Sciences For Prosperity

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Table of Contents

List of Tables

List of Figures

List of Acronyms

AMR	Antimicrobial Resistance
AMU	Antimicrobial Use
AQI	Air Quality Index
ASC	Annual Scientific Conference
CCHF	Crimean Congo Haemorrhagic Fever
CDC	Centre for Diseases Control
DTRA	Defense Threat Reduction Agency
ECTAD	Emergency Centre for Transboundary Animal Diseases
EISMV	Inter-State School of Veterinary Science and Medicine
EMA-I	Event Mobile Application
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GHS	Global Health Security
GHSA	Global Health Security Agenda
GoU	Government of Uganda
HDI	Human Development Index
IHR	International Health Regulations
IHR-MEF	International Health Regulations—Monitoring and Evaluation Frame work
ISAVET	In-Service Applied Veterinary Epidemiology Training
JEE	Joint External Evaluation
JRA	Joint Risk Assessment
LAN	Local Area Network
LIMS	Laboratory Information Management Systems
LPM	Linear Probability Models
MAAIF	Ministry of Agriculture, Animal Industries, and Fisheries
MCM	Multisectoral Coordination Mechanism
MoFPED	Ministry of Finance, Planning & Economic Development
MoH	Ministry of Health
MoU	Memorandum of Understanding
MWE	Ministry of Water and Energy
NADDEC	National Animal Disease Diagnostic and Epidemiology Center
NALIRI	National Livestock Resources Research Institute
NAP	National Action Plan
NBW	National Bridging Workshop
NCDs	National Communicable Diseases
NDP	National Development Plan
NEMA	National Environment Management Authority
NGOs	Non-Governmental Organization
NOHP	National One Health Platform
NPA	National Planning Authority

OHSP	One Health Strategic Plan
OHTWG	One Health Technical Working Group
OIE	World Organisation for Animal Health
OTs	Operational Tools
PHC	Primary Health Care
PoC	Proof of Concept
PPP	Purchasing Power Parity
PVS	Performance of Veterinary Services
RVF	Rift Valley Fever
SDGs	Sustainable Development Goals
SET	Surveillance Evaluation Tool
SIS	Surveillance and Information Sharing
SIS-OT	Surveillance Information Sharing Operational Tool
SOPs	Standard Operating Procedures
STEI	Science, Technology, Engineering & Innovation
UHC	Universal Health Coverage
UN	United Nations
UNAS	Uganda National Academy of Sciences
UNEP	UN Environment Programme
UNHS	Uganda National Household Survey
USAID	United States Agency for International Development
UWA	Uganda Wildlife Authority
VoCs	Volatile Organic Compounds
WHO	World Health Organization
ZDCO	Zoonotic Diseases Coordination Office

About the Uganda National Academy of Sciences

The Uganda National Academy of Sciences (UNAS) is an autonomous and honorific service organization comprising a diverse group of scientists from the physical, biological, social, and behavioural sciences. These scientists work together in an interdisciplinary and trans-disciplinary manner to achieve their main goal of improving livelihoods, welfare, and prosperity of the people of Uganda through the development and enhanced application of integrated knowledge in the sciences and humanities. The success of the Academy lies in the strength and expertise of its membership and its ability to mobilize scientific experts to advise government policymakers and other stakeholders.

The membership includes Founding Members, Fellows of the Academy, Foreign Fellows, and Honorary Fellows.

The organizational structure of UNAS consists of the General Assembly, Council, Standing Committees, and the Secretariat.

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PAPER REVIEWERS

All presenters at the conference have reviewed and approved their respective papers in this report for accuracy. In addition, the papers were reviewed in draft form by independent reviewers chosen for their diverse perspectives and technical expertise, in accordance with the procedures approved by UNAS Council. The purpose of the independent review is to provide candid and critical comments that assist UNAS in making the published report as sound as possible, and to ensure that the conference proceedings meet institutional standards, including those for objectivity and evidence. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

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PREFACE

The Uganda National Academy of Sciences is committed to providing an autonomous forum through which scientists can exchange ideas, knowledge, and experiences aimed at generating, promoting, sharing, and using scientific knowledge and giving evidence-based advice to government and society. This is done annually through various mechanisms, including the Annual Scientific Conference.

UNAS has held an Annual Scientific Conference since 2001, on themes including from Sciences for Sustainable Development, Science Education for Development, Biotechnology for Development, Impact of Climate Change on National Development, Human Resources for National Development, Urbanization for Development, and National Resilience and Recovery: Pandemics, Emergencies, Crises and Opportunities, among others.

The 21st ASC was held virtually on October 29, 2021. The theme for the conference was, "Uganda's Health: Transcending Sectors, Looking to the Future." Six sub-themes were presented at the conference, including: Health in Context: Beyond Traditional Conceptions of Health, Applications of the One Health Concept in Uganda, Vital Tools for Improved Health in Uganda, Healthy Air: Combatting Air Pollution in Uganda, Health Beyond Health Systems: Implications for a Healthy Economy, and Recovery & Resilience in a Post-Pandemic Uganda.

Papers were presented by individual scientific experts from each of the selected fields. During the sessions, papers were discussed by plenary, and after the conference only five authors revised their papers considering comments from plenary and comments from independent reviewers. The ASC was attended by over 160 participants, including government officials, regional academies, academicians, and researchers, actors from the private sector and civil society, and development partners.

This report is composed of two sections. Section I includes the papers presented by the individual experts, and other contents of the 2021 ASC. The views presented in Section I are those of the individual authors, and not necessarily those of the Uganda National Academy of Sciences. Section II includes the profiles of distinguished Fellows who were inducted into the Academy Fellowship in the year 2021.

SECTION I: CONFERENCE PAPERS

Health in Context: Beyond Traditional Conceptions of Health

Dr. Sally K. Stansfield

Background

To put health in "context", our biggest challenge is to choose the scope of that context. As scientists, we are schooled to tightly define the scope of our studies to enhance the precision and accuracy of our findings and the resulting conclusions. But to expand "beyond traditional conceptions," we must explore beyond the usual disciplinary constraints of the health sector. We are in good company, with the other papers presented in this scientific conference demonstrating UNAS' deep commitment to working across disciplines to improve the human condition.

Defining Health

The World Health Organization (WHO) defines health as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO Constitution, Official Record World Health Organization, 2, 100, 1946).

Despite this relatively holistic definition, physicians attend mostly to the single battle against a single illness in a single patient. So focused, they ignore the larger war against that same disease in the broader community, or the more upstream efforts to prevent those diseases and their risk factors in regions, nations, and globally.

Even in their practice of clinical medicine, however, doctors do provide some preventive and wellness care. Most reproductive healthcare, for example, including prescription of contraceptives, helps individual women to maintain autonomy and control over their lives (Reznek 1987).

We can do much more, though, to promote the health and well-being of people and their communities. Social well-being has been identified by the World Health Organization (WHO, 1948) as a central component of an individual's overall health. Researchers assert that social well-being is rooted in the function of communities and varies from one community to another based on cultural context. Social well-being, they point out, "is an end state in which basic human needs are met and people are able to coexist peacefully in communities with opportunities for advancement". Social well-being and health require equal access to basic needs (water, food, shelter, and health services). Most importantly, "peace cannot be sustained over the long term without addressing the social well-being of a population (WHO, 2015)."

The Organization for Economic Co-operation and Development (OECD, 2011) has historically used indicators such as gross domestic product (GDP) to assess the relative prosperity of communities and societies. More recently, however, it has been recognized that such measures, assessed at the national level, fail to reflect the real and important differences in social well-being within nations. More recent research has developed better metrics to reflect the importance of community and organizational participation, community or group membership, or social capital and social cohesion within nations to assess health and well-being (Andrews, 1976; Coleman, 1988; Putnam, 2000).

Collective Health and Healthy Societies

Understanding health as social, and not just personal, has already moved us from individual health to public health. But few doctors and even fewer private citizens think instinctively about public health. Medical schools focus little attention on public health, as they train us to detect and treat disease in individual patients. But public health specialists consider the health of communities, nations, and even ecosystems (Choudhary, 2021; Lackey, 2001, Inkpen, 2019). Others speak of population health (Kindig, 2003), or global health (Holst, 2020).

Even broader and more comprehensive is the concept of "Planetary Health," which focuses on people and rather than diseases, and deals with the reduction of health inequalities due to income, education, gender, and living environments with the objective of enabling all people on the globe to enjoy the right to health and well-being (Gostin, 2018; Schütte, 2018; Horton, 2014). Planetary health implicitly addresses the threats posed to the human species by pandemics or climate change, as well as the health and diversity of other species (Schütte, 2018).

Each term has slightly different meanings. But what these approaches to public health do have in common is that that they encourage us to not only understand the health of groups of people, but to take a more preventive than curative perspective and to consider risk factors. Kindig (2003), for example, suggests that population health is "the aggregate health outcome of health-adjusted life expectancy (quantity and quality) of a group of individuals, in an economic framework that balances the relative marginal returns from the multiple determinants of health." Holst (2020) asserts that "Global Health regards health as a rights-based, universal good; it takes into account social inequalities, power asymmetries, the uneven distribution of resources and governance challenges."

In fact, it wasn't until the 1800s in Europe that health leaders recognized that living conditions were a key determinant of health. Rudolf Virchow, the famous German pathologist, was among the first to point out that human illness is mostly attributable to "defects in society (Jha, 2016)." Both he and his colleague Friedrich Engels pointed out that politics and economics lead to inequalities in living conditions, which result

in health disparities and resulting ill health and excessive mortality. In the 1830s and 1840s, London Lawyer Edwin Chadwick led a commission that identified air pollution and sanitation as causes of illness, especially in poor neighborhoods. Only after these landmark observations did European leaders come to understand the protection of health as a societal responsibility. John Snow's famous identification of the cause of epidemic cholera in London in 1854 further established the importance of environmental sanitation as a determinant of health (Jha, 2016).

The measurement of the health of populations enables the quantification and comparison of disease burdens associated with each illness or its risk factors. Even more powerfully, it enables comparison of the cost-effectiveness of interventions to prevent or treat each threat to health. This further makes it possible to select the interventions that will make the most difference within constrained resources.

The "determinants" of health have gained more attention in recent years. The Commission on Social Determinants of Health's final report (WHO, 2008) made it clear that health inequities can only be rectified if we go beyond the immediate causes of disease to examine social hierarchies and the conditions in which people grow, learn, work and play. Addressing these root causes of health threats demands broader interventions and a whole-of-government approach, including through coordinated interventions across sectors.

Emerging Threats to Health and Social Stability

A recent Lancet editorial (2021) points out that, "In 2020, a virus that thrived on chronic disease and inequality became the great revealer." Indeed, COVID-19 has demonstrated the disturbing relevance of political and economic health determinants. We see that social status, occupation, and even ethnicity have defined some populations as more vulnerable to disease and death. These populations have reduced access to vaccines, life-saving treatments, and are at higher risk of the impoverishing effects of COVID-related economic stresses.

Inequities are corrosive for societies. The world's richest 1% have more than twice as much wealth as 6.9 billion people (Oxfam, 2021).

Inequity and Poor Governance Lead to Social Instability

Lebanon: Endemic corruption and coronavirus lockdowns have sparked recurrent national protests, further exacerbating Lebanon's financial crisis.

Brazil: As COVID-19 deaths surpassed 500,000, Brazilians took to the streets in June to protest President Jair Bolsonaro's pandemic response.

USA: Divisive politics, misinformation and fears of an unfair election led to a violent and deadly insurrection after the last presidential election.

South Africa: Deadly riots killed at least 215 people in July and exposed South Africa's corrosive inequities and endemic anger. Unemployment exceeds 32%, poverty affects more than half of its 60 million people, and 20% suffer food insecurity.

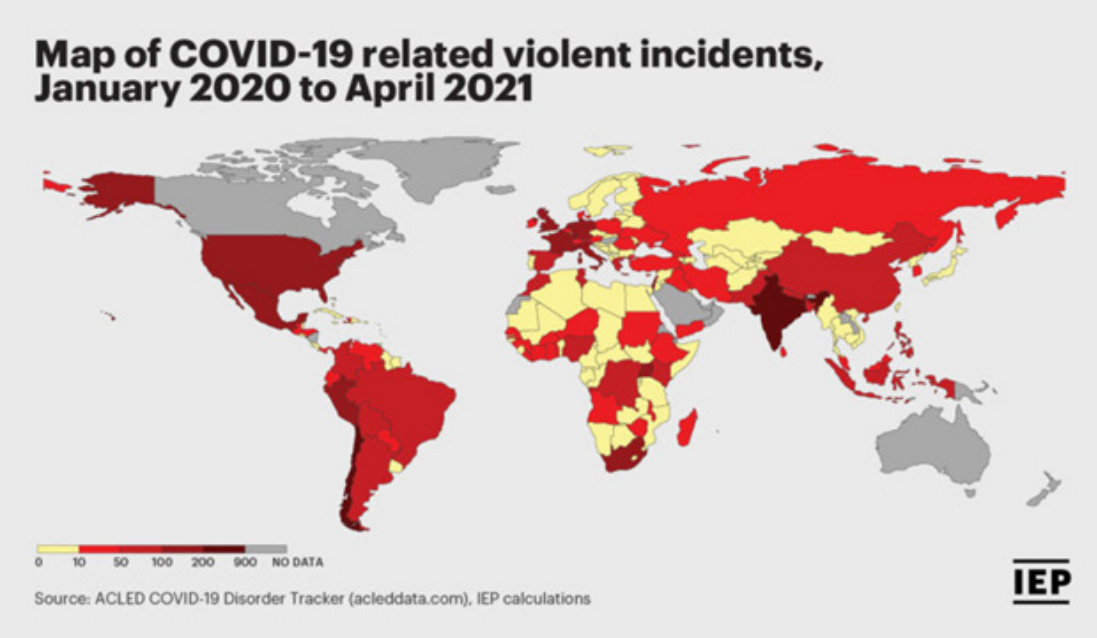
Venezuela: An ongoing socioeconomic and political crisis has been marked by hyperinflation, escalating starvation, crime, high mortality due to COVID, massive emigration, and social unrest.

Though the effects of the pandemic are still playing out, we already see that COVID has revealed this egregious inequity, and "increases the likelihood of political instability and violent demonstrations (IE&P, 2021)." The number of violent demonstrations has increased substantially in the past year, with a total of more than 5,000 Covid-19 related violent events occurring in 158 countries. GPI's report (IE&P, 2021) ascribed this to the economic uncertainty and political tensions caused by lockdowns and COVID-19.

The economic impact of this and other violence on the global economy in 2019 caused a global decrement of $14.5 trillion in purchasing power parity (PPP). This is equivalent to 10.6% of the world's economic activity, or $1,909 per person. Sub-Saharan Africa has been disproportionately affected by civil unrest, which rose by more than 800% from 32 riots and protests to 292 over the period from 2011 to 2019 (IE&P, 2021).

Besides the political instability and civil unrest, several countries reported surges in hate crimes, directed mostly against people of Asian descent. For example, more than 85% of Asian-Australians experienced pandemic-related discrimination during 2020. Vancouver reported a 717% increase in hate crimes during the pandemic to date (IE&P, 2021). Feelings of social isolation and financial stress due to the pandemic appear to be causal factors in the surge in interpersonal and domestic violence.

Figure 1: Global distribution of COVID-19 related violence



Another major threat to human health and social stability is emerging due to our collective neglect of climate change. Wildfires, drought, storms, and floods are clearly on the rise, and are taking lives all over the world. More than five million deaths occur each year due to temperature changes alone. Nearly a quarter of these excess deaths (23.88%) occur in Africa (Zhao, 2020).

By 2050, societies will be further threatened by climate-related migration. Up to 86 million additional migrants are expected in sub-Saharan Africa, 40 million in South Asia and 17 million in Latin America. The United Nations predicts that a record 200 million people will need humanitarian assistance next year due to extreme weather, infectious disease, and conflict, at a cost of up to $29 billion (UN, 2019).

Though it is an older problem, human institutions themselves are a persistent barrier to tackling these social and health problems. COVID-19 has pushed all health systems to their limits, thereby exposing severe gaps in public health infrastructure. Fragmentation of governance, including vertical funding streams for single diseases, separation of tertiary care from primary care, and differences in local health priorities, have hampered response efforts (Lal, 2021).

Ministries of health rarely achieve the level of integration and collaboration that is required to solve health problems and to address health threats. Even at the global level, the failure to achieve robust collaboration underly our tardy detection and response to emerging health threats. As an example, UNAIDS was established as a separate institution at the height of the AIDS epidemic, in part because WHO was bureaucratically averse to the intersectoral collaboration required to tackle the problem.

Beyond AIDS, we have now come to understand very well that multisectoral collaboration is required. Reduction of injuries due to road traffic accidents, ensuring the safety and security of the food supply, improving child health, and reducing deaths due to crime and poor environmental sanitation all require intersectoral action. Many of the required policies and interventions fall well outside the authority of the health ministry. As a result, the responsibility and accountability for improved health must be borne by government-as-a-whole. But health leaders remain the best champions for this intersectoral action (Adeleye, 2010). “Health improvement is the guiding principle to lead a recovery away from regressive policies that harm the most vulnerable (and will result in future catastrophes) and point us towards change that supports equity and sustainability… (Lancet, 2021).”

Perhaps the biggest threat to our health and security is our own species. Whether because of fear or greed, we are loathe to intervene in politics to improve governance. We have shown willful neglect of looming climate change. And we, as scientists, are partly responsible for these failures. We have been too content to dwell in disciplinary siloes. We have allowed our institutions and government ministries to avoid the courageous intersectoral action required to identify and tackle our most important social problems.

