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Comparing and contrasting two United Nations Environment Programme reports on covid-19

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Comparing and contrasting two United Nations Environment Programme reports on covid-19

Introduction

The cause of covid-19 and other emerging infectious diseases, especially zoonotic, is of intense interest and great importance. In October 2022 a report by me was published by the United Nations Environment Programme (UNEP) into the causes and implications of the pandemic.[1] This adds to an earlier (July 2020) UNEP report into the pandemic.[2]

Drivers of zoonotic disease emergence

Each of these UNEP reports identifies a number of important drivers for zoonotic emergence. While the two reports substantially agree (see table 1), there are also some divergences, the discussion of which is the main purpose of this letter. There is insufficient space here to permit a longer discussion of the concordant drivers.

2022 report (2022 rank)	2020 report (2020 rank)
Intensification of livestock raising (2)	Unsustainable agricultural intensification (2)
Increased use and exploitation of wildlife (3)	Increased over exploitation and unsustainable, unregulated or illegal trading of wildlife (3)
Unsustainable utilization of natural resources accelerated by urbanization, land use change and extractive industries (4)	Unsustainable use of natural resources accelerated by urbanization, land-use change and extractive industries (4)
Climate change as a driver of bat and rodent densities (5)	Climate change (7)
Increased global travel and transportation (6)	Travel and transportation (5)
Viral mixing (?)	Changes in food supply chains (6)

Table 1. A comparison of six similar "drivers" of zoonotic disease emergence discussed in each report. Slight changes in the wording and ranks are evident. "Viral mixing" was listed as the final driver in the 2022 report, but given no rank. Adapted from Table 3.[1]

Each report agrees that the rearing of livestock, especially if housed in crowded conditions, probably enhanced by the proximity of multiple species, creates a risk of viral mixing and zoonotic spillover.[3] This risk is well documented for poultry farms and intensive pig farming. The interaction of wild bats (feeding on fruit overhanging one or more piggeries) and intensively farmed pigs in Malaysia triggered the 1998 outbreak of Nipah virus there.[4] Severe Acute Respiratory Syndrome (SARS) is thought to have arisen primarily from the farming of palm civets (*Paguma larvata*) in southern China (2002), though viruses of strong similarity to SARS were also detected in raccoon dogs (*Nyctereutes procyonoides*) while SARS antibodies were also found in a third species, the Chinese ferret badger (*Melogale moschata*).[5] The farming of racoon dogs is currently a leading hypothesis to explain the initial transmission of

SARS-CoV-2 from an animal to a human.[6] However, as yet (unlike for SARS) no candidate animal has been proven as the proximal reservoir of SARS-CoV-2.[6]

The earlier UNEP report points out longer and more diversified food supply chains create additional opportunities for disease transmission, including at poorly managed informal wildlife and fresh produce markets ("wet markets") that deliver products along poorly regulated supply chains. The latter report focuses on an aspect of this it calls "viral mixing", which it agrees is facilitated by long food supply chains. Such mixing may occur at a wet market, or "upstream", in a farm, large or small. The latter report also speculates that the mingling of animals born in captivity with those introduced from the wild, including by smuggling, may increase the risk of new viral reassortments and zoonoses which may then adapt to human beings.

Two drivers remain to be discussed. One is mentioned in each report with slightly different interpretations. The second has no equivalent in the earlier report (see table 2).

2022 report (2022 rank)	2020 report (2020 rank)
Changes in food value preferences (1)	Increasing demand for animal protein (1)
Laboratory and medical procedures contributing to outbreaks and pandemics (7)	No equivalent

Table 2. A comparison of the major contrasting drivers of zoonotic disease emergence discussed in each report, one of which has no equivalent. Adapted from Table 3 in Ref 1.

Changes in food value preferences versus an increasing demand for animal protein

Each report agrees that the farming of livestock to supply meat and other animal products is the most important underlying driver of potential zoonotic spillover. The chief difference between these reports, with regard to this aspect, concerns the word "protein". Animal sources of protein are generally considered higher in "quality" than from plants, not only because they contain all essential amino acids needed by humans, but also because they enable faster growth.[7] Such protein is particularly important for infants and young children, and possibly in older people losing muscle mass.[7] However, a mix of amino acids that maximally stimulate cell replication and growth may increase the risk of cancer and thus be sub-optimal for most of adult life.[8] In addition, for most people, adequate protein can be easily obtained via a vegan or vegetarian diet.

