Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

The best course of action for GPEI is to work with the Expanded Programme on Immunisation (EPI) to promote IPV (three doses per child), and to withdraw OPV from countries that reach 85% coverage in children younger than 5 years. Providing IPV through the EPI in Afghanistan and Pakistan will prevent WPV type 1 and cVDPV type 2 polio. The same tactic will prevent polio anywhere, caused by cVDPV types 1, 2, or 3.

We declare no competing interests.

*T Jacob John, *Dhanya Dharmapalan*
drdhanyaroshan@gmail.com

Christian Medical College, Vellore, India (TJJ); Paediatric Infectious Diseases, Apollo Hospitals, Navi Mumbai 400614, India (DD)

1 WHO. Polio eradication strategy 2022–2026: delivering on a promise. Geneva: World Health Organization, 2021.
2 Thompson KM, Kalkowska DA. An updated economic analysis of the global polio eradication initiative. *Risk Anal* 2021; **41:** 393–406.
3 Soudarssanane MB, Rotti SB, Srinivasa DK, Ramalingam G. Paralytic poliomyelitis in children under 6 years in Pondicherry: a community survey. *J Epidemiol Community Health* 1993; **47:** 210–14.
4 Anderson RM. Directly transmitted viral and bacterial infections of man. In: Anderson RM, ed. Population dynamics of infectious diseases. London: Chapman and Hall, 1982: 137.
5 Singh J, Datta KK. Epidemiological considerations of the age distribution of measles in India: a review. *J Trop Pediatr* 1997; **43:** 111–15.
6 WHO. The relation between acute persisting spinal paralysis and poliomyelitis vaccine (oral): results of a WHO enquiry. *Bull World Health Organ* 1976; **53:** 319–31.
7 John TJ. Two good reasons to drop type 2 virus from oral polio vaccine. *Lancet* 2004; **364:** 1666.
8 Jorba J, Diop OM, Iber J, et al. Update on vaccine-derived polioviruses—worldwide, January 2016–June 2017. *MMWR Morb Mortal Wkly Rep* 2017; **66:** 1185–91.
9 WHO. Circulating vaccine-derived poliovirus type 3—Israel. April 15, 2022. https://www.who.int/emergencies/disease-outbreak-news/item/circulating-vaccine-derived-poliovirus-type-3---israel (accessed June 3, 2022).

COVID-19 and microbiome diversity in sub-Saharan Africa

We read with interest the COVID-19 Forecasting Team's description of the variation in COVID-19 infection–fatality ratio,[1] confirming that differences in COVID-19 mortality between geographies are largely explained by the age structures of their populations. However, we fear that the lower than anticipated burden of severe COVID-19 in most of sub-Saharan Africa gets lost in estimations from models based on data from the few African countries that have reliable excess mortality data but are not representative of sub-Saharan Africa. Moreover, country-level estimates of COVID-19 infection–fatality ratio hide the observation that COVID-19 mortality in sub-Saharan Africa is highly concentrated in sections of the population with a more western lifestyle—usually wealthier individuals in urban centres.[2] Such disparity is obvious for most people living in sub-Saharan Africa, where COVID-19 is sometimes popularly called "VIP disease" or "rich person disease".

We suspect that, besides a higher prevalence of obesity, hypertension, and diabetes among wealthier people, immunological factors are at play. Several studies associate chronic parasitic infection (more prevalent among people living in poverty with a less westernised lifestyle) with less severe clinical presentation of COVID-19.[3,4] Such findings are consistent with the importance of a diverse microbiome and chronic immune stimulation in maintaining a well trained immune system that is less likely to cause hyperinflammation, which is critical in severe COVID-19.

Although unexplored, the notion that the better-off might fare worse is not unique to COVID-19 in sub-Saharan Africa. It is also consistently documented that autoimmune diseases, more prevalent in high-income countries, share a common pathway with severe COVID-19, linking reduced microbiome diversity to hyperinflammation, popularised as the hygiene hypothesis.[5] Similar links have been documented in HIV serosurveys in the 2000s in sub-Saharan Africa, in which the better-off had higher risk of HIV infection.[6]

It is vital to deepen our understanding of microbiome diversity and linked immunological factors in the severity of COVID-19, and account for this when modelling COVID-19 infection–fatality ratios.

We declare no competing interests.

**Wim Van Damme, Richard Wamai, Yibeltal Assefa, Laurens Liesenborghs, Dieudonné Mumba*
wvdamme@itg.be

Department of Public Health (WVD) and Outbreak Research Team (LL), Institute of Tropical Medicine, 2000 Antwerp, Belgium; Department of Cultures, Societies, and Global Studies, Northeastern University, Boston, MA, USA (RW); School of Public Health, the University of Queensland, Brisbane, QLD, Australia (YA); Department of Parasitology, Institut National de Recherche Biomédicale, Kinshasa, Democratic Republic of the Congo (DM)

1 COVID-19 Forecasting Team. Variation in the COVID-19 infection–fatality ratio by age, time, and geography during the pre-vaccine era: a systematic analysis. *Lancet* 2022; **399:** 1469–88.
2 De Weerdt J, Van Damme W. Health, wealth and the double paradox of COVID-19 mortality in low-income countries. *SSRN* 2021; published online March 2. https://doi.org/10.2139/ssrn.3793427 (preprint).
3 Achan J, Serwanga A, Wanzira H, et al. Current malaria infection, previous malaria exposure, and clinical profiles and outcomes of COVID-19 in a setting of high malaria transmission: an exploratory cohort study in Uganda. *Lancet Microbe* 2022; **3:** e62–71.
4 Wolday D, Tasew G, Amogne W, et al. Interrogating the impact of intestinal parasite-microbiome on pathogenesis of COVID-19 in sub-Saharan Africa. *Front Microbiol* 2021; **12:** 614522.
5 Finlay BB, Amato KR, Azad M, et al. The hygiene hypothesis, the COVID pandemic, and consequences for the human microbiome. *Proc Natl Acad Sci USA* 2021; **118:** e2010217118.
6 Piot P, Greener R, Russell S. Squaring the circle: AIDS, poverty, and human development. *PLoS Med* 2007; **4:** 1571–75.

Author's reply

We thank Wim Van Damme and colleagues for their interest in our work and their Correspondence. Their comments highlight unique aspects of how the COVID-19 pandemic has unfolded in sub-Saharan Africa. These include the difficulty of estimating