Health as the Foundation of Shared Prosperity

> For a long time, health has been considered by politicians as secondary to other aspects of governing: an added bonus that can be molded, a budget that can be reallocated, a policy that can be sidelined, instead of the driving force of a functioning economy. Without health, there is no productivity, no GDP, no trade, and no education (Lancet, 2021).

No society can be resilient to stresses if some socioeconomic or ethnic groups bear excess exposure or vulnerability to risks and their consequences. It is incumbent on us, as scientists, to mobilize the evidence and knowledge required to deliver equitable health, well-being, and social stability.

To achieve this mobilization of science for health and social well-being, and to make our societies more resilient, we need "a philosophical change in how we care for each other and our environment (Lancet, 2021)." Intersectoral collaboration is required—with ministries of finance eliminating the health threats of poverty, ministries of education protecting children and adolescents, ministries of agriculture ensuring food security and good nutrition, and with ministries of the environment ensuring community resilience in response to the health dangers of climate change. "Coordinated, intersectoral action to improve health, including between ministries, between different levels of government, and with stakeholders outside government, is necessary in order to address complex and persistent health challenges (Adeleye, 2010)."

We know what the global community can achieve with science and with multilateral collaboration. Smallpox has been eradicated and polio is nearing elimination. The world has developed safe and effective COVID vaccines in record time. While more remains to be done, child health interventions in Africa have reduced under-five mortality by nearly 60% in the last 30 years. Uganda's successes in controlling a series of epidemics, including AIDS, Ebola, yellow fever, measles, and the Crimean-Congo hemorrhagic fever, are recognized globally.

Building upon these successes and the lessons from the COVID-19 pandemic, WHO has begun a new campaign to reach out beyond the health sector. In May 2021, the WHO Council on the Economics of Health for All was established to ensure that "health is at the heart of all government action and investment decisions (WHO, 2021)." The Council will focus on new strategies to "shape economies and financial systems with the objective of building healthy societies that are just, inclusive, equitable, and sustainable."

Much has also been done to strengthen the capacities for outbreak response in Africa, including through the establishment of the Africa Centers for Disease Control and Prevention by the African Union and international partners in 2017. Paired with national

efforts to strengthen epidemic preparedness and response, these investments have done much to speed the response to COVID-19. But inequities still hamper virus control, especially in densely populated settlements, among migrant worker populations, and among informal workers who can ill afford to reduce travel or to socially distance. Those inequities must be addressed.

Lal and colleagues (Lal, 2021) have emphasized that global health security (GHS) will not be achieved without equitable access to health and well-being, including through universal health coverage (UHC). They point out that we require a "reimagined framework for global health that prioritizes health-system integration across UHC and GHS domains, innovative and unified health financing, cross-sector resilience indicators, and equity as a core value offers a necessary path ahead."

It is universally agreed that equitable and resilient societies will fare better in the face of future economic strains, pandemics, and the inevitable stresses of looming climate change. "Climate stabilization must be the cornerstone of the 2020s and beyond, closely entwined with equity (Lancet, 2021)." That equity must be inclusive not only of marginalized populations of the present but must also acknowledge the needs and rights of future generations. We must strive to be "good ancestors" for the sake of our children and grandchildren.

Conclusions

To make these changes and to harness the power of African science, we must urgently:

- Mobilize science across disciplines to tackle health inequities and climate change;
- Set the agenda to ensure African leadership for global action; and,
- Demand the resources to make the continent more resilient, including to build capacity for science and innovation, for local manufacturing of essential medicines and supplies, and to accelerate improvements in health and social well-being.

REFERENCES

Adeleye, O.A., & Ofili, A.N. (2010). Strengthening Intersectoral Collaboration for Primary Health Care in Developing Countries: Can the Health Sector Play Broader Roles? *Journal of Environmental and Public Health, Volume 2010, Article ID 272896, 6 pages, doi:10.1155/2010/272896.*

Andrews, F., & Withey, S. (1976). *Social indicators of well-being. New York*: Plenum Press. Choudhary, S. (2021). Community Health and Its Importance. Primary Health Care: *Open Access 2021, Vol.11, Issue 2, 365.*

Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology, 94, 95–120.*

Gostin L, Meier B, Thomas R, Magar V, Ghebreyesus T. 70 years of human rights in global health: drawing on a contentious past to secure a hopeful future. *Lancet*. 2018;392(10165):2731–5

Holst, J. Global Health – emergence, hegemonic trends and biomedical reductionism. *Global Health* 16, 42 (2020). https://doi.org/10.1186/s12992-020-00573-4

Horton R, Beaglehole R, Bonita R, Raeburn J, Mckee M, Wall S. From public to planetary health: a manifesto. *Lancet*. 2014;383(9927):847.

Inkpen, S.A., 2019. "Health, Ecology and the Microbiome," *eLife*, 8: e47626. doi: 10.7554/eLife.47626.

Institute for Economics & Peace (IE&P, 2021). Global Peace Index 2021: *Measuring Peace in a Complex World*, Sydney, June 2021. http://visionofhumanity.org/reports (accessed Date Month Year).

Kindig, D.& Stoddart, G. (2003) What Is Population Health? *American Journal of Public Health* March 2003, Vol 93, No. 3

Lackey, R.T. (2001). Values, Policy, and Ecosystem Health: Options for resolving the many ecological policy issues we face depend on the concept of ecosystem health, but ecosystem health is based on controversial, value-based assumptions that masquerade as science, *BioScience*, Volume 51, Issue 6, June 2001, Pages 437–443, https://doi.org/10.1641/0006-3568(2001)051[0437:VPAEH]2.0.CO;2

Lal, A., Frondu, N.A, Heymann, D.L., Gitahi, G. & Yates, R. (2021). Fragmented health systems in COVID-19: rectifying the misalignment between global health security and universal health coverage. *Lancet* 2021; 397: 61–67.

Lancet (2021). Health as a foundation for society. Editorial, , P1, January 02, 2021 DOI: https://doi.org/10.1016/S0140-6736(20)32751

OECD. (2011). *Better life compendium of OECD well-being indicators*. Paris: OECD.

OXFAM (2021). https://www.oxfam.org/en/5-shocking-facts-about-extreme-global-inequality-and-how-even-it (accessed 10/September/2021)

Published Online December 1, 2020 https://doi.org/10.1016/ S0140-6736(20)32228-5.

Putnam, R. (2000). Bowling alone: *The collapse and revival of American community.* New York: Simon and Schuster.

Reznek, L., 1987. *The Nature of Disease*, New York: Routledge, pp 71-73.

Schütte S et al. Connecting planetary health, climate change, and migration. *Lancet. Planetary Health* 2018;2(2):E58-E59. doi: 0.1016/S2542–5196(18)30004–4.

United Nations (2019). UN News: https://news.un.org/en/story/2019/12/1052731
Wang J, Geng L. Effects of Socioeconomic Status on Physical and Psychological Health: Lifestyle as a Mediator. *Int J Environ Res Public Health*. 2019;16(2):281. Published 2019 Jan 20. doi:10.3390/ijerph16020281.

World Health Organization (2008). *Commission on Social Determinants of Health Final Report*. Closing the Gap in a generation. https://www.who.int/publications/i/item/WHO-IER-CSDH-08.1

World Health Organization (2015). Beyond bias: exploring the cultural contexts of health and well-being measurement. https://www.euro.who.int/__data/assets/pdf_file/0008/284903/Cultural-contexts-health.pdf

World Health Organization (2021). News release, 6 May 2021: Global experts of new WHO Council on the Economics of Health for All announced. https://www.who.int/news/item/06-05-2021-global-experts-of-new-who-council-on-the-economics-of-health-for-all-announced

Zhao, Q. (2021). Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: a three-stage modelling study. www.thelancet.com/planetary-health Vol 5 July 2021 e415, *Lancet Planet Health* 2021; 5: e415–25.

Application of One Health in Uganda: FAO's Experience

Antonio Querido, Willington Bessong Ojong, Ayebazibwe Chrisostom, and Susan Ndyanabo

Abstract

Human health is inextricably intertwined with animal and environmental health. One Health seeks to increase communication and collaboration between human, animal, and environmental health professionals. Zoonotic diseases are health risks shared among humans, wildlife, livestock, and pets. Over 75% of emerging infectious diseases are zoonotic. 60% of human pathogens are zoonotic. Most agents of bioterrorism are zoonotic.

Beyond zoonoses, disease processes across species are shared. Agriculture and food security form the foundation of civilization. Food security is equally inextricably linked with global health, global sustainability, and international security. There is no global health without global food security. Many diseases are emerging and spreading because of widespread deforestation, environmental degradation, and bush meat consumption—which are all linked to food security. Global climate change also affects food security.

Collaborative One Health approaches support governments to effectively prevent, detect, and respond to emerging health challenges, such as zoonotic diseases, that arise at the human-animal-environment interface. To overcome these challenges, operational and outcome-oriented tools that enable animal health and human health services to work specifically on their collaboration are required. International capacity and assessment frameworks such as the IHR-MEF (International Health Regulations—Monitoring and Evaluation Framework) and the OIE Performance of Veterinary Services (PVS) Pathway are tools that help leverage countries' development of functional integrated systems that can provide robust responses to disease challenges.

FAO's Strategic Framework seeks to support the 2030 Agenda through the transformation to more efficient, inclusive, resilient, and sustainable agri-food systems for better production, better nutrition, a better environment, and a better life—leaving no one behind. We describe here the One Health situation in Uganda, and efforts from the animal health systems perspective by FAO to improve Joint External Evaluation (JEE) scores in collaboration with the Ministry of Agriculture, Animal Industries, and Fisheries (MAAIF). Overall, Uganda's approach to coordination and collaboration for addressing health-related issues is increasingly rooted in One Health approach.

1. Introduction

There is an intricate link between human and animal health and the surrounding environment. Any disruptions to this complex web results in adverse consequences for all the key elements. Transmission of diseases between these interfaces, including zoonotic diseases such as avian influenza, rabies, Ebola, anthrax, and Rift Valley Fever—as well as food-borne diseases and antimicrobial resistance—account for more than three-quarters of emerging and re-emerging infectious diseases, and present a serious threat to animal and public health.

The first step to decreasing zoonotic disease threats is understanding where and why risk exists. Previously, the approach has been for each sector to apply its own specific tools and processes for outbreak investigation, surveillance, and risk assessment of zoonotic diseases. Today, multi-sectoral approaches and tools have highlighted the need for multi-disciplinary and multi-sectoral collaboration, coordination and cooperation between the human, animal, and environmental sectors to implement a One Health approach.

One Health is an integrated approach that calls for increased multidisciplinary and intersectoral cooperation and communication to address diseases that emerge at the human-animal-ecosystem interface and that pose a threat to animal and human health. Diseases with the potential to jump from animals in the wild to livestock or humans are of special concern under a One Health framework.

A One Health approach is important for national and global health security, in implementing the World Health Organization's (WHO) International Health Regulations (2005) and the international standards for animal health, veterinary public health, zoonotic diseases, and animal welfare developed by the World Organisation for Animal Health (OIE), and to contribute to many of the Sustainable Development Goals of the 2030 Agenda.

In this context, the Tripartite—a consortium consisting of the Food and Agriculture Organization (FAO) of the United Nations, the OIE, the WHO, and more recently the UN Environment Programme (UNEP)—reflects a longstanding and successful partnership to taking a One Health approach to address the challenges of public health, animal health (both domestic and wildlife), and the environment that are facing the world today. In fact, the Tripartite advocates for effective multisectoral, multidisciplinary, and transnational collaboration at the local, national, regional, and global levels. A multidisciplinary and multisectoral collaboration, through a One Health approach, is required to effectively prepare for, detect, assess, and respond to emerging and endemic zoonotic diseases.

Working together, the Tripartite has developed global guides, such as the Tripartite Guide to Addressing Zoonotic Diseases in Countries, as well as standard tools to ensure a consistent and harmonized approach throughout the world. Three Operational Tools (OTs) have been developed to support national staff in these efforts: (1) the Multisectoral Coordination Mechanism OT (MCM OT), (2) the Joint Risk Assessment OT (JRA OT), and (3) the Surveillance and Information Sharing OT (SIS OT). The JRA operational tool, for example, enables each sector to have a holistic understanding and integrated risk analysis, along with joint identification of solutions and their implementation, with a stronger global commitment.

To adequately assess risks from zoonotic diseases, antimicrobial resistance, food safety, or any health threats at the environment-animal-human interface, a wide variety of information on the hazards—epidemiological, environmental, climate-related, human and animal, among others—must be considered. Such health event-specific information can then be shared and assessed jointly through the national animal health and public health sectors, and with other stakeholders. However, to proceed efficiently the sectors must agree on a standard approach and processes and be guided by best practices. Historically, since the animal health and human health sectors have had different objectives in conducting risk assessments, different approaches, processes, and definitions have evolved in each sector. But with successful Tripartite collaboration, the JRA tool represents a compromise between the approaches, processes and terminology generally used for risk assessment by the animal health and public health sectors.

JRA operationalization outputs and recommendations are used by the national One Health platforms to update their preparedness and response plans. This joint exercise also contributes to strengthening multi-sectoral collaboration and coordination in national preparedness and response to any public health threats.

2. FAO and One Health Approaches

FAO promotes One Health in work on food security, sustainable agriculture, food safety, antimicrobial resistance (AMR), nutrition, animal and plant health, fisheries, and livelihoods. Ensuring a One Health approach is essential for progress towards anticipating, detecting, preventing, and controlling diseases that spread between animals and humans, to tackle growing AMR, to ensure food safety, and to prevent environment-related human and animal health threats.

FAO works with partners to promote global health, eliminate hunger, promote food safety and healthy diets, prevent and control zoonoses and AMR, protect farmer livelihoods from the impacts of plant and animal diseases, and to increase the sustainability of agricultural practices. In this regard, FAO supports member countries to build and implement effective collaborative One Health strategies, simultaneously addressing the health of people, animals, plants, and the environment. As such, the One Health approach is used to design and implement programmes, policies, and legislation.

To anticipate, detect, prevent, and respond to plant, animal and foodborne disease outbreaks and AMR, FAO encourages the sharing of epidemiological data and laboratory information across sectors and borders, which can result in more effective coordinated planning and response.

Good One Health planning, communication, collaboration, and response efforts occur when government officials, researchers, and workers across sectors at the local, national, regional and global levels join forces.

FAO One Health priorities include:

1. Strengthening monitoring, surveillance, and reporting systems at the regional, national, and local levels to prevent and detect animal and zoonotic disease emergence and control disease spread.
2. Understanding risk factors, including socioeconomic and cultural contexts, for disease spillover from wildlife to domestic animals and humans, to prevent and manage disease outbreaks.
3. Developing capacities at regional, national, and local levels for better coordination and information-sharing among institutions and stakeholders.
4. Reinforcing veterinary and plant health infrastructure, and safe food and animal production practices from farm to table.
5. Increasing the capacities of the food and agriculture sectors to combat and minimize the risks of AMR.
6. Promoting food safety at national and international levels.

The above–cited operational tools can be used independently or in coordinated efforts to support national capacities for preparedness and response, ultimately linking to existing international policies and frameworks, and supporting efforts for global health security. Specifically, the JRA OT provides additional support on the area of risk assessment to countries implementing the Tripartite Zoonotic Guide.

3. Evolution of One Health in Uganda

Uganda is considered a "hot spot" for emerging and re-emerging zoonotic disease outbreaks because of its biological diversity and high population pressure, increasing human-animal interaction and presenting a high risk of zoonotic pathogen disease spillover. In the recent past, the country has experienced several epidemics including Ebola, Marburg, plague, avian influenza, Rift Valley Fever (RVF), yellow fever, and Crimean Congo Haemorrhagic Fever (CCHF). Recently, the country experienced an increase in the frequency and intensity of extreme weather variability, and epidemics ranging from vector-borne to zoonotic disease outbreaks. For example, RVF—which is usually triggered by sustained heavy rains—was for the first time reported in Uganda in the Southwestern part of the country in March 2016. Uganda also has one of the fastest growing populations globally, which has resulted in land degradation, wildlife poaching, loss of biodiversity, and increasingly variable climate patterns.

These dynamics promote close human interaction with animals that may carry new disease threats. Besides these threats, there is evidence of a growing problem of AMR, with nearly 70% of Enterobacteriaceae isolated from blood cultures at a tertiary hospital in 2014-15 found to be resistant to third generation cephalosporin, and 20% resistant to carbapenem. AMR is a very complex problem, much more multifaceted than any other infectious threat, and poses a significant challenge to global health and animal production with significant economic consequences. It is a direct consequence of the selection pressure from antibiotic use in humans, animals, and the environment, and thus its control and containment require a One Health approach. Epidemics overwhelm health systems, cause social disruptions, and devastate economies. For example, recurrent outbreaks of Ebola, Marburg, CCHF, RVF, and the current COVID-19 pandemic in Uganda, have posed heavy impacts on the country in terms of their economic burden, with interruptions to international trade and tourism, in addition to social disruptions and the straining of health systems. Therefore, efforts that integrate inputs from multidisciplinary and diverse sets of knowledge holders are needed to understand the risks and find solutions.

While the One Health approach was not yet institutionalized, Uganda has had some successful multi-sectoral disease response initiatives in the past. These initiatives include:

1. The Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome (HIV/AIDS) epidemic in the 1980s which was brought under control through strong political leadership and multi-sectoral collaboration including civil society and other sectors participation.
2. The establishment of the Veterinary Public Health Division within the Ministry of Health (MoH) in the early 1980s. This division recognizes the importance of the two sectors; human and animal health working together.
3. The Uganda Trypanosomiasis Control Council, which was established in 1992. Its Coordinating Office, with Control of Trypanosomiasis in Uganda as its secretariat, was one of the earliest high-level multi-sectoral coordinating bodies for disease response.

