Using the 'shit' of the current COVID-19 crisis as fertiliser for the soil to lay the foundations of a new and sustainable era: lessons from past crises to improve the future

ABSTRACT

Studies of past crises have demonstrated that adverse experiences during critical periods of human development hamper the individual's ability to reach its full potential and leaves lasting marks on health, behaviour, productivity and society as a whole. The COVID-19 crisis has severely worsened the environment in which we live and in which our future generations are being shaped, and will lead to loss of future human potential and capital. It is clear that the COVID-19 pandemic does not only harm the current world population, but also affects our future, as well as that of future generations. The science of transgenerational plasticity demonstrates that investments in early life hold the promise of having beneficial effects across multiple generations. As governments are reopening societies and prioritising policies, their overarching goal should be to improve the environment in which future generations grow and develop, learn and live. This will change the lifetime trajectories of children for the better and affect future health, school success, behaviour, productivity and well-being. This prioritisation will prove to be the most effective intervention to build sustainable futures but will also yield returns many times the original investment. It is a promising way to break the intergenerational cycle of adversity and accelerate progress on achieving the Sustainable Development Goals.

Summary box

What is already known about this subject?

- Studies of past crises have demonstrated that adverse experiences during critical periods of human development hamper the individual's ability to reach its full potential and leaves lasting marks on health, behaviour, productivity and society as a whole.

What are the new findings?

- The COVID-19 pandemic has a negative effect on the environment in which future generations are being shaped, with increased rates of poverty (Sustainable Development Goal, SDG1), hunger (SDG2), disease (SDG3), gender inequality and violence (SDG5) and disruption of education (SDG4).

What are the recommendations for policy and practice?

- Policies should prioritise investments in improving the environment in which future generations grow and develop, this will change the lifetime trajectories of children for the better and affect future health, school success, behaviour, productivity and well-being.
- Such policies will yield returns many times the original investment, provide a promising way to break the intergenerational cycle of adversity and accelerate progress on achieving the SDGs.

The current COVID-19 crisis provides the world with many unprecedented challenges, but it also gives us opportunities to learn. Insights from scientific documentation of the long-term consequences of previous crises teaches us lessons that can be used to rebuild our societies and make them more sustainable. Metaphorically using the 'shit' of the crisis as fertiliser for the soil base to lay the foundations of a new era.

Scientific investigations of past crises, including wars, famines, natural disasters, terrorist attacks and pandemics, have demonstrated that adverse experiences during critical periods of human development hampers the individual's ability to reach its full potential and leaves lasting marks on health, behaviour, productivity and society as a whole. For instance, men and women who were exposed to the 1944–1945 wartime starvation in the Netherlands during the earliest phases of their development in utero, had poorer mental and physical health as adults, with poorer cognitive function, lower labour market participation, increased levels of hospitalisation and increased mortality.[1] Strikingly similar consequences were found among those who were exposed to famines in different settings, such as The Great Leap Forward Famine in China, and the Biafran famine.[2 3] MRI scans of the brain revealed lasting consequences of adverse early life conditions on brain architecture among those conceived during famine,[4] but also among those whose early development coincided with a natural disaster.[5] The mechanisms through which the environment during critical periods of development shapes later function is not only mediated by altering the structure of organs such as the brain, but also through epigenetic changes which allow these effects to be transferred from one generation to the next.[6] Although the consequences of prenatal exposure to pandemics have been studied less, analyses of US census data have shown that those who experienced the 1918 influenza pandemic had lower educational attainment, income and socioeconomic status and increased rates of physical disability, and cardiovascular disease than cohorts born before or after the pandemic.[7 8] Clearly, adverse environmental experiences during critical periods of development affect human health and potential across the lifespan.

This may not be surprising since the most rapid growth and development in the human lifespan occurs in the earliest years of life when most biological milestones are met. The environmental conditions in which the individual grows and develops shape the ability to learn, school success, economic participation, behaviour, susceptibility to disease and addiction, and overall health and well-being. It lays the foundation for human developmental potential. In fact, the economic burden to society of poor early life conditions are staggering and seem to follow to Pareto principle (80–20 rule). A large (80%) share of societal costs are generated by a relatively small segment (20%) of the population.[9] A recent international data linkage study with administrative information of 4 million people across multiple sectors revealed that those who experienced adverse early life conditions incurred the majority of social, criminal and healthcare costs.[10] It shows that inequality clusters among individuals who had a poor start in life leaving

them at a social, economic and health disadvantage.