On the other hand, iron deficiency, with or without iron deficiency anaemia, affects as many as 3.6 billion people.[9] This is, therefore, an enormous global health problem, with immense negative implications for the economy and society, as well as for human well-being, because it harms learning, stamina, earning capacity and immunity.[10] Zinc deficiency is also widespread, especially in low-income settings, and often accompanies iron deficiency.[11] The frequency of iron and zinc deficiency, combined, must greatly exceed that of protein deficiency.

Although the consumption of animal products is not needed, by most people, to provide adequate protein (provided the right combinations of plants are eaten), animal products are far superior to plants as bio-available sources of the micronutrients iron, zinc and vitamin B12, the latter of which (as is well-known) cannot be supplied at all from a vegan diet. Animal products can also be useful sources of beneficial fatty acids and calories. In summary, the second UNEP report does not question the value of modest dietary ingestion of animal products for most people to obtain and to maintain good health, but argues that the chief

benefit from such diet is not via protein intake. The latter report implies that part of the perceived rejuvenating power attributed to the eating of meat, including wild meat, is genuine, but due more to the absorption of micronutrients within animal products, rather than to its protein.

The later report also argues that this is not a reason to stop eating animal products but instead points towards alternative, cost-effective mechanisms that may reduce meat demand, while at the same time maintaining or improving health.[12] These alternative approaches are the treatment of micronutrient-robbing parasitic diseases (e.g. hookworm)[13] and the intake of supplements, especially iron and zinc, particularly where diets are high in phytates or when soil levels of zinc are low.[11]

The role of laboratory and medical procedures contributing to zoonotic outbreaks and potentially to pandemics

The final major difference in the drivers discussed by each report is that the latter includes the role of laboratory and medical procedures in contributing to zoonotic outbreaks and to potential pandemics. It lists fifteen documented escapes of eleven pathogens from laboratories, including the viruses that cause Ebola,[14] smallpox,[15] SARS, H5N1 influenza and foot and mouth disease. It also describes (with other examples) how the reuse of unsterile needles contributed to the early spread of HIV/AIDS in Sub-Saharan Africa[16] and to a large epidemic of hepatitis C in Egypt.[17]

This second UNEP report also warns that the deliberate alteration of viral characteristics, even in a highly secure laboratory, may result in the inadvertent or purposeful creation of new viral forms, with properties that either might not evolve in nature, or are very unlikely to. Such research is variously called “dual use”, “dual use of concern”, “gain of function” and “gain of function research of concern”.[18] Some research that can be described as gain of function (but not of concern) is recognised as valuable, even by critics of its alleged potential to create “potential pandemic pathogens”.[19] Critics of such experimentation argue that it has profound risks, and requires exemplary governance, transparency and oversight if it is to be safely undertaken.[20] Such an ethical environment is, however, not sufficiently engrained within some of the virological research community, as illustrated, for example, by the failure of one of its key members to declare conflicts of interest and to disclose relevant material to the *Lancet* Commission into the pandemic.[21]

Conclusion: broadening the scope of One Health and Planetary Health

The One Health High-Level Expert Panel, involving 26 experts recently (June 2022) defined One Health.[22] Like other One Health definitions[23-24] these authors do not speculate about nor appear to recognise the role of laboratory procedures (forms of biorisk) as contributing to potential disease spillovers. In contrast, however, the foreword to a recent WHO report, written by WHO’s chief scientist[18] (September 2022) states “this framework aims to raise awareness about the importance of biorisk management in the context of the One Health approach”. This letter strongly endorses the implicit appeal in this foreword to broaden the scope of One Health to include biorisks, particularly those that might generate potentially pandemic pathogens (PPPs).