In March 2017, Uganda established priority zoonotic diseases in the country using the CDC One Health zoonotic disease prioritization tool. The five criteria used to prioritise and rank the zoonotic diseases included: 1) severity of the disease in humans, 2) availability of effective control strategies, 3) potential to cause an epidemic or pandemic in humans or animals, 4) social and economic impact, and 5) bioterrorism potential. These criteria yielded seven priority zoonoses: Anthrax, Zoonotic Influenza viruses, Viral Haemorrhagic Fevers, Brucellosis, Trypanosomiasis, Plague, and Rabies. These were classified as zoonotic diseases whose prevention, early detection, and response can be effectively implemented through the application of One Health principles.

4. Institutional Arrangements for One Health Implementation

In March 2016, Uganda developed a One Health Framework that was agreed upon and endorsed by the technical heads of the following three ministries: Ministry of Health, Ministry of Agriculture, Animal Industries and Fisheries, Ministry of Water and Energy (MWE) and the Uganda Wildlife Authority (UWA), an agency under the Ministry of Tourism Wildlife and Antiquities. In November 2016, the One Health Framework was formalised through the signing of an MoU between these entities, leading to the establishment of the Uganda National One Health Platform (NOHP). The One Health Strategic Plan (OHSP) lays emphasis on seven priority zoonotic diseases, along with antimicrobial resistance, public health threats, and related bio-security issues in its initial 5-year period (2018- 2022).

The implementation of the OHSP is the responsibility of the government, with support from partners and other stakeholders. The Uganda NOHP is responsible for oversight and coordination of the implementation of the One Health strategic plan. The NOHP has two key structures. These are the One Health Technical Working Group (OHTWG) and the Zoonotic Diseases Coordination Office (ZDCO), each with their own clear terms of references. These structures are charged with the management, leadership, monitoring and evaluation, and coordination of implementation of the Uganda One Health Strategic Plan. The OHTWG is responsible for advising government, partners, and other agencies on One Health issues, technical guidance and oversight to ZDCO, advocacy and resource mobilization, and reviewing and updating ZDCO plans and budgets and those of its subcommittees. The ZDCO is the secretariat of the NOHP in Uganda and is responsible for coordinating the implementation of One Health activities by government under the supervision of the OHTWG.

5. FAO Support to One Health Approaches in Uganda

In recognition of the global threat posed by emerging and re-emerging infectious zoonotic diseases, FAO established the Emergency Centre for Transboundary Animal Diseases (ECTAD) in Uganda, amongst other disease hotspot member states to provide specialized support. Through the ECTAD unit in Uganda, FAO has been providing support to the Government of Uganda (GoU) since 2016 to improve management of animal diseases to prevent them from causing health issues in humans. This approach consists of improving the government's capacity and capability for prevention, early detection, and rapid response by animal health systems to address health risks at the interfaces, through fostering a One Health approach.

One Health implementation is an area where lessons are continuously learned and shared to promote deeper commitment to such multidisciplinary collaboration. Conscious of this, FAO's advocacy and support for One Health in Uganda is helping to create new awareness and also political commitment. To this end, FAO is engaged with partners

such as United States Agency for International Development (USAID), the Defense Threat Reduction Agency (DTRA), the World Health Organization (WHO), and the World Animal Health Organization (OIE) to support implementation of One Health in Uganda.

5.1. Implementation of Emergency Pandemic Threat (EPT-2) and Global Health Security Agenda

Uganda is a member of the GHSA and a signatory to the International Health Regulations. FAO provides support around five major action packages as follows:

5.1.1. Work Force Development Action Package

Healthier animals are directly linked to the health and prosperity of communities who rely on them for their livelihoods, food security, and nutrition. Gaps in the animal health sector to prevent, detect, and respond to outbreaks in a timely manner at a local level, often contribute to the persistence and expansion of animal health threats across countries and borders. It is important that every country has enough well-trained field veterinary epidemiology staff to protect human health, reduce animal losses, ensure consumer protection, promote safe trade, and improve livelihoods.

In this regard, the Frontline In-Service Applied Veterinary Epidemiology Training (ISAVET) programme was developed by FAO in partnership with the United States Agency for International Development (USAID) and Texas A&M University, and in collaboration with African universities including Makerere University in Uganda and the Inter-State School of Veterinary Science and Medicine (EISMV) in Senegal. The training is designed to develop skills in the animal health workforce. It strengthens field level preparedness, early detection and rapid effective response to transboundary animal diseases, emerging infectious diseases, and antimicrobial resistance within an integrative One Health approach. The Frontline ISAVET can be adapted to any country through a consultative needs assessment that identifies skills gaps in epidemiology at all levels.

Working in consultation with MAAIF, this support identifies needs and skills gaps and develops targeted training programmes. This training is designed from a multisector group approach by specialists including those from the animal health, human health, and wildlife sectors. This approach provides core competencies for Frontline ISAVET development. The training covers three key areas: epidemiology, laboratory, and emergency management. It provides animal health workers with disease detection and response skills to save lives and livelihoods. In 2019, the very first ISAVET training was piloted in Uganda. So far, two cohorts of ISAVET trainings have been implemented with over 40 staff trained. There is now a need for ownership and internalization of this training program.

According to animal health sector profile studies conducted in Uganda, the livestock sector is largely dominated by public service, with 69% of 1,200 animal health workers involved in the public sector. This category is formally employed by the government system. In addition, approximately 500 (31%) animal health workers are employed in the private sector. This category of the animal health workforce is involved in private business, such as drug provision and animal health service provision. At the country level, a total of 620 and 230 animal health workers are in the eastern region, and the central region, respectively. Five hundred and 430 are in the northern region and the western region, respectively. Further findings revealed staff shortages and gaps in capacity (including education) at the local government level, and huge staffing gaps at the center (Ministry of Agriculture Animal Industry and Fisheries), with difficulties to operationalise services due to the lack of basic tools and fuel. This study strongly recommended that there should be continued assessment of capacities in the workforce available to deliver the required veterinary services, as well as readiness capability to detect, predict, and respond to priority zoonotic diseases at the national, district, and field levels.

According to the JEE findings 2017 that clearly show the progress made and what is required, it is now clear that Uganda needs a One Health Workforce Strategy. But the animal health sector must first bridge existing capacity gaps.

In collaboration with MAAIF and the Uganda Veterinary Board, FAO is facilitating a review of continuous professional development among animal health workers, so at to permit them live up to engagements that will promote competence in executing tasks that align best production practices and integrated animal health service delivery.

5.1.2 Antimicrobial Resistance Action Package

Without effective antimicrobials for prevention and treatment of infections, some common medical procedures will become very high-risk. In addition to increased morbidity and mortality, AMR increases the overall cost of health care through lengthier stays in hospital and the requirement for more intensive treatment. FAO supports the Global Action Plan on AMR and the associated work of the Tripartite on AMR through information sharing and building capacity to provide guidance and the sharing of best practices to assist Uganda to improve awareness on AMR and related threats. The need to develop capacity for surveillance and monitoring of AMR and AMU (antimicrobial use) in food and agriculture value chains are major imperatives.

As of March 2021, some gains have been made in the fight against AMR in the animal sector, namely:

1. Launching the National Action Plan (NAP) on AMR in 2018.
2. Institutionalizing the One Health (OH) approach.
3. Forming and operationalizing the National Task Force on AMR.
4. Arousing interest by the Government of Uganda and development partners to support AMR-targeted interventions.

5. Drafting the national AMR surveillance protocols in the poultry, dairy, and beef value chains (an initiative of MAAIF with support from the Fleming Fund).
6. Isolated research efforts, mainly driven by scientists from Makerere University, ILRI, NALIRI, and several NGOs.

5.1.3 Priority Zoonotic Diseases

This action package consists of actions to improve early warning and detection, timely data sharing, laboratory testing, and joint outbreak response capacities in the human, animal health, and wildlife sectors to create and strengthen the mechanisms necessary to effectively detect and respond to emerging zoonotic threats, and to thereby enhance global health security.

This action package seeks to implement guidance and models on behaviours, policies, and practices to minimize the spillover, spread, and full emergence of zoonotic disease into or out of human populations.

Key actions carried out include:

1. Strengthening and maintaining the human resource and technical capacities of animal, human, and wildlife health services to support zoonotic disease prevention, detection, and response activities.
2. Establishing and strengthening coordination, communication, multi-sectoral engagement, and information sharing among member countries involved.
3. Strengthening surveillance systems through innovative digital tools such as Event Mobile Application (EMA-I), the Surveillance Evaluation Tool (SET), and the Surveillance Information Sharing Operational Tool (SIS-OT).
4. Increasing continuous professional development opportunities on surveillance and control plans.
5. Supporting outbreak investigations and multisectoral/multidisciplinary after-action reviews.
6. Supporting One Health coordination.
7. Establishing good emergency management practices

5.1.4 National Laboratory Systems Action Tract

Since 2016, FAO has been building capacity for laboratory information management systems (LIMS) in Uganda. The SILAB provides an automated electronic recording function to support diagnostic activity and epidemiological surveillance, to facilitate laboratory accreditation, and to quickly notify about outbreaks. It consists of a web application tool employed as a supporting information system to the laboratory diagnostic activity for veterinary laboratories. The system is hosted on a local server accessible via any computer connected to the local area network (LAN), and where facilities exist from any computer with an internet connection. It traces out the whole procedure from the arrival of samples to the final test report. This system and its upgrades have been extended to the National Animal Disease Diagnostic and Epidemiology Center (NADDEC) and other regional laboratories in the country.

Other tasks carried out systematically to ensure a robust national laboratory system include the following:

a) Annual proficiency tests.
b) Training staff on diagnosis of priority zoonotic diseases.
c) Infectious substance shipping/certification.

5.1.5 Biosafety and Biosecurity

This action package seeks to advance global biosafety and biosecurity, in support of various international instruments and agreements, including IHR, the Biological Weapons Convention, and UNSCR 1540. Biological events, when not met with adequate levels of prevention and preparedness, can have significant public health, social, and financial consequences. The 2014 Ebola outbreak in West Africa, for instance, killed over 11,000 people and had consequences far beyond the effected countries' health systems, including political and socioeconomic ramifications. In this regard, and in collaboration with MAAIF, the ECTAD provides the following support:

1. Provision of refresher and advanced biosafety and biosecurity training for personnel.
2. Profiling of facilities and inventory of dangerous pathogens.
3. Regional-level biosafety and biosecurity training.
4. Laboratory Management Tool assessments.
5. Provision of guidance on waste management standard operating procedures.
6. Accreditation follow-up (ISO 17025).

5.2 Africa Sustainable Livestock 2050 Project

ASL2050 is a policy initiative supported by USAID to collaborate with the GoU on current policies and programmes that consider the long-term effects of fast-changing livestock systems on public health, livelihoods, and the environment. These system considerations are strategic for supporting healthy livestock systems to 2050. The objective in Uganda is to minimize the risk of livestock-driven public health threats in urban and peri-urban areas. Specifically, FAO is currently partnering with stake holders to:

1. Assess public health risks along the livestock value chain as well as profiling good practices against current practices.
2. Assess bottlenecks in the adoption of good practices along the livestock value chain through a public-private partnership approach.
3. Establish a guidebook on the identification of effective public sector procedures for the adoption of good practices along the livestock value chain.
4. Advocate for a process with the public sector in Uganda that supports the adoption of good practices to reduce public health threats along the livestock value chain.

5.3 National Bridging Workshops (NBWs) Process

In partnership with WHO, FAO Uganda implements a National Bridging Workshops project for International Health Regulations and Performance of Veterinary Services (IHR-PVS-UNJP/GLO/093/WHO). This project aims at linking the PVS and IHR by facilitating the integration of human-animal health efforts. The NBW is a novel tool that bridges internationally accepted frameworks and tools from the two sectors to allow for improved collaboration while supporting sector-specific needs.

NBWs puts mechanisms in place for administrative and technical collaboration among animal health, public health, and other relevant sectors. Capacity for multi-sectoral collaboration is an obligation under the International Health Regulations (IHR, 2005), and gaps in national multi-sectoral capacity, including between human, animal, environmental health, and other relevant sectors, have been routinely noted during Global Health Security Agenda (GHSA) national assessments and during Joint External Evaluations (JEE). These gaps have also been reported and confirmed in World Organization for Animal Health (OIE) Performance of Veterinary Services (PVS) Pathway reports. Moreover, while the global capacities for the detection and the response to emergencies has significantly improved in recent years, many countries still react to emergencies in an ad hoc manner, and lack of coordination between the human and animal health sectors—especially when decisions need to be made rapidly—often creates confusion, inefficiencies, and missed opportunities. Guidance material and technical assistance to improve preparedness and operational readiness are requested by countries from international organizations and partners, including the WHO, OIE and FAO.

5.4 Improving JEE Scores for One Health at Sub-national Level in Uganda: Proof of Concept Districts

In a bid to walk the talk of One Health by encouraging community engagement at the subnational level, FAO and MAAIF have been implementing activities aimed at accelerating JEE scores under the Global Health Security Agenda (GHSA). In 2019, twelve districts in Uganda were selected to gradually showcase as best practice GHSA Proof of Concept districts, following implementation of selective health security measures. Bi-annual reviews facilitate progressive assessment and adjustment to ensure the achievement of set goals, with each district undertaking self-assessment as the basis for future backstopping and follow-up.

The PoC Tool (82 parameters) considers cross-cutting system pillars such as strengthening real-time surveillance and information systems. Twelve out of 146 decentralized districts in Uganda were selected (in July 2019) to constitute GHSA PoC districts. PoC baseline highlights included: confirmation of disease outbreaks, hardcopy surveillance reports, presence of surveillance SOPs, and budgeting for annual disease surveillance. PoC follow-up on activities included district assessments, technical backstopping, mentorship, training, procurement of key materials, development

planning consideration, public-private partnerships, and advocacy and awareness creation. At baseline assessment, only five out of the 12 Districts submitted at least one monthly passive disease surveillance to the centre.

Overall, there was improved service delivery following GHSA PoC intervention. It was noted that some key activities can be implemented without the need for extra district-level budgetary support.

6. Challenges

Even though the One Health Platform is now in its implementation stage, as guided by the Memorandum of Understanding, a superior legal instrument is required to provide its operations with a thrust that can effectively galvanize resources for more efficient risk mitigation.

While zoonotic disease spill-over to human populations and the concept of controlling infections at-source is well appreciated, the animal health sector continues to be under-resourced in critical elements of surveillance and reporting of animal diseases and laboratory diagnosis.

Convincing policymakers of the benefits of planning and investing in animal surveillance for public health gain is often challenging where data on zoonoses burdens are scant, and when the threat is not immediately apparent.

7. Conclusion

Political will and leadership, against a backdrop of robust stakeholder mobilization, support, and sustainable funding mechanisms, are essential for effective enforcement of One Health. Evidence and lessons from different country experiences show that there is no one-size-fits-all approach to operationalizing One Health.

Uganda has successfully established a cross-sectoral coordinating mechanism for implementation of the One Health approach to managing emerging infectious diseases and related threats. An enhanced surveillance system in domestic and wild animals that meets the needs of animal and human health, a critical workforce trained in the One Health approach, improved outbreak investigations, and a robust and productive public health programme are needed. On a general note, challenges need to be comprehensively and collectively addressed. FAO remains engaged in providing support in its bid to promote better production in Uganda.

References

E. Buregyeya et al. 2020. / Journal of Epidemiology and Global Health Operationalizing the One Health Approach in Uganda: Challenges and Opportunities

FAO – UG 2021: National Animal Health Workforce Profile: A synthesis of Human Resource Availability to implement One Health in Uganda: A Technical Report.

FAO UG: A Review of Levels of Antimicrobial Resistance and Appraisal of Infection Prevention and Control Measures in Poultry, Dairy and Pig Value Chains in the Districts of Kampala, Wakiso and Mukono. Technical Report Project Number: FRUGA/OSRO/GLO 507USA (unpublished)

Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, et al. Global trends in emerging infectious diseases. Nature. 2008;451:990–3. doi: 10.1038/nature06536.

Kajumbula H, Fujita AW, Mbabazi O, Najjuka C, Izale C, Akampurira A, et al. Antimicrobial drug resistance in blood culture isolates at a Tertiary Hospital, Uganda. Emerg Infect Dis. 2018; 24:174–5. doi: 10.3201/eid2401.171112.

Ministry of Health, Ministry of Agriculture, Animal Industry and Fisheries, Uganda Wildlife Authority, Ministry of Lands, Water and Environment. Uganda One Health Strategic Plan 2018-2022. Kampala: 2018.

Ministry of Water and Environment. Water and Environment Sector Performance Report 2018. Kampala, Uganda: Ministry of Water and Environment; 2018.

Taking a Multisectoral, One Health Approach: A Tripatite Guide to Addressing Zoonotic Diseases in Countries. World Health Organsiation (WHO), Food and Agriculture Organisation of the United Nations (FAO), World Animal Health Organisation (OIE), 2019.

Uganda One Health Strategic Plan 2018-2022, January 2018

UN Uganda population. 2019

UN. Global health security agenda. 2019.

Healthy Air: Combatting Air Pollution in Uganda

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Abstract

Clean air is one of the fundamental pillars of health for animals and plants. New reports of increased noncommunicable cardiovascular and respiratory diseases associated with air pollution among mainly urban dwellers worldwide are on the increase. The main causation or sources of air pollution are mainly from motor vehicles emissions, emissions from industry, open burning of municipal waste, atmospheric transport of air polluting substances over long range (e.g., Harmattan dust), biogenic emission sources, such as volcanic eruptions, unpaved roads (dust), and poor land use practices.