One of the tragic aspects of a poor start in life is its intergenerational transmission[11] Growing up in adverse environmental conditions (such as poverty, undernutrition or maltreatment) hampers an individuals' ability to develop to their full potential and thereby are less likely to provide their children a good start in life. This fuels the perpetuation of poverty, violence and inequalities and negatively affects health and well-being of future generations while increasing the burden of costs on resources. The corollary of the transgenerational transmission is that investments in early life hold the promise of having beneficial effects across multiple generations. The science of transgenerational plasticity demonstrates how individual trajectories are launched in early development to influence the ability of the individual and its descendants to successfully meet the demands of critical transitions over the lifetime. For example, Heckman and Karapakula have shown in the Perry preschool project that early investments in preschool education do not only benefit the health and school success of those directly exposed to the programme, but that the benefits extend to their siblings as well as their children. People who had participated in the Perry preschool project as a child, themselves had children who had higher levels of education and employment and participated less in crime than children of people in the control group.[12]

The potential consequences of investments in early life are thus both multidomain and multigenerational. Improving the environment in which future generations are being shaped has tremendous potential to accelerate progress in multiple Sustainable Development Goals (SDGs). For instance, improving nutrition in early life (SDG2) will achieve progress on multiple other domains, including health (SDG3), education (SDG4), economic productivity (SDG8) and reduce inequalities (SDG10) (see figure 1). Providing each child with the best possible start in life, free from poverty (SDG1), hunger (SDG2), disease (SDG3), domestic violence and maternal disadvantage (SDG5) and with good quality education (SDG4) will contribute to a healthier, more equal future and lay the foundations for a better world for generations to come.[13]

Figure 1 Illustrating how change in one single SDG in early life has effects on many SDGs in later life. SDG, Sustainable Development Goal.

Before the start of the current COVID-19 pandemic, millions of children worldwide were already failing to reach their full potential due to suboptimal conditions in early life such as poverty, undernutrition, neglect, violence, pollution or lack of education and stimulation. This is made even worse by the COVID-19 induced crisis. The COVID-19 induced changes in first 5 SDGs alone severely worsened the environment in which we live and in which our future generations are being shaped, and will lead to loss of future human potential as well as human capital. Levels of poverty (SDG1) are increasing globally, with women and children being most heavily affected. Growing up in poverty has negative consequences for growth, development and health of children and negatively affects their learning ability and chances to optimally contribute to society.[11] At the same time, the World Food Program predicts that the number of people facing hunger and food insecurity (SDG2) will double this year due to the pandemic. Undernutrition in early life has lasting negative consequences for health, the ability to learn and productivity.[1] Because of the disruption of the healthcare systems, much of the maternity care and basic youth healthcare have become minimal, which is projected to increase morbidity and mortality among women and children[14] (SDG3) with estimates far exceeding the numbers of deaths due to the virus itself. With 188 countries having suspended schools, education (SDG4) of almost all children worldwide has been disrupted. The extent to which education is continued online differs widely and is likely to increase inequalities with unknown long-term consequences. Lack of education and stimulation during those formative early years is likely to negatively impact educational attainment, health and productivity. Many reports have highlighted the increasing gender inequality (SDG5) with domestic violence as one dramatic example where women suffer the consequences of the indirect pandemic effects more. This further hampers the developmental potential of millions worldwide. Domestic and family violence is widespread, often beginning in pregnancy and harms both mother and child.[15] Children exposed to violence in early life (before and/or after birth) have increased risk of mental and

physical illness, substance abuse and violence, perpetuating a vicious cycle of adversity.[16]

It is clear that the current pandemic does not only harm the current world population, but also affects our future, as well as that of future generations. As governments are reopening societies and prioritising policies their overarching goal should be to improve the environment in which future generations grow and develop, learn and live. This will change the lifetime trajectories of children for the better and affect future health, school success, behaviour, productivity and well-being, contributing to acceleration towards achieving multiple SDGs. There is a triple dividend of preventing further adverse environmental exposure and prioritising the youngest; it will have the potential to improve the current lives of people, their future as well as the lives of their future children. This prioritisation will prove to be the most effective intervention to build sustainable futures but will also yield returns many times the original investment.[17] It is a promising way to break the intergenerational cycle of poverty, violence and inequality and accelerate progress on achieving the SDGs. Let us learn lessons from past crisis and use this knowledge to build a better future.