This WHO report defines gain of function as “research that results in the acquisition of new biological phenotypes, or an enhancement of existing phenotypes”. It points out that any such research that is “anticipated to enhance the transmissibility or virulence (or both) of potential pandemic pathogens raises significant biosafety and biosecurity risks.”[18]

This WHO report is of significance because it documents concern at the highest level of global health about the possibility for viral "engineering" to generate a pandemic. In October 2014 a US moratorium on research intended to create novel potential pandemic pathogens was introduced. However, in December 2017 this funding pause was lifted by the US National Institutes of Health.[25] The WHO report, together with this second UNEP report, hints at a global re-awakening of concerns about such research, as does anxiety about the expansion of biosafety laboratories.[26]

Although attribution of SARS-CoV-2 to such research remains speculative, some argue that it is plausible.[27,28] Both the WHO and the second UNEP report implicitly recognise the relevance of viral engineering and synthetic biology to One Health.[18] Such laboratory constructs are also relevant to planetary health because synthesised organisms can be conceptualised as "novel entities", a term coined by and associated with the "planetary boundaries" literature.[29] In turn, planetary boundaries is a key explanatory framework for planetary health. To date, like One Health, definitions of planetary health also overlook this field.[30,31]

Each of these UNEP reports is relevant to One Health, but the second calls for an important broadening of its scope, to recognise the risk of viral engineering as a novel source of zoonotic emergence.

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References

1. United Nations Environment Programme (UNEP) (2022) COVID-19: A Warning. Addressing Environmental Threats and the Risk of Future Pandemics in Asia and the Pacific. Bangkok, Thailand: UNEP. https://wedocs.unep.org/20.500.11822/40871 accessed 25 October, 2022.
2. UNEP (2020) Preventing the Next Pandemic: Zoonotic diseases and how to break the chain of transmission. Nairobi, Kenya: UNEP. https://www.unenvironment.org/resources/report/preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and accessed 25 October, 2022.
3. Jones BA, Grace D, Kock R, Alonso S, Rushton J, Said MY. (2013) Zoonosis emergence linked to agricultural intensification and environmental change. Proceedings of the National Academy of Science of the United States of America; 110: 8399-404. https://doi.org/10.1073/pnas.1208059110
4. Epstein J, Field H, Luby S, Pulliam J, Daszak. P. (2006) Nipah virus: impact, origins, and causes of emergence. Current Infectious Diseases Reports; 8: 59-65. https://doi.org/10.1007/s11908-006-0036-2
5. Guan Y, Zheng BJ, He YQ, et al. (2003) Isolation and characterization of viruses related to the SARS coronavirus from animals in Southern China. Science; 302: 276-8. https://doi.org/10.1126/science.1087139
6. Worobey M, Levy JI, Serrano LMM, et al. (2022) The Huanan market was the epicenter of SARS-CoV-2 emergence. Science; 377: 951–9. https://doi.org/10.1126/science.abp8715
7. Willett W, Rockström J, Loken B, et al. (2019) Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems. The Lancet; 393: 447-92. https://doi.org/10.1016/S0140-6736(18)31788-4