In Uganda, air quality trends show an increase from an average concentration of 79µg/m3 of PM2.5 concentration registered in the morning, starting from 5:00 am and peaking at 8:00 am, with a decrease after 9:00 am. Increase in PM2.5 is again recorded after 5:00 pm, and this is typical for all sites in Uganda. The extent of pollution resulting from PM2.5 is higher in the greater Kampala area than in other areas. Dust from un-tarmacked roads, volcanic emissions and landslides could also be contributing to the spikes in PM2.5 concentrations in other areas.

Nitrogen dioxide (NO2) concentration within the greater Kampala area was within WHO guidelines (40 µg/m3), except for the Central Business District (CBD) and Wandegeya which are characterized by high traffic flows of close to 125,000 vehicles accessing the city per day. Other areas outside Kampala city were within acceptable WHO guideline limits, however, major towns along the Jinja highway had elevated concentrations of NO2 above 40 µg/m3. This elevation in NO2 is likely associated with high traffic flows, with about 50,000 vehicles passing along that road per day.

Several initiatives have been put in place by the government of Uganda to address these air quality issues. Such initiatives include the formulation of the National Environment Air Quality Regulations, installation of air quality monitors at strategic locations, tarmacking urban roads, ensuring proper waste management practices, promoting the use of renewable energies as opposed to fossil fuels, and imposing and age limit on cars imported into the country to no more than 15 years from the date of manufacture. Reductions in motorized traffic flows have also been introduced in the Kampala CBD on weekends, through exclusive use of non-motorized means of transport on the designated streets. Besides, air quality targets for urban areas have been set for PM2.5 at an hourly mean of 40 µg/m3, and for NO2, at an annual mean of 40 µg/m3, to be attained within the National Development Plan (NDP III) time period (2020-2025).

1. Introduction

The environment where human beings live is premised on three key block components, namely: land, water, and the atmosphere (The National Environment Act No5 of 2019). The status of these block components is dependent of the level of human interactions therein, in the quest for development and improved livelihood. On land, if the interactions are very negative, this is often described as land degradation (Tom O. Okurut and Caleb N. Weggoro, 2011), and if positive then it is described as conservation (National Environment Management Authority Uganda, 2000). Similarly, in aquatic environments, water pollution is described when the actions of humans contaminate water beyond its natural status, and pristine water is associated with water in its natural state. Literature on land and water status abounds and represents sustained interest in their status globally and in national settings (Government of Uganda, 1997; The Land (Amendment) Act, 2010); Okurut T O, 2012; Kanyesigye C, Sonko Kiwanuka, Kaggwa C R and Okurut T O, 2003).

Interest in the status of the constituents of the atmosphere has not been much like the other block components but has grown rapidly in the last 20 years (WHO global air quality guidelines, 2021). Air is one of the key constituents of the atmosphere that is very critical for human survival and the environmental health of all living things in general. The status, or quality, of air in the atmosphere has been changing due to sustained human-induced activities that emit toxic gasses, particulate matter, and radiation, beyond its self-cleaning capacity. Air quality, which is a measure of how clean or unclean air is globally, nationally or at the local level, is changing and has galvanized nations to take action to minimize the contamination or pollution of air.

Clean air is one of the fundamental pillars of the health of animals and plants. However, reports of worldwide increases in noncommunicable cardiovascular and respiratory diseases among humans (WHO global air quality guidelines, 2021), such as asthma, chronic bronchitis, tuberculosis, obstructive pulmonary and cardiovascular diseases, and lung cancer, among others, are clearly associated with air pollution among mainly urban dwellers. Therefore, there has been a rapid increase in studies on air quality and air pollution, spread out across many countries, with some leading to the enactment of specific laws and regulations to regulate air quality on the same pedestal as for water and land pollution. The main causes or sources of air pollution are motor vehicles emissions, emissions from industry (especially coal mining), the burning of municipal waste, unpaved roads (dust), and poor land use practices. The extent of each varies depending on the status of the economy and industrialization levels of different countries.

2. Factors Compromising Air Quality

Air quality within any specific environment may get contaminated or polluted due to two causal pathways: noxious gas emissions from both anthropogenic sources or industrial emissions, and solids of different sizes floating into the air or environment. There are several known sources that are responsible for generating both the gaseous and solid emissions that compromise air quality (US EPA, 2019b; UNEP, 2016a; UNEP,2020). These include:

- Combustion of fuels and biomass for various purposes such as energy generation, cooking, using firewood, charcoal, plastics (typical African kitchens), transportation (vehicular and aircrafts), bush burning, and refuse burning, among others.
- Non-combustion processes and actions that generate volatile and semi-volatile organic compounds (VOCs) and/or ozone.
- Construction—especially roads—and resuspended dust from unpaved roads. Atmospheric transport of air polluting substances over long distances (e.g., Harmattan dust).
- Biogenic emission sources, such as volcanic eruptions, landslides, and wetland degradation processes.
- Tobacco smoking, especially in non-ventilated indoor spaces.

Human exposure to poor air quality occurs both indoors (at homes, work places, etc.) and outdoors. Indoor air pollution is generated from both indoor sources but also from outdoor (ambient) air pollutants that get trapped inside the building. This route is often considered to be the main source of indoor air pollution (observed by dusty tables, linens, and shelves), as well as other pathways such as particulate matter and gaseous pollutants (including sulfur dioxide (SO2), carbon monoxide, nitrogen dioxide, and ozone). NO2 and SO2 are transport-related air quality pollutants and, as such, they are functionally influenced by the number of vehicles passing a point at any given time, traffic levels or jams, junctions, and maintenance efficiency, among others. Especially high concentrations are recorded at large junctions.

Indoor air quality affects more of the population due to the tendency of more people to stay indoors and hence prolong their time of exposure. Ambient air quality, on the other hand, is subject to high temporal variations, which is influenced by the spatial distribution of the sources of pollution and daily operational plans. The density and emission concentration of the pollutant and weather conditions determine the overall impact the pollutant will have on the environment and humans. It is thus not uncommon to find high variability of air quality within an urban setting. In a city such as Kampala, air pollution is typically worse in the city center, near round-abouts and road junctions, and where vehicle congestion is often observed.

In both ambient and indoor settings, the impact of the prevailing air quality on human health is influenced by exposure time. In areas where the polluting substances have very low concentrations, ordinarily having a low impact, air pollution becomes more serious if the exposure time is prolonged. Similarly, in circumstances when pollutant concentration is high, but exposure time is short, the resultant impact may be negligible.

3. Air Quality Status in Uganda

Air quality regulations in Uganda have not been given the attention they deserve, despite the impacts that pollution has on the population and the environment. The National Environment Act Cap 153 of 1995, for instance, puts more emphasis on land and water environmental contaminants than on atmospheric contaminants. Uganda has instead been relying on the WHO Guidelines of 2006 (WHO, 2006) to guide air quality and emission regulations in the country. However, recent reports on air quality in Uganda from the National Environment Management Authority (National State of Environment Report, 2018-19) have identified that air quality in the country is indeed polluted, especially in urban areas. The main routes and sources of air quality decline (pollution) were also identified as coming from: motor vehicles (50%); open burning of municipal waste (15%), industries (3%); unpaved roads (30%), and poor land use practices (1%). It is instructive to note that despite the tax imposition on old vehicles, they still come in droves and still constitute the main source of air pollution in the country.

The quality of air, measured by the Air Quality Index (AQI), is a color-coded guide for reporting and forecasting daily air quality. The identified pollutant parameters typical in the Ugandan environment, that are also used globally for monitoring air quality include particulate matter (PM) of size 2.5 microns (μm) or less (PM2.5), particulate matter of size 10 microns or less (PM10), nitrogen dioxide (NO2), sulphur dioxide (SO2), ozone (O3), carbon monoxide (CO), and residual hydrocarbons (HC) in high concentration levels. The risk factors to public health for each of these parameters is illustrated in the table below (WHO 2021).

Table 1: Possible health outcomes from exposure to air pollutants

Long Term Exposure			
#	Pollutant	Characteristics & Source	Health Outcomes
1	NO_2	- Brownish gas, very reactive - *Fuel combustion* -	- Asthma attacks - Respiratory mortality - All-cause mortality
2	SO_2	- Colorless gas with a pungent smell readily soluble in cold water - *Combustion of Sulphur containing fuel; mining processes & volcanic eruptions*	- Asthma attacks - All-cause mortality - Respiratory mortality
3	PM $_{2.5}$ & PM_{10}	- Ditto-	- All-cause mortality - Cardiovascular mortality - Respiratory mortality - Lung cancer mortality -
4	CO	- Colorless, odorless gas, highly poisonous - *Incomplete combustion of carbon*	-
5	Volatile organic compounds (VOCs)	- A mixture of organic compounds with air masses - *Burning of fossil fuels paints, paint strippers and other solvent0, wood preservatives, aerosol sprays, cleansers and disinfectants, moth repellents and air fresheners and stored fuels and automotive product*	

In the past five years, the government of Uganda has returned itself to the challenges of air pollution. This focus has been spiked by the climate change discourse that has placed the aspect of anthropogenic and industrial emissions high on global and national agendas. It has been recognized that poor air quality (air pollution) in the country could compromise all the initiatives of economic transformation that are being undertaken. The drive to popularize air quality issues in the country has been championed by the National Environment Management Authority, the Makerere University Air Quality Initiative Project, and the Kampala Capital City Authority. The drive was informed by data from an air quality monitoring programme undertaken by NEMA and Makerere University, and complementary measurements completed by the American Embassy.

In the NOSER (2019), specific initiatives undertaken in the country to respond to air pollution challenges include: revision of the National Environment Act, formulation of the National Environment Air Quality Regulations, installation of air quality monitors at strategic locations, tarmacking of urban roads, ensuring proper waste management practices, promoting the use of renewable energy as opposed to fossil fuels, and imposing an age limit on cars imported into the country to no more than 15 years from

the date of manufacture. Other initiatives, such as by Makerere University School of Computer Science under the Air Quality Initiative project have fabricated low-cost and portable air quality sensors that can be used to collect real-time data on air quality and can be accessed on a phone with the use of an app or on their website. Kampala Capital City Authority has also initiated various programs aimed at reducing air pollution within the city, including the formation of the Kampala Pollution Control Task Force, the installation of air quality monitoring devices around Kampala, construction of non-motorized streets within the city center, and pedestrian walkways to reduce traffic congestion but encouraging mass transport. The ambient air quality targets for urban areas set by NEMA to be attained within the period 2020-2025 under the National Development Plan III are demonstrated in Table 2 below.

Table 2: NDP III-defined air quality targets

Air pollution index Kampala (ambient air)	**Parameter**	**Current position**	**Air quality target**
	$PM_{2.5}$	65µg/m^3- hourly mean	40 µg/m^3 hourly mean
	PM_{10}	80µg/m^3 hourly mean	50 µg/m^3 hourly mean
	NO_2	75µg/m^3 hourly mean	40 µg/m^3 annual mean
	SO_2	- (no previous data)	20 µg/m^3 hourly mean
	O_3	- (no previous data)	12.5 µg/m^3 hourly mean

4. Air Quality Trends

It is only recently that actual measurements of air quality in Uganda have been done, revealing unique trends that are presented in this paper. The air quality data collected is real-time, and as such it was possible to learn of the trends in air quality during the 1st Covid-19 lock down, which was characterized by a virtual absence of the usual heavy traffic on roads, especially from motorcycles (boda bodas).

As earlier indicated, the Air Quality Index (AQI) is a method developed by the U.S. Environment Protection Agency (EPA 2014) for easy communication and to depict the status of air quality using a color-coded system. The AQI is divided into 6 categories corresponding to levels of health concern from “good” to “hazardous,” as shown in Table 3 below. PM2.5 is used as an indicator pollution parameter and is hence the first to be used in assessing air quality trends.

Table 3: The air quality index (AQI)

#	AQI Category	AQI Index	Corresponding $PM_{2.5}$ Conc.	Description
1	Good	0-50	0-12.0	Air quality is considered satisfactory, and air pollution poses little or no risk.
2	Moderate	51-100	12.1-35.4	Air quality acceptable, but for some pollutants, there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
3	Unhealthy for sensitive groups	101-151	35.5-55.4	Members of sensitive groups may experience health effects. The general public is not likely to be affected
4	Unhealthy	151-200	55.5-150.4	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects
5	Very unhealthy	201-300	150.5-250.4	Health alert: everyone may experience more serious health effects
6	Hazardous	301-500	Above 250.5	Health warnings of emergency conditions. Entire population likely to be affected

5. Measurement Methodology

5.1 Determination of nitrogen oxide

Nitrogen dioxide was analyzed using the diffusion tube method. This method involves the use of small plastic tubes with a steel mesh disc that is coated with triethanolamine (TEA), a chemical that absorbs nitrogen dioxide. When gases pass over this mesh the chemical changes. This chemical change indicates the amount of nitrogen dioxide in the air during the monitoring period.

Tubes were attached in a vertical position to stationary objects such as lampposts, road signs, railings, or drain pipes. The bottom cap is removed so that the air can get into the tube by diffusion. Nitrogen dioxide in the air reacts with the chemical on the mesh at the top of the tube and changes into nitrite. The tube is left in place with the bottom cap off for a given period, after which time the bottom cap is replaced, and the tube is returned to the laboratory for analysis.

In the laboratory, the steel mesh is removed and washed with distilled water, which is then analyzed. The concentration of nitrogen dioxide is found by directing ultraviolet light (UV) through the water sample. The amount of light absorbed is equivalent to the concentration of nitrogen dioxide that was present in the air during the monitoring period.

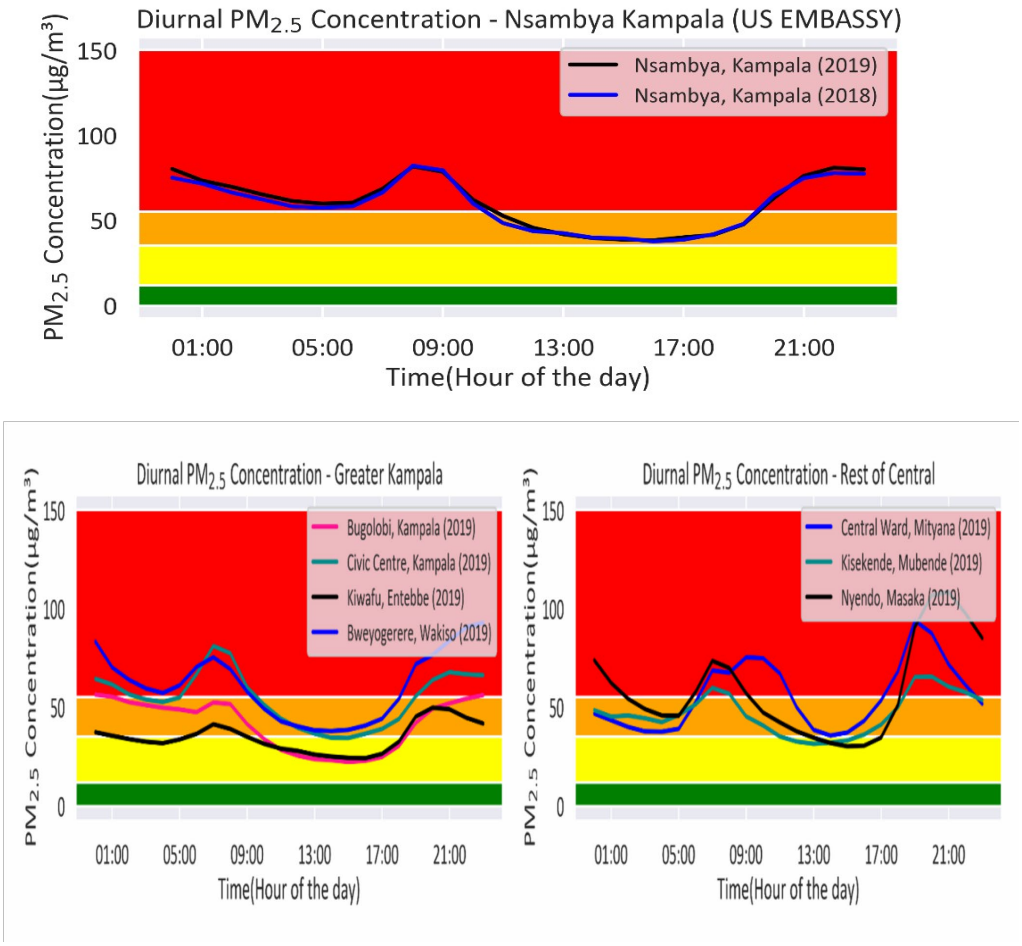
5.2 Determination of PM2.5 and PM10

PM2.5 and PM10 were measured using the beta attenuation method. This method uses conventional optical particle counters where the OPC-N2 measures the light scattered by individual particles carried in a sample air stream through a laser beam. These measurements are used to determine particle size (related to the intensity of light scattered via a calibration based on Mie scattering theory) and particle number concentration. Particle mass loadings for PM1, PM2.5, and PM10 are then calculated from the particle size spectra and concentration data, assuming a particle density and refractive index (RI).

