Peru	Latin America & Caribbean	214,788	6109	3%	0.759	73%	70%	94%	66%	91%	74%	
South Africa	Sub-Saharan Africa	61,927	1354	2%	0.705	62%	44%	76%	50%	93%	76%	44%
Sri Lanka	South Asia	1880	11	1%	0.780	45%	54%	93%	99%	89%	96%	
Thailand	East Asia & Pacific	3134	58	2%	0.765	75%	47%	91%	87%	99%	99%	84%

Country income classification was obtained from the World Bank [2]; COVID-19 related data as at 13 June 2020 was obtained from the World Health Organisation (WHO) [1]; health indicator data was obtained from the WHO Global Health Observatory [9]; water, sanitation and hygiene data was obtained from the WHO Global Health Observatory and UNICEF [9,10]. Data was unavailable for blank cells. Darker shading reflects better indicators.

spread unemployment, food and housing insecurity, have a major impact on the economy, further compromising health and increasing intrafamilial violence.

CHALLENGES OF CARING FOR CHILDREN IN LMICS

LRTIs are a major cause of hospitalisation and death among children <5 years in LMICs [33,34]; and presenting features are indistinguishable from those of COVID. This is a major challenge especially during Respiratory Syncytial Virus (RSV) or influenza seasons. Therefore, rapid widespread testing of sick children for COVID is needed, to appropriately manage and isolate those who are infected. However, testing capacity is extremely constrained in many LMICs and scaling up rapid testing is challenging.

Ensuring that adequate infection prevention measures are maintained while awaiting confirmatory laboratory results is essential. Overcrowded wards are an existing barrier to infection prevention transmission within health facilities in LMICs and could enhance SARS-CoV-2 [35,36]. Furthermore, the mainstay of COVID-19 therapy includes provision of oxygen for the severely ill and intensive care for those who are critically ill, but over half of health facilities in resource limited settings have insufficient oxygen supply and pulse oximetry, and dedicated paediatric intensive care services are rare [37,38]. Upscaling oxygen supplies, including high-flow nasal cannula oxygen and providing innovative methods for oxygen delivery in LMICs is urgently required.

Lack of adequate personal protective equipment (PPE) for health care workers (HCWs) hinders effective provision of care to suspected and confirmed COVID-19 paediatric cases and increases the risk of transmission to this vital work force. Health care workers are particularly vulnerable to infection and providing adequate PPE is a major concern in LMICs [39]. Increasing evidence shows that SARS-CoV-2 is predominately spread via aerosols, and that nasal oxygen systems, coughing or even speaking may generate aerosols [40,41]; therefore protection of HCWs with N-95 or respirator masks is a key, effective form of protection for which there are inadequate supplies in LMICs [19,39].

Maintaining regular childhood preventive and curative services through the pandemic is a particular problem in LMICs, due to resource constraints, closure of facilities, limited access to health facilities and insufficient health care workers or drug supplies. For example, immunisation or nutritional programs and services providing chronic care (such as for TB, HIV) may be compromised.

PUBLIC HEALTH CHALLENGES

Implementing effective public health interventions to prevent transmission and disease may be especially challenging in crowded, poor areas in LMICs. These efforts are further compromised in countries where national leaders do not consider the COVID-19 pandemic an important public health issue. A multi-sectorial approach is needed to improve access to running water, limit crowding and provide housing or adequate living conditions. Strengthening social security systems and poverty alleviation are critical for poor communities through the pandemic and require intersectoral collaboration and government commitment and vision.

Identification and isolation of infected people and contact tracing may be difficult in LMICs with poorly developed systems for rapid testing, contact tracing and isolation, especially in the context of very crowded living conditions, use of public transport and many close contacts.

Universal wearing of cloth masks is an important low cost intervention to reduce transmission that may especially be important in areas of crowding where social distancing is difficult [39]. How-

ever, lack of clear recommendations from the World Health Organisation (WHO) and conflicting guidelines have hampered efforts [42]. Universal mask wearing may be effective not only to reduce COVID transmission, but also transmission of other viral pathogens and tuberculosis [42–47]. A key challenge is to scale up effective use throughout LMICs. Universal use of surgical masks in health care facilities is also needed to prevent transmission especially as COVID may be spread by asymptomatic or pre-symptomatic people. N-95 masks should be worn during aerosolising procedures, by HCWs taking care of respiratory or COVID patients, and by HCWs on the frontline with high levels of exposure to SARS-CoV-2, including in emergency rooms, intensive care unit (ICU) settings or medical wards [19,39,48].

Re-opening of schools in the context of COVID is complex. Only half of schools globally have access to water and soap for hand washing, and levels are lower in LMICs [49]. Moreover, public schools are often over-crowded which may enhance disease transmission [50,51]. Safe re-opening of schools will require investments to improve basic sanitation facilities, universal use of masks, environmental controls, operational changes (such as smaller classroom sizes, social distancing in classes), screening of staff and students for symptoms and exclusion of high-risk staff from the workplace. These may be especially challenging in LMIC settings, where schools are already under-resourced and overcrowded.

CONCLUSION

Similar to HICs, children in LMICs are not at major risk for severe COVID disease, but there are major negative indirect effects on child health. The current crisis is a harsh reminder of the global inequity in health services for children in LMICs. The pandemic highlights key challenges to the provision of child health in LMICs, but also provides opportunities to strengthen child health broadly in such settings [52].

DIRECTIONS FOR FUTURE RESEARCH

- The role of children in community transmission of SARS-CoV-2 in LMICs
- Factors that mitigate the development of severe disease in children in LMICs, and the role of prior other infections or vaccination in stimulating possible immune protection
- The impact of co-infections such as tuberculosis, that are highly prevalent in LMICs on the disease spectrum of COVID in children
- The long term impact of COVID on child health in LMICs

FUNDING

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors. H Zar is supported by the SA Medical Research Council.

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