Tessa Roseboom

Department of Epidemiology and Data Science, Department of Obstetrics and Gynaecology, Amsterdam UMC Location AMC, Amsterdam 1105 AZ, The Netherlands

Correspondence to Dr Tessa Roseboom, Amsterdam UMC Location AMC, Amsterdam 1105 AZ, The Netherlands; t.j.roseboom@amsterdamumc.nl

Contributors TR conceived and wrote the manuscript.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not required.

Provenance and peer review Not commissioned; internally peer reviewed.

To cite Roseboom T. Using the 'shit' of the current COVID-19 crisis as fertiliser for the soil to lay the foundations of a new and sustainable era: lessons from past crises to improve the future. *BMJ Nutrition, Prevention & Health* 2020;**3**:e000122

Received 16 June 2020
Accepted 21 June 2020

bmjnph 2020;**3**:e000122.
doi:10.1136/bmjnph-2020-000122

ORCID iD
Tessa Roseboom http://orcid.org/0000-0003-0564-5994

REFERENCES

1 Roseboom TJ. Epidemiological evidence for the developmental origins of health and disease: effects of prenatal undernutrition in humans. *J Endocrinol* 2019;242:T135–44.
2 Li C, Lumey LH. Exposure to the Chinese famine of 1959-61 in early life and long-term health conditions: a systematic review and meta-analysis. *Int J Epidemiol* 2017;46:1157–70.
3 Hult M, Tornhammar P, Ueda P, *et al*. Hypertension, diabetes and overweight: looming legacies of the Biafran famine. *PLoS One* 2010;5:e13582.
4 de Rooij SR, Caan MWA, Swaab DF, *et al*. Prenatal famine exposure has sex-specific effects on brain size. *Brain* 2016;139:2136–42.
5 King S, Dancause K, Turcotte-Tremblay A-M, *et al*. Using natural disasters to study the effects of prenatal maternal stress on child health and development. *Birth Defect Res C* 2012;96:273–88.
6 Hanson MA, Skinner MK. Developmental origins of epigenetic transgenerational inheritance. *Environ Epigenet* 2016;2:dvw002–9.
7 Almond D. Is the 1918 Influenza Pandemic Over? Long-Term Effects of *In Utero* Influenza Exposure in the Post-1940 U.S. Population. *J Polit Econ* 2006;114:672–712.
8 Almond D, Mazumder B. The 1918 influenza pandemic and subsequent health outcomes: an analysis of SIPP data. *Am Econ Rev* 2005;95:258–62.
9 Caspi A, Houts RM, Belsky DW, *et al*. Childhood forecasting of a small segment of the population with large economic burden. *Nat Hum Behav* 2017;1:0005.
10 Richmond-Rakerd LS, D'Souza S, Andersen SH, *et al*. Clustering of health, crime and social-welfare inequality in 4 million citizens from two nations. *Nat Hum Behav* 2020;4:255–64.
11 Scorza P, Duarte CS, Hipwell AE, *et al*. Research review: intergenerational transmission of disadvantage: epigenetics and parents' childhoods as the first exposure. *J Child Psychol Psychiatry* 2019;60:119–32.
12 Heckman JJ, Karapakula G. *Intergenerational and Intragenerational Externalities of the Perry preschool project, IZA discussion papers, no. 12363*. Bonn: Institute of Labor Economics, 2019.
13 Clark H, Coll-Seck AM, Banerjee A, *et al*. A future for the world's children? A WHO-UNICEF-Lancet Commission. *Lancet* 2020;395:605–58.
14 Roberton T, Carter ED, Chou VB, *et al*. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. *Lancet Glob Health* 2020;8:e901–8.
15 UNICEF. Violence against women, 2015. Available: https://unstats.un.org/unsd/gender/downloads/WorldsWomen2015_chapter6_t.pdf
16 Hughes K, Bellis MA, Hardcastle KA, *et al*. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. *Lancet Public Health* 2017;2:e356–66.
17 Heckman JJ. Skill formation and the economics of investing in disadvantaged children. *Science* 2006;312:1900–2.