6. Results and Typical Trends Observed

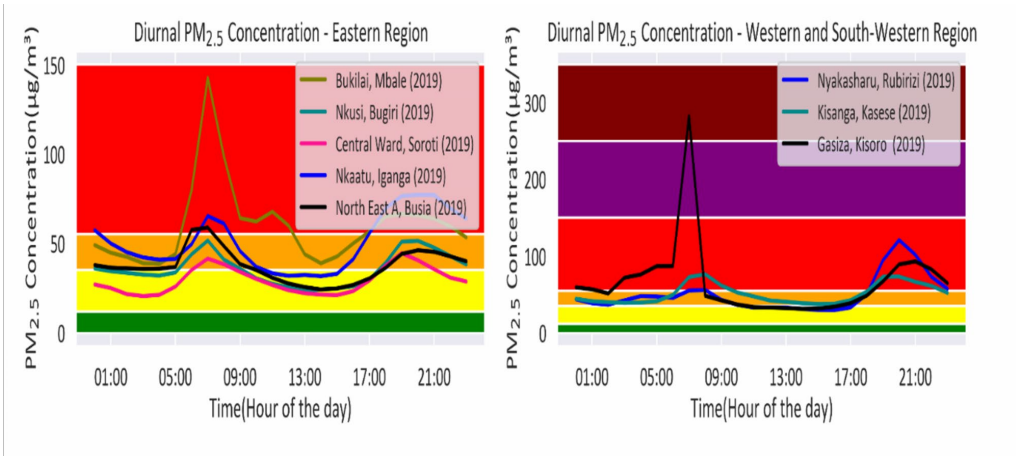
6.1 PM2.5 variation in a typical 24-hour period (diurnal profiles) in selected locations

Figure 2: PM2.5 concentrations in the Greater Kampala Metropolitan Area (GKMA) and Central Region



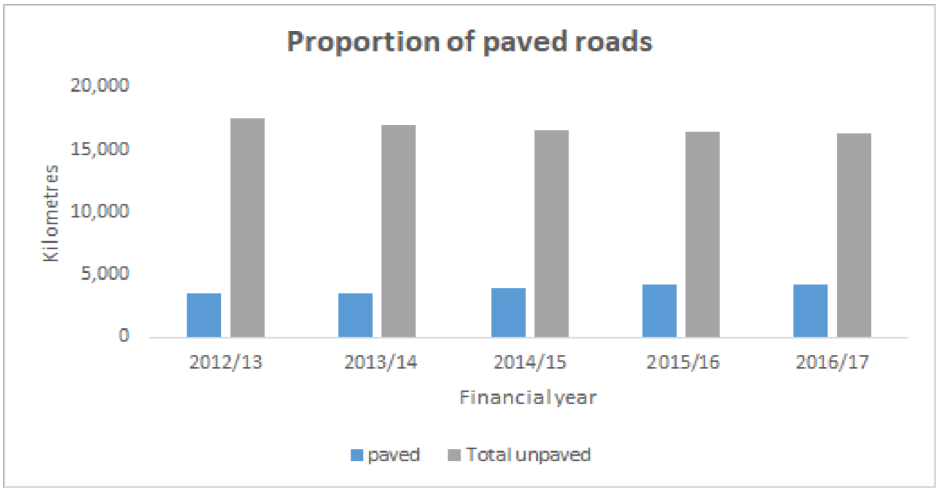
Key trends: Peak values noted at times of peak traffic in the urban areas.

Figure 3: $PM_{2.5}$ concentrations in selected town in eastern and western Uganda



The peaking in Kisoro and Mbale may be because of dust emissions from un-tarmacked roads, volcanic, and land slide characteristics of the location.

Figure 4: Proportion of paved and unpaved national roads in Uganda

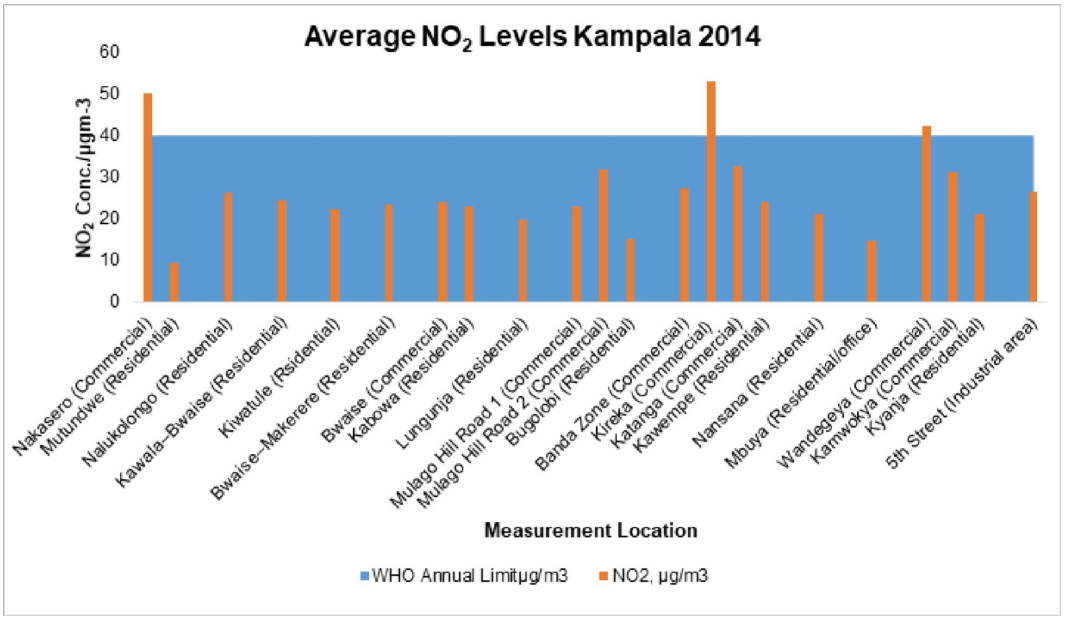


Source: UBOS 2018

The high concentrations of PM2.5 observed can be related directly to the high proportion of unpaved roads, that when agitated plume the air with dust particles.

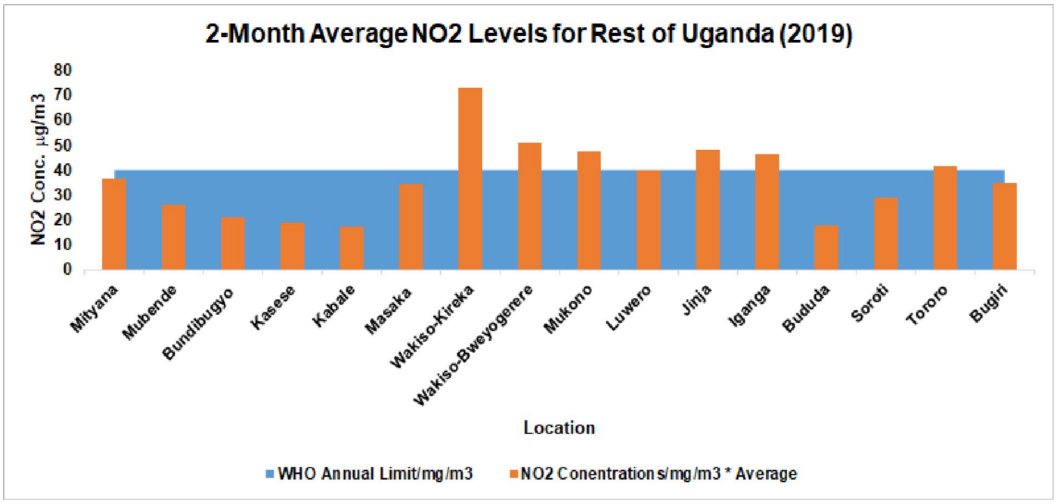
6.2 Trends for nitrogen dioxide

Figure 5: Nitrogen dioxide concentrations measured at selected locations in Kampala



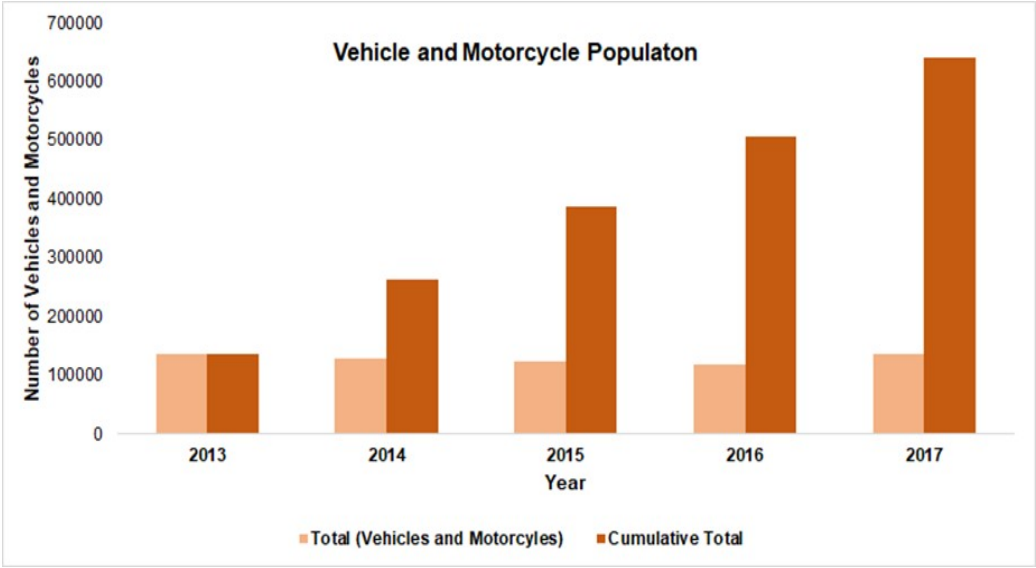
Source: Kirenga et al. 2015

Figure 6: Nitrogen dioxide trends in several other Ugandan municipalities



Source: NSOER

Figure 7: Trends in the number of vehicles in Uganda, 2013-2017



Source: UBOS 2018

7. Impact of COVID-19 and Response Measures on Air Quality in Kampala

Because of the various initiatives and restrictions around the city due to COVID-19, there was a reduction in the number of vehicles accessing the city center, which obviously had an impact on air quality. A study to assess the extent of the impact of the COVID-19 lockdown on air quality within Kampala city was hence conducted, specifically looking at the three major parameters of concern to human health—nitrogen dioxide (NO2), particulate matter (PM2.5), and ground level Ozone (O3).

The following were the findings: a 67% mean reduction in the concentration of nitrogen dioxide, and 50% mean reduction in PM2.5, and a 42.1% mean reduction in ozone concentrations. All the parameters dropped to levels that were within the acceptable limits of the World Health Organization air quality guidelines, which was not the case before the lockdown.

Figure 8: Diurnal trends of NO2 measured at NEMA stations during the first lockdown

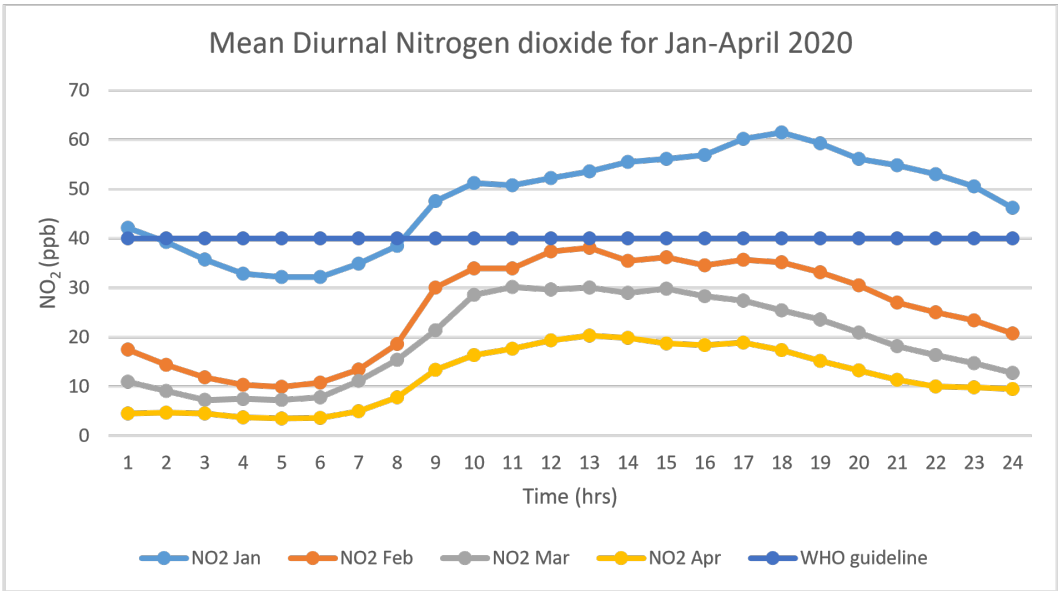


Figure 9: Diurnal trends of PM2.5 measured at NEMA stations during the first lockdown

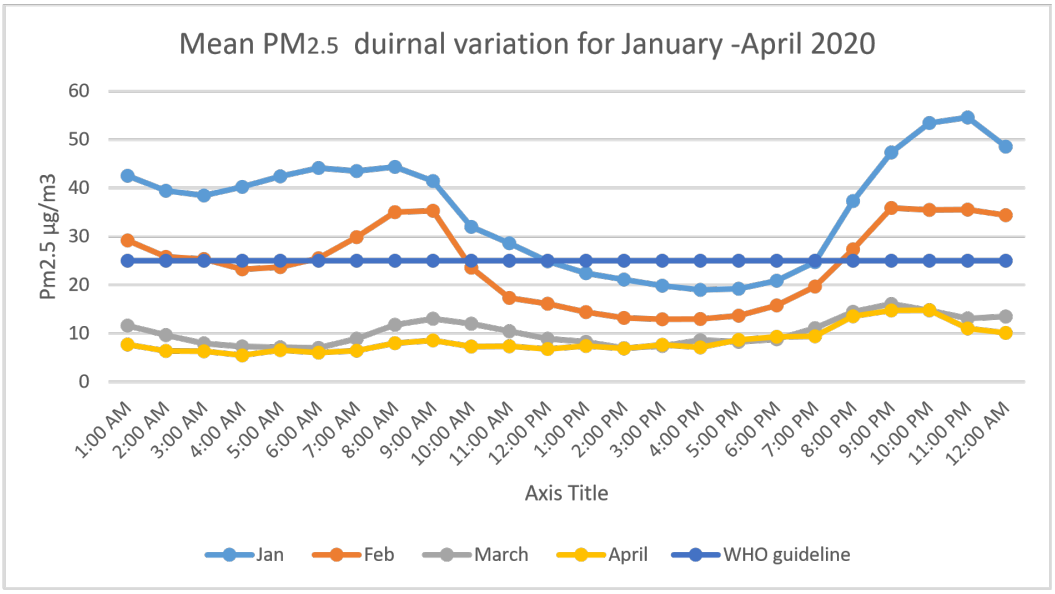
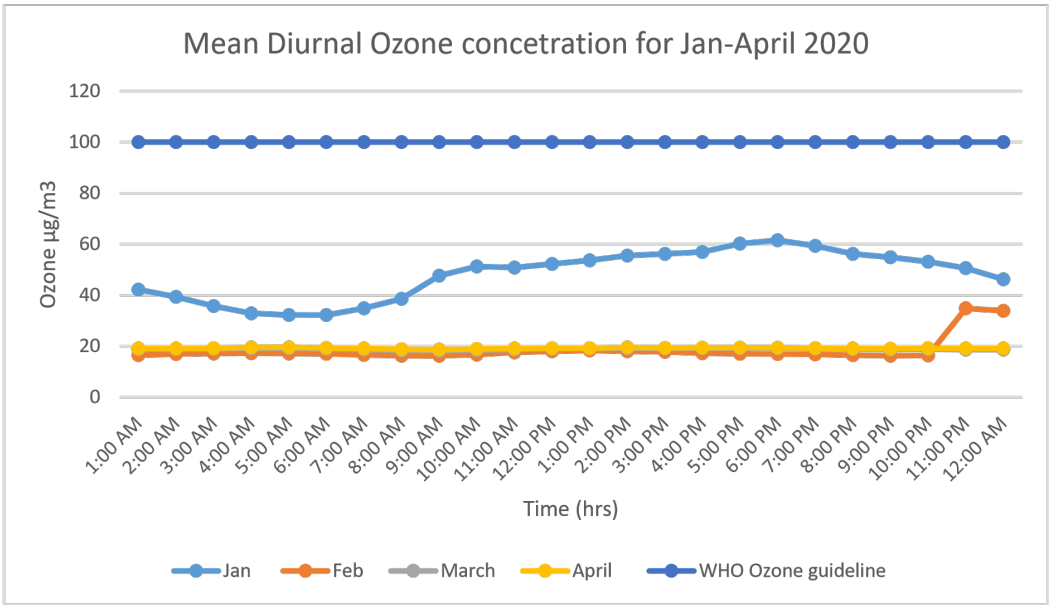


Figure 10: Diurnal trends of ozone measured at NEMA stations during the first lockdown



8. Conclusions and Recommendations

The major air quality drivers in Uganda include motor vehicles emissions, emissions from industries, burning of municipal waste, dust releases from unpaved roads, and poor land use practices. All the above drivers, including the fuel sources used in a homestead, contribute to the pollution of both ambient and indoor air quality, which consequently impacts human health. Various initiatives are hence key to improving air quality, which among others include the formulation of air quality standards, air quality monitoring to produce information that will inform decision making by government and all concerned agencies, tarmacking murram roads, ensuring proper waste management practices, and promoting the use of renewable energies as a substitute to fossil fuels. All these efforts, coupled with the further imposition of an age limit on reconditioned vehicles imported into the country would improve the quality of air in Uganda. Data on air quality over longer time periods is also key to informing evidence-based legislation and policies to improve air quality and reduce the unacceptable health burden that results from air pollution.

Efforts by all players to reduce air pollution is acknowledged. However, the increasing population will continue to put pressure on the environment, which will be realized through environmental degradation when left unchecked. It is therefore important, that continuous monitoring of air quality and expansion of the monitoring network is prioritized so that the drivers of air pollution in Uganda can be critically assessed to minimize its sources.