8. Tomasetti C, Li L, Vogelstein B. (2017) Stem cell divisions, somatic mutations, cancer etiology, and cancer prevention. Science; 355: 1330-4. https://doi.org/10.1126/science.aaf9011
9. Camaschella C. (2019) Iron deficiency. Blood; 133: 30-9. https://doi.org/10.1182/blood-2018-05-815944
10. Musallam KM, Taher AT. (2018) Iron deficiency beyond erythropoiesis: should we be concerned? Current Medical Research and Opinion; 34: 81-93. https://doi.org/10.1080/03007995.2017.1394833
11. Gupta S, Brazier AKM, Lowe NM. (2020) Zinc deficiency in low- and middle-income countries: prevalence and approaches for mitigation. Journal of Human Nutrition and Dietetics; 33: 624-43. https://doi.org/10.1111/jhn.12791
12. Kovats RS, Butler CD. (2012) Global health and the global environment: linking research and policy. Current Opinion in Environmental Sustainability; 4: 44-50. https://doi.org/10.1016/j.cosust.2012.01.012
13. Loukas A, Hotez PJ, Diemert D, et al. (2016) Hookworm infection. Nature Reviews Disease Primers; 2: 1-18. https://doi.org/10.1038/nrdp.2016.88
14. Silver S. (2014) Laboratory-acquired lethal infections by potential bioweapons pathogens including Ebola in 2014. FEMS Microbiology Letters; 362: 1–6. https://doi.org/10.1093/femsle/fnu008
15. Heymann DL, Aylward RB, Wolff C. (2004) Dangerous pathogens in the laboratory: from smallpox to today's SARS setbacks and tomorrow's polio-free world. The Lancet; 363: 1566-8. https://doi.org/10.1016/S0140-6736(04)16234-X
16. Pépin J. (2013) The origins of AIDS: from patient zero to ground zero. Journal of Epidemiology and Community Health; 67: 473-5. https://doi.org/10.1136/jech-2012-201423
17. Strickland GT. (2006) Liver disease in Egypt: Hepatitis C superseded schistosomiasis as a result of iatrogenic and biological factors. Hepatology; 43: 915-22. https://doi.org/10.1002/hep.21173
18. WHO (2022). Global Guidance Framework for the Responsible use of the Life Sciences. Mitigating biorisks and governing dual-use research. Geneva, Switzerland: WHO https://www.who.int/publications/i/item/9789240056107 accessed 25 October, 2022.
19. Lipsitch M, Inglesby TV. (2014) Moratorium on research intended to create novel potential pandemic pathogens. mBio; 5: e02366-14. https://doi.org/10.1128/mBio.02366-14
20. Wain-Hobson S. (2013) H5N1 viral-engineering dangers will not go away. Nature; 495: 411. https://doi.org/10.1038/495411a
21. Sachs JD, Karim SSA, Aknin L, et al. (2022) The Lancet Commission on lessons for the future from the COVID-19 pandemic. The Lancet; 400: 1224-80. https://doi.org/10.1016/S0140-6736(22)01585-9
22. One Health High-Level Expert Panel (OHHLEP), Adisasmito WB, Almuhairi S, et al. (2022) One Health: A new definition for a sustainable and healthy future. *PLOS Pathogens*; 18: e1010537. https://doi.org/10.1371/journal.ppat.10105
23. Amuasi JH, Lucas T, Horton R, Winkler AS. (2020) Reconnecting for our future: The Lancet One Health Commission. *The Lancet*; 395: 1469-71. https://doi.org/10.1016/S0140-6736(20)31027-8
24. Zinsstag J, Waltner-Toews D, Tanner M. Why One Health? (2021) In: Zinsstag J, Schelling E, Crump L, Whittaker M, Tanner M, Stephen C, eds. The Theory and Practice of Integrated Health Approaches. Second ed. Wallingford, UK: CABI: 15-24.
25. Burki T. (2018) Ban on gain-of-function studies ends. The Lancet Infectious Diseases; 18: 148-9. https://doi.org/10.1016/S1473-3099(18)30006-9
26. Mallapaty S. (2022) COVID prompts global surge in labs that handle dangerous pathogens. *Nature*; **610**: 428-9. https://doi.org/10.1038/d41586-022-03181-x

27. Harrison NL, Sachs J. (2022) A call for an independent inquiry into the origin of the SARS-CoV-2 virus. Proceedings of the National Academy of Science (USA); 119: e22027691. https://doi.org/10.1073/pnas.2202769119
28. van Helden J, Butler CD, Achaz G, et al. (2021) An appeal for an objective, open and transparent scientific debate about the origin of SARS-CoV-2. The Lancet; 398: 1402-4. https://doi.org/10.1016/S0140-6736(21)02019-5
29. Steffen W, Richardson K, Rockström J, et al. (2015) Planetary boundaries: Guiding human development on a changing planet. Science; 347: 736-46. https://doi.org/10.1126/science.1259855
30. Whitmee S, Haines A, Beyrer C, et al. (2015) Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. The Lancet; 386: 1973–2028. https://doi.org/10.1016/S0140-6736(15)60901-1
31. Haines A, Frumkin H. (2021) Planetary Health. Safeguarding Human Health and the Environment in the Anthropocene. Cambridge UK: Cambridge University Press.

Declaration of interests

☐ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☒ The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

The author is the sole author of the UNEP report from 2022 cited in this letter.