References

Air quality Trends in Kampala City, (2020); NEMA Internal Report

Gail Krantzberg and Velma I Grover (2018): Great Lakes Lessons in Participatory Governance CRS Press Boca Raton FL 33487-2742 USA

Government of Uganda (1997); The Water Act, Cap. 152

Kanyesigye C, Sonko Kiwanuka, Kaggwa C R and Okurut T O.; (2003). Water Quality improvement in the inner Murchison Bay, Lake Victoria: A case study of algal removal at Gaba II Treatment Plant. The African Journal of Tropical Hydrobiology and Fisheries Vol. 11, (special issue), pp 1 – 22

Kirenga, B.J., Meng, Q., Van Gemert, F., Aanyu-Tukamuhebwa, H., Chavannes, N., Katamba, A., Obai, G., Molen, T.V.D., Schwander, S. and Mohsenin, V. (2015). The state of ambient air quality in two Ugandan cities: a pilot cross-sectional spatial assessment. International journal of environmental research and public health, 12(7), pp.8075-8091.

National Development Plan III (2020). Ministry of Finance Planning and Capital Development

National Environment Management Authority (NEMA) Uganda (2000); The National Environment (Wetlands, Riverbanks and lakeshore management) Regulations,2000

National State of Environment Report (2018-19); National Environment Management Authority publication (2019).

Okurut T.O.(2012)., A Holistic Approach to Natural Resources Management: A Case of Lake Victoria Basin.

The Land (Amendment) Act (2010); The Uganda Gazette No 10 Vol CIII dated 12th February 2010

The National Environment Act (2019). The Uganda Gazette No 29 Volume CXII. 2019.

The National Environment Act (2019). The Uganda Gazette No 29 Volume CXII 2019.

Tom O. Okurut and Caleb N. Weggoro (2011); Lake Victoria Basin; a New Frontier for the Development of East Africa. Taweza Communications, Nairobi

UNEP (2016a). Sand and dust storms. Nairobi: United Nations Environment Programme

UNEP (2020). Used vehicles and the environment: A global overview of used light duty

US EPA (2014). Air Quality Index-A Guide to Air Quality and Your Health. Available from: https://www.airnow.gov/index.cfm

US EPA (2019b). AP-42: Compilation of air emissions factors. In: Air emissions

factors and quantification [website]. Washington (DC): United States Environment Protection Agency (https://www.epa.gov/air-emissions-factors-and-quantification/ap-42compilation-air emissions-factors vehicles: flow, scale and regulation. Nairobi: United Nations Environment Programme (https://www.unep.org/resources/report/global-trade-used-vehicles-report).

WHO air Quality Guidelines (2006).

WHO global air quality guidelines (2021). Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. ISBN 978-92-4-003422-8 (electronic version); ISBN 978-92-4-003421-1.

WHO global air quality guidelines (2021). Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide. ISBN 978-92-4-003422-8 (electronic version); ISBN 978-92-4-003421-1.

Health Beyond Health Systems: Implications for a Healthy Economy

Corti Paul Lakuma

Abstract

Health provision is increasingly being addressing through non-health system determinants of health. This change is occurring because the effects of health systems may not wholly determine sickness or injuries. Using UNHS 2015/16 data, results suggest a strong positive association between lower education, income, better working terms, and better housing with health outcomes of households in the income lower quintile when compared with those in the highest quintile, and in households in regions other than Kampala. However, the study also observes weaknesses in the health system, which has led to insignificant health-seeking behaviour, the rise of NCDs, low access to health insurance, and low levels of critical health infrastructure and staffing.

The study recommends investment in the post-primary training section, measures to address food insecurity in the country, and partnerships and innovative approaches between the public and private sectors to deliver affordable housing and related infrastructure such as electricity and piped water. There is also a need to provide decent waged employment through balanced investments in social and economic policies to enhance skilled, technical, and hands-on personnel for the economy. Finally, the observed weaknesses in the health system call for a re-visiting of the primary health care (PHC) approach. The PHC emphasises integrating socioeconomic aspects to health care through community participation and cross-sectoral collaborations and coordination.

1. Background

Health provision is increasingly shaped by non-health system determinants of health. These shape health across a wide range of indicators, settings, and populations. The effects of health systems may not wholly determine sickness or injuries (Braveman et al., 2011). In this case, a healthy economy, herein interchangeably referred to as socioeconomic determinants of health, is pertinent to healthy citizens. However, the building blocks of a healthy economy rest on socioeconomic pillars such as household characteristics, education, employment, institutions, wealth, housing, perceptions about self and community, and health systems. These pillars influence a person's socioeconomic position, which, in turn, plays a role in determining health outcomes.

The World Health Organisation (WHO) recognises the strong links between socioeconomic factors, public policies, and health. Indeed, in 2012, the World Health

Assembly passed resolution 65.8, which endorsed the Rio Political Declaration on Socioeconomic Determinants of Health. The resolution emphasised the need for "delivering equitable economic growth through resolute action on social determinants of health across all sectors and at all levels (WHO, 2013)." In addition, health equity is framed as a cross-cutting theme within the Sustainable Development Goals (SDGs) conceptual framework that aims to help countries develop inter-sectoral goals and target areas for improving development (Marmot and Bell 2018). Achieving health equity therefore requires action on the social determinants of health (WHO 2008).

There is an increasing need to integrate health equity into inter-sectoral action, partnerships, and alliances, government policies, regulatory frameworks, and strategies in Africa. This integration comes out partly because the bulk of health problems originate outside the health sector (WHO 2013a). However, current development policy frameworks in different sectors do not address the socioeconomic determinants of health and, therefore, miss out on opportunities to positively impact health. Moreover, this lack of integration of socioeconomic determinants results in the health sector dealing with health problems created by other sectors (ibid). This aspect became even more visible during COVID-19, where its impact went beyond health to impact the economy. In turn, it has impacted health negatively.

Initially, primary healthcare (PHC) in Uganda aimed to integrate socioeconomic aspects into health care. PHC policy, strategy, and planning were supposed to embed community participation and inter-sectoral collaboration. However, the instability of the 1980s and the emergence of the HIV/AIDs pandemic resulted in new approaches that eclipsed the PHC method of work. Moreover, the health sector reforms of the 1990s shifted emphasis to efficiency, cost-effectiveness, health financing, and economic fundamentals, thereby abandoning the other elements focused on community participation and inter-sectoral collaboration. As a result, Uganda's Health Policy of 2016 and the numerous Health Sector Strategic Plans hardly mention the inter-connectedness of the health system with socioeconomic aspects of life articulated through community participation and inter-sectoral collaboration.

The Third National Development Plan (NDP III) recognises the need to integrate education and health services under the human development programme to address these gaps. This priority aligns with the broader objective of improving labour productivity for increased competitiveness and better quality of life for Ugandans—in turn, a better health economy. The integration is a testimony that health exists beyond health systems.

For instance, better incomes would lead to improvements in health status. However, if these incomes are not well distributed, they are likely to lead to uneven health outcomes. Some observations emerge when examining the associations between health status outcomes, proxied by self-reported health status (ill-health and injuries in the past 30

days), and selected policy variables from the Ugandan data. Analysis reveals a positive, albeit weak, correlation with income headcount (see Figure 12), a negative association with literacy rate (Figure 13), a negative relationship with sanitation proxied by having a pit latrine (Figure 15). Further, health-seeking behaviour has a relatively low positive effect on health status (Figure 14). In all these examples, there are significant variations across sub regions.

Other outcomes of low incomes in Uganda are the low level of Uganda's human capital, characterised by low productivity (38 percent), low human development (HDI at 0.516), and fewer STEI graduates (2 out of 5 are STEI graduates) (NPA, 2020). Nevertheless, significant progress has been made so far in maternal and child health. The maternal mortality ratio declined from 438 per 100,000 live births in 2011 to 336 in 2016, and infant mortality improved from 54 to 43 per 1,000 births over the same period. However, this progress is uneven across geography and income groups. In addition, there is limited access to health insurance, at only 2 percent (ibid). The COVID-19 pandemic, with its adverse impacts on the economy, is likely to impact these health outcome indicators.

To sum up, the proposed framework for intersectoral action in NPD III is limited within the human capital program, out of the identified 18 programs. Different sectors beyond education impact health and, in turn, influence the health of the economy. These findings thus pose some questions: what are the critical and contextual socioeconomic determinants that the different NDP programs need to integrate into their implementation frameworks? How does recognising these socioeconomic determinants and their subsequent implementation lead to a healthy economy and the reverse? Thus, the main objective of this paper is to explore the links between socioeconomic determinants and a healthy economy in Uganda.

The rest of the study is as follows: section 2 outlines the approach and provides the context, methodology, and data sources. Section 3 discusses the results, which are composed of descriptive statistics and regression results. Finally, section 4 offers some conclusions and policy messages.

2. Study Approach

2.1 Contextual and Conceptual Framework

Socioeconomic determinants of health are the condition in which someone is born, grows, lives, and ages. There are some studies on Uganda, such as Ssewanyana and Kasirye (2012), Bakeera (2011), Roberts et al. (2009), Odwee et al. (2006), and Lawson (2004) that have endeavoured to provide insights on these socioeconomic determinants. Common to these studies is that the health system alone cannot improve health overall or reduce health disparities without addressing where and how people live.

As earlier mentioned, Figure 11 suggests that the building blocks of a healthy economy rest on socioeconomic pillars such as household characteristics, education, employment, institutions, wealth, housing, perception about self and community, and health systems. These pillars influence a person's socioeconomic position, which, in turn, play a key role in determining their health outcomes. In addition, a healthy economy can impact a person's ability to lead a healthy life through an enabling institutional environment and participation in activities that empower their capabilities to achieve their potential. Therefore, this study aims to identify critical areas necessary for improving health, and to develop objectives for Uganda to measure progress towards achieving a healthy economy.

Figure 11: Construction of health beyond health systems

Household Characteristic	Education	Employment	Institutions	Wealth	Housing	Perception about Self and Community	Health system
Sex	Literacy Rate	Wage work	Registered Business	monthly profit	Public Housing	Change work	Doctor consultation
Age	Primary Education	Temporary work	Documentation (ID, Birth Certificate, License)	Asset value	Number of sleeping rooms	Satisfied with Job situation	Attends private hospitals
Marital Status	Secondary Education	Not in Employment Education or Training (NEET)		Total Consumption Per Person	Shared toilet	Victim of a crime	Attends government hospitals
Dependency Ratio	Tertiary Education	Private sector		Household Consumption Per Person	Electricity grid		Distance to hospital less than 5km
		Public Sector		Food Consumption Per Person	Piped water		Distance to hospital more than 5km
		Contract			Finished walls		Health insurance coverage
		Paid Leave Sick Leave Social sector Self-employed Hours worked Income Instability			Finished floors		
			Health Outcomes				
		Health Status		Life expectacy			

Generally, socioeconomic determinants include high-level factors such as education, wealth, and housing, which cascade into lower-level ones such as literacy, expenditure, and safety (see Figure 11). However, the causal pathways are not as linear as presented here, and there is also complexity presented by the long periods during which these relationships play out. For instance, education can influence many health outcomes through three pathways. The first pathway is linear: education develops into knowledge

and skills, which this facilitates healthier behaviours. The second pathway is non-linear: education leads to better, higher-paid work. There are then subsequent links from income to health through various pathways, such as work-related benefits, neighbourhood opportunities, and decreased stress. Finally, the third pathway depicts the health effects of education through psychobiological processes such as control beliefs, subjective social status, and social networks.

The selection of high- and low-level factors in Figure 11 is informed by the NDP III (see NPA 2020), and other strands of the literature, which identify Uganda's development context and the challenges therein. The selected factors reveal the influence of social factors in shaping health across a wide range of health outcome indicators, settings, and populations. These factors are not meant to undermine the role of health systems on health—instead, they are meant to include factors beyond just the health system itself. However, as earlier emphasized, the relationships between socioeconomic factors and health are not straightforward. In addition, there are active controversies regarding the strength of the evidence supporting a causal role of some socioeconomic factors.

Nevertheless, MoFPED (2021) identifies a significant subsistence economy in Uganda, at 39 percent. Uganda's high population growth rate of 3 percent is straining its capacity to deliver health, education, housing, electricity, and piped water, among other services (NPA, 2020). The population is also characterised by an unfavourable age structure, where a significant young population (0-14 years) constitutes 49.3 percent, revealing a high dependency burden. In addition, there is a missing market of required skills due to a mismatch in the knowledge produced by training institutions. Furthermore, the quality of education remains low, characterised by low levels of literacy and numeracy, coupled with high rates of school dropouts. As earlier mentioned, there are persistent vulnerabilities and wide regional disparities in poverty. Many of the regions in the East have experienced poverty reversals[1]. Furthermore, low investment in social protection systems has impacted poverty and vulnerability levels across the entire population. In this case, addressing gaps in social services provision, infrastructure, and income, among other factors, is essential for improving health and reducing health disparities.

The current strategy of private sector-led housing development cannot meet the growing demand for affordable housing (Kayiira 2020). Thus, there is a growing housing deficit, estimated at 2.4 million units, growing by 200,000 units per year (UBoS 2018). In addition, the residential mortgage sector remains underdeveloped. Currently, Uganda has a total value of UGX 768 billion (USD 208 million) in residential mortgage loans collectively held by formal banking and non-banking financial institutions (ibid). However, high interest rates on mortgage loans remain an impediment to the development of the residential mortgage sector. In addition, low-income households,

1. The percentage of people living below the poverty line (1.00 USD per day) was 21.4 percent in FY2017/18 compared to the NDPII target of 14.2 percent. Bukedi (43.7 percent), Busoga (37.5 percent), Bugisu (34.5 percent), and Teso (25.1 percent) have experienced reversals.

which account for more than 60 percent of Uganda's urban households, cannot afford the formal housing system (ibid). This has led to the rise of self-built housing and informal settlements/slums, which often violate city ordinances and physical plans (Lakuma et al. 2017).

Figure 16 suggests that while dwelling ownership has increased, it has not been matched with health improvement, especially in central 1, central 2, Busoga, Lango, Teso, and Karamoja. This negative relationship points to the low quality of homes owned by Ugandans. On the supply side, private developers are keener to provide housing for better-off urban middle- and high-income groups than low-income groups (ibid). In this case, the poor are left to live in houses built in an environment that poses barriers to health, such as lack of safety, poor drainage, exposed garbage, and substandard housing.

There is a low functionality of health facilities amidst a high burden of common infections, maternal and child health, nutrition complications, and pandemics (COVID 19, Ebola, and HIV/AIDS), and epidemics[2] . Recently, there has been a rise in NCDs with high mortality incidences outstripping existing health investments. In addition, resistance to antibiotics is increasingly becoming a challenge with potential impacts on mortality, morbidity, and cost of healthcare.

While Uganda has attained nearly 100 percent geographical coverage of the population living within 5km access to a health facility providing primary healthcare for infectious diseases, actual functional coverage and service delivery performance is much lower. The low performance is likely a consequence of the limited scope of comprehensive services, especially for preventive, specialty, and diagnostic services (Odokonyero et al., 2017).

In addition, there is a gap in human resources and infrastructure, which has reduced the functionality of health facilities at all levels, especially in rural areas. Total health expenditures per capita, at USD 51, is lower than the USD 86 required to deliver on universal health care (UHC) (ibid). Health expenditures are primarily funded by donors and out-of-pocket for clients, which is unsustainable and impoverishing. Donors largely support the health sector in Uganda. Lakuma and Lwanga (2017) note that between 2017 and 2019, up to 70 percent of development financing in the health sector was provided by donors.

2.2 Study Methods

The empirical analysis of determinants of health status is based on the class of household models where household members maximize welfare and health status as an outcome (Becker 1981; Singh et al. 1986). The model has been widely used in studies examining the determinants of health status (Ssewanyana and Kasirye 2012). In these models,

2. More than half, 53 percent, of children under five (5) years and nearly a third, 32 percent, of women of reproductive age, are anaemic.

household welfare is a function of the individual utilities of household members (see the formal statement in Appendix B). In turn, individual utilities are dependent on health status, social determinants of health, and the health system. In this case, health status is the dependent variable, and social determinants and health systems provide the set of independent and control variables. To capture differences in access to services, we compare the experiences of two household groups: the lower quintiles (1st to 4th quintiles) and the highest quintile (5th quintile). The paper also makes a spatial contrast by comparing household experiences in regions other than Kampala (North, East, West and Central) with those in Kampala. The estimators used are linear probability models (LPM) to cater for the earlier mentioned linear relationships between some determinants and outcomes of interest. We re-estimate the model using a probit estimator for cases where there is no convergence, which suggests that the relationship is non-linear.

2.2.1 Data sources

The study relies on the 2016/17 Uganda National Household Survey (UNHS) conducted by the Uganda Bureau of Statistics (UBoS). This survey collects high-quality data on household demographic and socioeconomic characteristics to monitor Uganda's development performance on key indicators in the various sectors. The survey is nationally representative, covering 17,450 randomly selected households in 112 districts in Uganda. The survey has four modules: socio-economic, labour-force, community, and price modules. Specifically, the survey collects information on education, health, household expenditures and poverty, food security, income and loans, information and communication technology, vulnerable groups, community characteristics, and non-crop household enterprises, presented at national, rural-urban, regional, and sub-regional levels. We do not use the 2019/20 dataset because it was conducted during the COVID-19 pandemic and may have many COVID-related biases.

2.2.2 Description of the model variables

Health status: We use two proxies for health status. One is constructed from the UNHS data based on self-reported health status—illness or injury in the past 30 days before the survey. If an individual reported an illness or injury, their health status takes on the dummy value of 1, otherwise, is assigned zero. The other proxy is life expectancy, constructed using life tables calculated based on death probabilities according to Farr's death rate method (Anderson, 1999). An indicator variable is then used to show those expected to live beyond the age of 24.

Household characteristics: As earlier mentioned, household characteristics are important determinants of health during infancy. Household size and its composition is derived from the household roster, focusing on the usual members only. We also consider the dependency ratio of both adults and children as a burden to households, and its likely negative impact on health status. For the dependency ratio, we include a dummy for those aged below 15 and above 64.

Household wealth: We proxy wealth by household consumption expenditure per adult equivalent. Household incomes are essential for health, and for the procurement of treatments for illness. Housing and related infrastructure such as water are key to providing shelter from bad weather and a sense of privacy for families, as well as protection from microbial infection. We use the following variables to measure the extent of access to infrastructure: public housing, number of sleeping rooms, shared toilet, electricity grid, piped water, finished walls, and finished floors.

Individual characteristics: These variables include age, gender, marital status, education, and employment status. Age measures the fact that a household member's health is likely to worsen with an increase in age. Education is an essential determinant for health-seeking behaviour and for earning income to procure healthcare services. We measure education attainment by including dummies for different levels of education, namely no education, completion of primary, post-primary, "O" level, "A" level, post-secondary, and university.

Several categories of employment are also included in the model to measure whether employment predisposes one to sickness. This is done by activity type[3] , and those not in employment, education, or training (NEET). Employment was also measured by service type/sector, namely: sector and company type[4] , work position[5] , temporary worker, paid leave, business accounting, work location, second job, hours worked in a week, whether one wants a change in work, whether one looked for another job (or an additional job) in the recent past, satisfaction with the main job, payment period, profit in last month of activity, unemployment, discouraged worker, and discouraged motivation. Most of the employment-related variables were found to have a non-linear relationship and were re-estimated using the probit model.

Community variables: Institutional variables come from the premise that living in a society with strong institutions could improve one's health through psychobiologic pathways. To measure the quality of institutions using household-level variables, we rely on birth registration, business registration, driving license, and employment contract. The idea here is that individuals able to achieve this type of official documentation live in a relatively well institutionalized environment.

To measure perceptions about self and community variables, we need to look at the extent to which households are exposed to crime, and the availability of alcohol in disadvantaged neighbourhoods, which may influence its use among young people and affect their health. In addition, living in a noisy community can impact sleep, which can have short-term health effects. In this case, we use job search, job change, and being a victim of crime to measure this aspect.

3 Namely, wage work, self-employment, helper in a business, trainee, and volunteer.
4 Where we are interested in whether a company is private or government.
5 Where one is either an employee, an employer, an own-worker, or a family worker.

Health system variables: Health systems are essential in preventing and treating health conditions. We use doctor consultations, attendance at private hospitals, attendance at government hospitals, distance to health facilities, and health insurance coverage as variables.

3. Results

3.1 Descriptive analysis

There is a strong positive association of household consumption quintile with age, education, better working terms, and better housing. There is a negative association with the dependency ratio, and health-seeking behaviours. For instance, workers in the highest quintile have a better working term. They tend to work shorter hours (31 hours, on average), and they tend to have an employment contract compared to their lower quintile counterparts. Nevertheless, those in the lower quintiles have more sick leaves than those in the highest quintile, but these results could be related to the fact that those in the highest quintile are unlikely to get sick more often. At the regional level, workers in Kampala have longer working hours (52 hours, on average) and have more extended sick leave than their counterparts.

Highest quintile workers also tend to have more contracts than their regional counterparts. Moreover, those in the highest quintile have better housing and related infrastructure conditions. For example, they are the least likely to share toilets when compared to their lower quintile counterparts. These results are similar for those workers in Kampala as compared to other regions.

Lastly, in the health system block, we note significant differences between the two income quintile groupings in health-seeking behaviour, morbidity to non-communicable diseases such as high blood pressure, diabetes, and heart disease, and health insurance distribution. The highest quintile has better health status overall. While these results are similar in the regional comparison, the households in Kampala have a higher health status.

3.2 Econometric results—non-health system determinants of health

Table 5 suggests that, in comparison with the highest quintile, health systems have no significant effect on those in the lower quintiles. While this result may overemphasize the importance of socioeconomic factors, they affirm the overwhelming importance of such elements. This result also supports the assertion by WHO (2013) that most of the cases that end up in hospitals are preventable by addressing the socioeconomic determinants of health. If social factors strongly shape health-related behaviours, this brings the role of income, education, and employment to the fore.

The gaps identified in the health system (not reported) are low supply of doctors, low health-seeking behaviour as measured by the rate of attendance at both private and

public hospitals, long distances to hospitals, inadequate insurance coverage, and an increase in the prevalence in terminal diseases such as diabetes, heart disease, and high blood pressure. Note that the gaps are interpreted relative to the highest quintile and in comparison to Kampala residents.

Indeed, Table 5 shows that lower educational status (primary education) accounts for the lower health status of households in lower quintiles. However, the influence of lower education marginally improves when we moderate the burden of household responsibilities imposed by household size and high dependency ratios. These results are consistent with Ssewanyana and Kasirye (2012), who find that higher maternal educational attainment significantly boosts children's health status.

The effects of education on health have been disputed owing to potential reverse causation, where sickness leads to lower educational achievement (Kawachi et al. 2010). However, it should be noted that links between education and health may not be explained by reverse causation because educational attainment is never reduced once attained. The gaps identified are in the post –primary training section, which would seemingly address the income and regional inequalities in health through the income pathway.

From Table 5, there is an observed association between wealth measures such as monthly earnings and health. In particular, the health status of households in the lower quintiles improves relative to those in the highest quintile with an increase in monthly income. However, the improvement is negatively associated with household responsibilities measured by household size and dependency ratio. These results are consistent in Table 6, where we compare households other than those in Kampala. Indeed, Odwee et al. (2006) confirm that health status in Uganda depends on factors such as household income.

Previous research on Uganda also points to an association between incomes and health. These strands of the literature suggest a potential dose-response relationship, adding to the probability that socioeconomic factors have a causal role. For example, Lawson and Appleton (2007) argue that a doubling of household income would reduce the morbidity of children by as much as 20 percent. Ssewanyana and Kasirye (2012) confirm such results, but from a gendered dimension of income. In this case, income seemingly improves the health status of girls more than boys.

Although the effects of poverty on health are hardly disputed, not everyone concurs about the effects of income. Ssewanyana and Younger (2008) argue that the importance of income should not be overemphasised. Income-health relationships reflect reverse causation (i.e., sickness leading to income loss). While ill-health often results in lost income, studies using longitudinal and cross-sectional data suggest that these losses do not account for the significant, pervasive relationships that have been observed. For

example, southwestern Uganda had the highest rates of stunting, yet it had a much lower incidence of poverty than the North or West Nile sub-regions (Sewanyana and Kasirye 2012). Indeed, other factors such as education are equally important. In addition, the health impacts of income are moderate since less premium is attached to wealth.

The effect of other wealth measures such as total asset value tend to reduce with an increase in the magnitude of the age variable (Table 5). This finding is particularly remarkable because income gradients generally tend to flatten in old age. This result is consistent in Table 6 when comparing households in regions other than Kampala with those in Kampala. In addition, we identify gaps in food intake both at the aggregate and household levels amongst the wealth measures. This suggests that there is a disparity in food intake between the wealthiest and poorest households, and between other regions and Kampala.

Table 5 suggests that socioeconomic differences are measured by underlying disparities in perceptions about self and community. The clamour to change job situations and a rise in crime could harm the health of households in the lower quintiles compared to those in the highest quintile, by acting as a pervasive stressor. Indeed, living in a society with a high crime rate could damage health through psychobiologic pathways, even without overt assault incidents. Moreover, exposure to crime escalates the probability of socially acceptable risky health behaviours and can increase the likelihood that young people will be involved in crime (Bingenheimer et al., 2005).

On the other hand, job satisfaction can enhance health (Table 4). This linkage is mainly because working conditions are associated with health status. For instance, employees without sick leave are more likely to go to work when ill, increasing the probability of disease spreading to workmates and clients (Cook et.al. 2009). It should be noted that these results are sustained in the regional comparisons in Table 6.

In addition, issues about self-perception and community link closely with housing. Table 5 suggests that households in the lower quintiles who live in public housing are associated with better standard of health than their counterparts in the highest quintile. This result holds even while the supply of public housing has been significantly diminished by population increases and rapid urbanisation. An increase in housing demand has led to the rise of an inadequately regulated “own housing” phenomena, tenements, and slums that encroach on wetlands and forest preserves. Living in substandard housing with lead pipes and an asbestos roof has been associated with low cognitive ability and stunted physical growth among exposed children (Lidsky and Schneider 2003). In addition, pollution and allergens are commonplace in slums and are associated with asthma (Lanphear et al. 2001).

Table 5 also suggests that households in the lowest quintiles can acquire housing with more rooms if they moderate their food consumption, educational expenses, dependency

ratio, and household size. On average, households with houses that have more than one room are associated with longer life expectancy. This result emphasizes the effects of congestion on household health. Table 5 also emphasizes the benefits of electricity, finished flooring, and toilets to household health. These results are consistent when comparing households living in places other than Kampala with those in Kampala (Table 6). Important to note here is that there has been little progress in providing piped water and improving the other aspects of housing, such as walls, other than for the wealthiest households and some households living in Kampala (see Figure 17).

Concerning employment, Table 7 suggests that waged employment is associated with higher health status and a longer life expectancy. Employed households spend more on health products and have a more heightened sense of self-accomplishment. This sense of accomplishment could influence health outcomes. Table 7 also shows that employment in the government sector is associated with higher life expectancy. This higher life expectancy is likely because government jobs enhance a sense of higher purpose and stability, which could be therapeutic. Longer hours of work also have better health status outcomes. Longer hours of work are essential in an informal economy with a casualized and under-utilised labour force. Longer hours of work earn more pay and give a sense of job permanence. However, there is scope to reduce the temporary, informal, and casual nature of labour, for this may have negative impacts on health. More investigation is required.

Despite the overwhelming evidence suggesting the association between socioeconomic factors and health, exposure to these factors does not automatically translate to health outcomes. State interventions and private provision of social protection, family support, support through other social networks, and individual-specific attitudes and norms that confer resilience may reduce the impacts of social conditions on household health status. In addition, households respond differently to socioeconomic adversity. Responses vary to the same socio-environmental trigger based on genetic immunity, social capital, support systems, and initial conditions. Therefore, the associations repeatedly observed (and illustrated in Table 4 to Table 7) between socioeconomic factors and health outcomes may result from differences in resources and exposures associated with socioeconomic factors. However, subjective perceptions about social status may also be influenced by cultural constructs about social hierarchy determined by wealth, influence, and prestige (Demakakos et al. 2008). In a nutshell, relationships between socioeconomic factors and health are complex, dynamic, and interactive; they may involve multiple mechanisms, including immunity.

4. Conclusions and policy recommendations

Despite challenges, controversies, and unanswered questions, there is strong evidence that social factors are potent determinants of health in Uganda. This paper finds consistent and reproducible associations between socioeconomic factors and health outcomes among the lower quintiles of the population compared with the highest

quintile, and in other regions of the country compared with Kampala. For example, primary education has an equalizing effect between the lower and highest quintiles if we remove the confounding effects of household size and reduce the dependency rate. However, it is not surprising that primary education does not improve health status in regions other than Kampala after an additional year of primary schooling. This suggests that there may be a threshold above which primary education no longer yields better health status at the regional level. These findings call for investment in the post-primary training section. Post-primary training has a seemingly greater impact in addressing income and regional inequalities in health through the income pathway.

This study finds an association between health status and income in both comparisons. However, these effects reduce with age, household size, and dependency rates. In addition, there are disparities in food intake between the wealthiest and poorest households, and between other regions and Kampala. This calls for measures that address food insecurity in the country.

We find a positive link between housing and health across the board. However, we also acknowledge the housing deficit, which calls for partnerships and innovative approaches between the public and private sector to deliver affordable housing and related infrastructure such as electricity and piped water.

There is also a need to provide decent waged employment through balanced investments in social and economic policies to enhance skilled, technical and hands-on human resource personnel for the economy.

The observed weaknesses in the health system demand a revisiting of PHC approaches that emphasize community participation in health matters. As earlier mentioned, community participation is embedded through frameworks, policies, strategy, and planning. There is also a need to integrate health systems with other sectors to address health-seeking behaviour, the rise of NCDs, low access to health insurance, and low levels of critical health infrastructure and staffing. However, cross-sectoral collaborations face multiple barriers, including differing priorities, funding streams, and timelines across agencies. Overcoming these barriers will require a major shift in financial and political incentives. The Health Sector Working Group, nevertheless, is a good place to start these collaborations.

Lastly, we recommend that future research should focus on measuring social factors better, monitoring social factors and health relative to policies, examining the health effects of social factors across lifetimes and generations, incrementally elucidating pathways through knowledge linkages, testing multidimensional interventions, and addressing political will as a key barrier to translating knowledge into action.

References

Anderson, R. (1999). United States life tables, 1997. National vital statistics reports; vol 47 no 28. Hyattsville, Maryland: National Center for Health Statistics.

Bakeera, S. (2011). Social determinants of health care use for Ugandan children:does social capital matter? . Kampala: Makerere University.

Becker, G. (1981). A Treatise on the Family. Cambridge, Massachusetts: Harvard University Press.

Bingenheimer, J.B., Brennan, R.T., & Earls, F.J. (2005). Firearm violence exposure and serious violent behavior. Science, 308(5726):1323-6.

Braveman, P., Egerter, S. and Williams, D.R. (2011). Review The social determinants of health: coming of age. Annu Rev Public Health. 2011;, 32():381-98.

Cook, W.K., Heller J., Bhatia R., & Farhang L. (2009). A health impact assessment of the Healthy Families Act of 2009. Oakland (CA): Human Impact Partners and San Francisco Department of Public Health;.

Demakakos P,. Nazroo J,. Breeze E,. & Marmot M. (2008). Socioeconomic status and health: the role of subjective social status. . Soc Sci Med. , 67:330–40.

Kawachi I., Adler, N.E., & Dow, W.H. (2010). Review Money, schooling, and health: Mechanisms and causal evidence. Ann N Y Acad Sci. 2010 Feb, 1186():56-68.

Kayiira, D. (2020). Uganda Housing Profile. Africa Housing Finance Yearbook 2019.

Lakuma, C. K. (2017). Country Reviews of Capacity Development. Kampala: EPRC Occasional Paper. 41.

Lakuma, C.P. & Lwang, M.M. (2017). LINKING BUDGETS TO PLANS IN A CONSTRAINED RESOURCE AND THE CASE OF UGANDA. EPRC Research Series no.131.

Lanphear, B. K. (2001). Contribution of residential exposures to asthma in us children and adolescents. Pediatrics, 107(6):E98.

Lawson, D. (2004). Determinants of Health Seeking Behaviour in Uganda - Is It Just Income and User Fees That Are Important? Development Economics and Public Policy Working Papers 30553, University of Manchester, Institute for Development Policy and Management (IDPM).

Lawson, D. and Appleton, S. (2007). Child health in Uganda—Policy determinants and measurements. European Journal of Development Research, 2(2): 191–204.

Lidsky, T.I., Schneider, J.S. (2003). Lead neurotoxicity in children: basic mechanisms and clinical correlates. Brain, 126(Pt 1):5-19.

Marmot, M. and Bell, R. (2018). The Sustainable Development Goals and Health Equity. Epidemiology, Volume 29, Number 1, January 2018.

MoFPED. (2021). Budget Speech Financial Year 2021/22. Kampala: Ministry of Finance, Planning and Economic Development (MoFPED).

NPA. (2020). Third National Development Plan. Kampala: National Planning Authority (NPA), Government of Uganda.

Odokonyero, T., Mwesigye, F., Adong, A., & Mbowa, S. (2017). UNIVERSAL HEALTH COVERAGE IN UGANDA: THE CRITICAL HEALTH INFRASTRUCTURE, HEALTHCARE COVERAGE AND EQUITY. EPRC Reseserch Series No 136.

Odwee, J.J.A.O., Okurut, F.N. and Adebua, A. (2006). The determinants of health care demand in Uganda: The case Study of Lira District Norhern Uganda. African Economic Research Consortium (AERC), Nairobi, Research Paper 155.

Roberts, B., Odong, V.N., Browne, J., Ocaka, K.F., Geissler, W., and Sondorp, E. (2009). An exploration of social determinants of health amongst internally displaced persons in northern Uganda. Conflict and Health, 3: 10.

Ssewanyana, S and Younger, S.D. (2008). Infant mortality in Uganda: Determinants, trends, and Millennium Development Goals. Journal of African Economies, 17:(1): 34–61.

Ssewanyana, S. and Kasirye, I. (2012). Causes of health inequalities in Uganda: Evidence from the demographic and health surveys. EPRC RESEARCH SERIES No. 96.

UBoS. (2018). Uganda National Household Survey (UNHS) 2016/17. Kampala: Uganda Bureau of Statistics (UBoS) .

WHO. (2008). Commission on Social Determinants of Health. Closing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health. Geneva, Switzerland: World Health Organization (WHO).

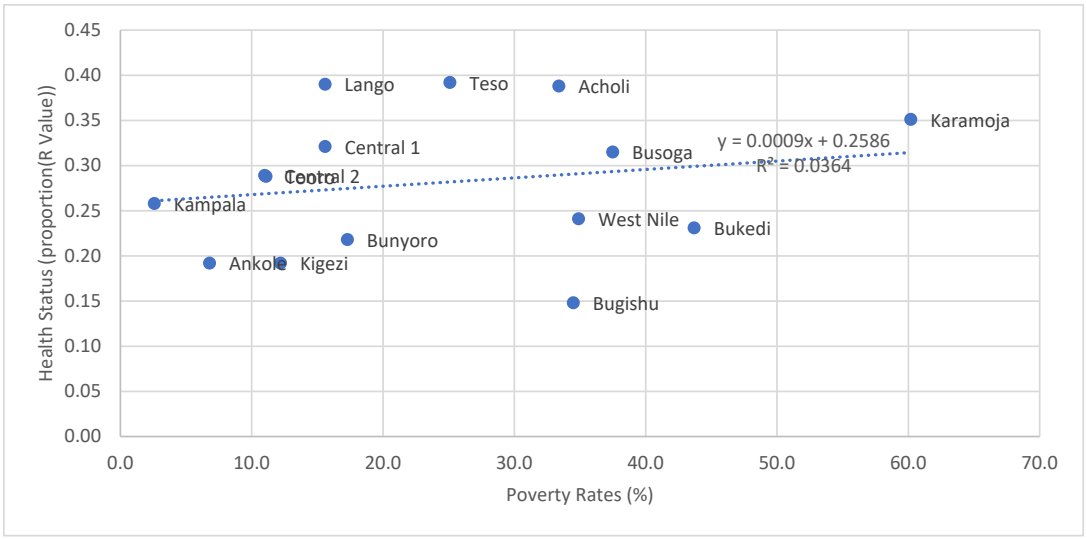
WHO. (2013). Communicating the economics of social determinants of health and health inequalities. . World Health Organization (WHO).

WHO. (2013). Integrating social determinants in all public policies: the case of health development in Botswana. World Health Organization (WHO).

Appendices

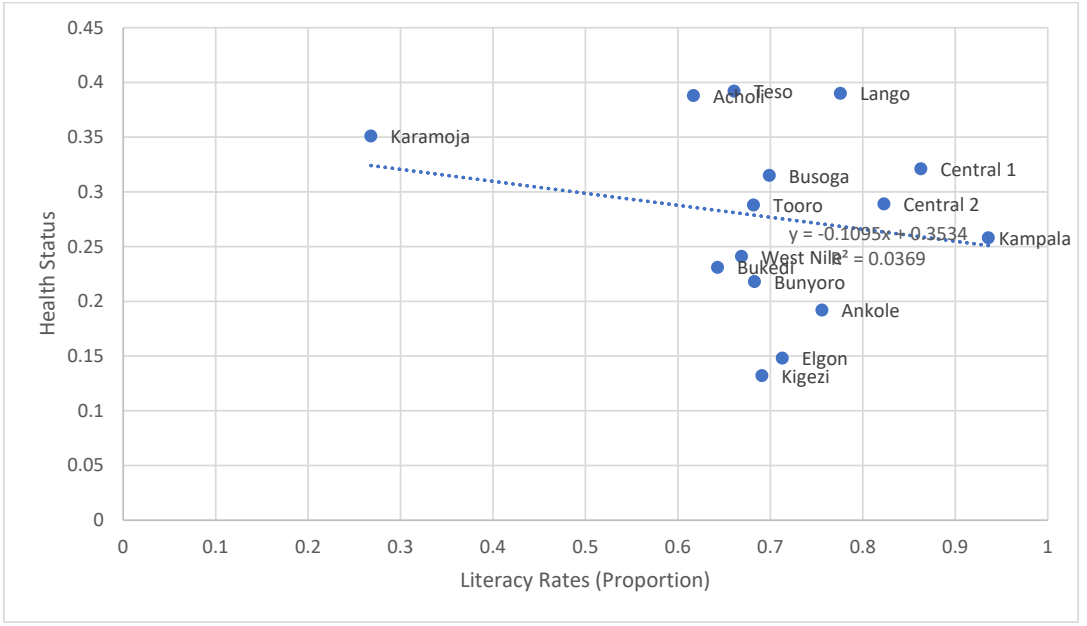
Appendix A: Figures

Figure 12: Correlation between proportion of poor persons and self-reported health status



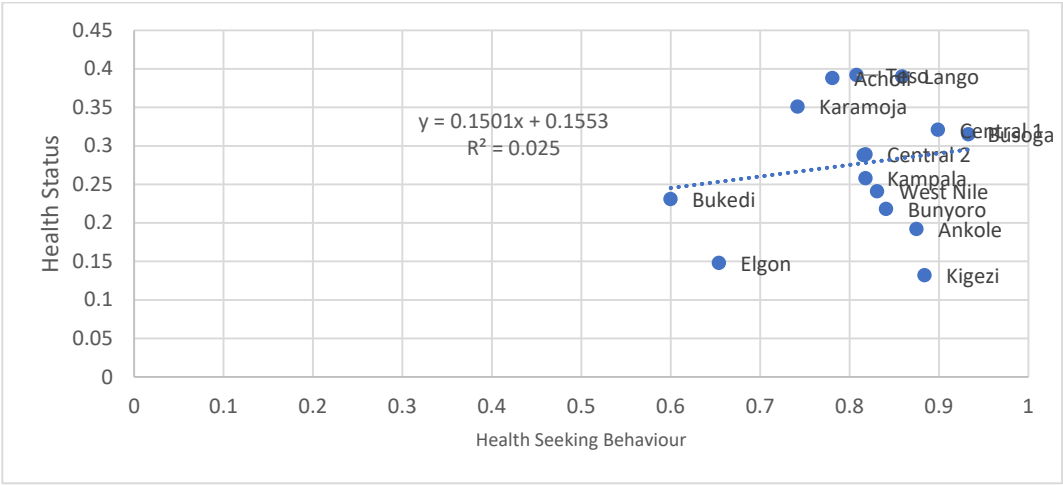
Source: Author's construction using UNHS 2016/17

Figure 13: Correlation between proportion of literate adults and self-reported health status



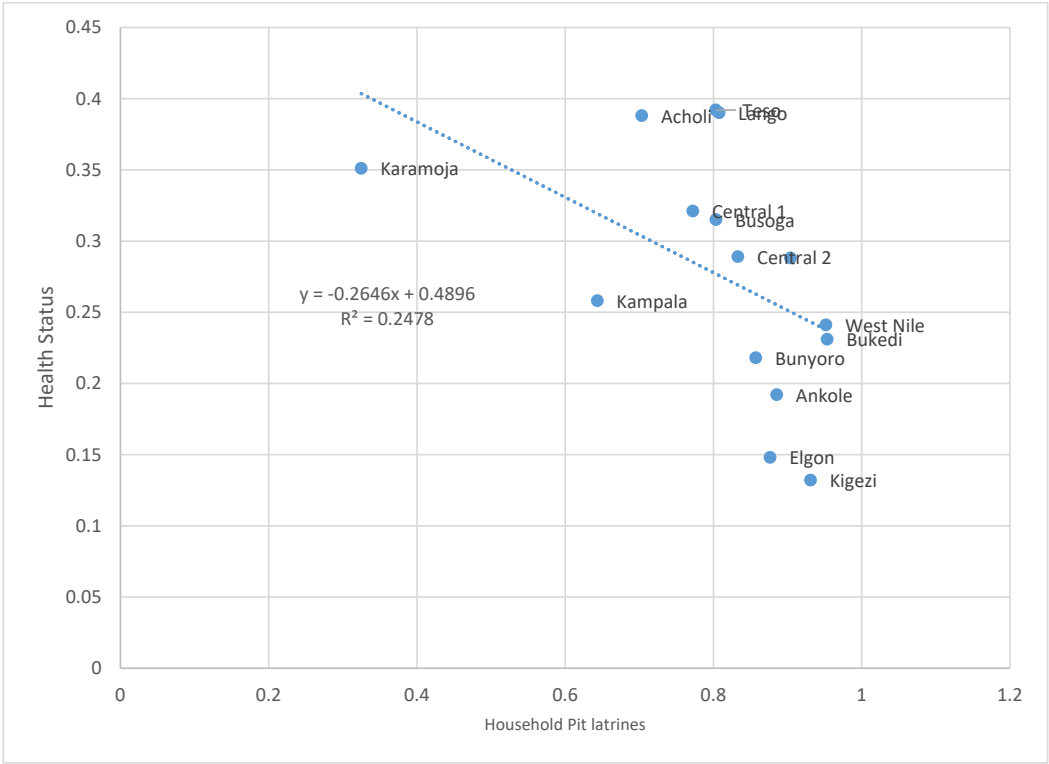
Source: Author's construction using UNHS 2016/17

Figure 14: Correlation between proportion of health-seeking persons and self-reported health status



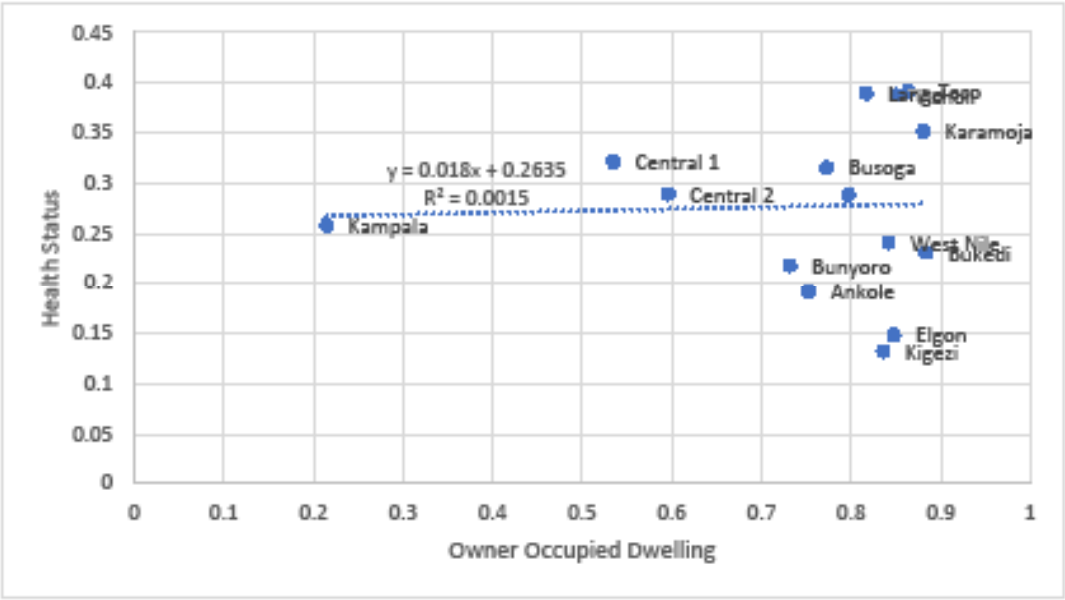
Source: Author's construction using UNHS 2016/17

Figure 15: Correlation between households with pit latrines and self-reported health status



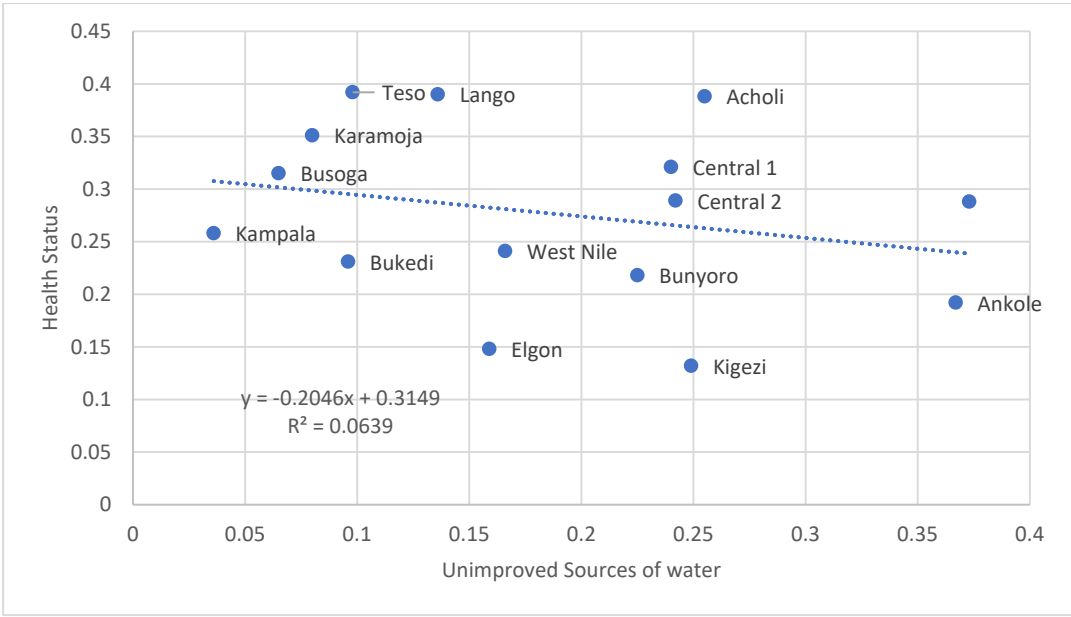
Source: Author's construction using UNHS 2016/17

Figure 16: Correlation between proportion of persons with owner-occupied dwelling and self-reported health status



Source: Author's construction using UNHS 2016/17

Figure 17: Correlation between proportion of households that use water from unimproved sources and self-reported health status



Source: Author's construction using UNHS 2016/17

Appendix B: Determinants of Health Status Theoretical Model

The analysis of determinants of health status is based on a household model in which household members maximize welfare where health status is one of the main arguments (Becker, 1981; Singh et al., 1986). In this model, a household's welfare function is determined by individual utilities, and the welfare function takes the form.

$$1\ W\left(U_m^M, U_d^D, \ldots, U_a^1, \ldots . U_a^J\right)$$

Where U_i indicates individual utility function; i = 1,..., n represents household members who include a household head (i = M)—assumed to be a provider; D are other adults; and i = 1,...J are household members. The individual utility is a function of a healthy economy and health system this is represented as:

$$2\ U^i = U(H, X, T_L)$$

Where H represents a vector of health status; X is a healthy economy, and T_L is healthcare available to each individual. In this framework, the health status depends on a healthy economy and health system. Therefore, the health status function is given by:

$$3\ H_a^i = H\left(C^i, X_N^i; \xi, \Omega\right)\ i = 1, \ldots, J$$

Where C^i is the benefits accruing from a healthy economy to the ith household; X_N^i represents health and other services consumed; ξ are the household's own characteristics, for example, household size and dependency; and Ω are the characteristics of a healthy economy that can impact on health, for example, access to safe water and housing. The quality of life received by each household depends on inputs such as health system, employment, education, and housing. The quality of life function can be expressed as:

$$4\ C_i = C\left(H_h, T_c^i; E^h, \Omega\right)$$

where H_(h)is the health status of household; T_c^i status of facilitation made to have an healthy economy; E^his the education attainment; and Ω as before represents all other factors that affect health status, for example, access to health infrastructure and employment. However, health status of the household is also a function of a healthy economy, which is characterized by the consumption of food and non-food goods, health services, and community characteristics.

$$5\ H_m = H\left(C^h, X_N^h; \xi^h, \Omega\right)$$

Appendix C: Regression Tables

Table 4: Comparison of Ugandans in the lower quintiles (1-4th) to the highest quintile (5th)

	Other Regions	Kampala	Lower Quintile (Q1 –Q4)	Highest quintile (Q5)
Household Characteristics				
Sex	0.39***	0.46	0.45*	0.48
Age	24.42***	27.24	27.12***	20.19
Marital Status	3.23*	2.88	2.80**	7.00
Household Size	4.57***	3.93	4.03***	5.87
Dependency Ratio: All	0.85***	0.80	0.85***	0.43
Dependency Ratio: Children	0.81***	0.77	0.82***	0.36
Education				
Literate	0.57***	0.93	0.92***	0.96
No Education	0.07***	0.03	0.02***	0.03
Completed Primary	0.53	0.80	0.78***	0.71
Completed Post-Primary Training	0.05	0.16	0.15***	0.25
Completed O-Level	0.17***	0.44	0.40***	0.59
Completed A-Level	0.07***	0.27	0.24***	0.40
Completed Post-Secondary Training	0.03	0.09	0.08***	0.14
Completed University	0.01***	0.11	0.09***	0.13
Employment				
Current Student	0.21***	0.17	0.18***	0.38
Unemployed	0.04**	0.07	0.06***	0.01
Discouraged Worker	0.10***	0.13	0.14***	0.04
NEET	0.36***	0.30	0.32***	0.15
Wage Employee	0.30***	0.36	0.33***	0.42
Temp. Worker	0.23	0.25	0.26	0.22
Hours Worked	42.09***	52.15	48.64***	31.31
Has Written Contract	0.15***	0.32	0.34**	0.47

	Other Regions	Kampala	Lower Quintile (Q1 –Q4)	Highest quintile (Q5)
Government Sector	0.02	0.04	0.05***	0.06
Private Sector	0.97	0.95	0.95***	0.97
Paid Leave	0.08***	0.24	0.24**	0.27
Sick Leave	0.13***	0.29	0.28***	0.31
Social Security	0.04***	0.17	0.17**	0.18
Operates Business	0.11	0.18	0.18***	0.09
Business Keeps Accounts	0.15	0.21	0.18***	0.22
Unstable Income	0.51**	0.67	0.47***	0.58
Registered Business	0.12	0.23	0.21**	0.23
Has Official Documentation	0.11	0.27	0.27***	0.31
Wealth				
Earnings in Past Month(10000)	14***	36.00	31.24	43.85
Total Asset Value (10000)	2433.00	2662.00	2432.74	3317.84
Total Cons. per Adult Equiv. (10000)	13***	18	17.09***	20.07
HH Cons. per Adult Equiv. (10000)	13***	18	17.29***	20.08
Food Cons. per Adult Equiv. (10000)	10***	19	12.42***	7.97
Housing				
Live in Public Housing	0.05**	0.04	0.04***	0.02
Number of Rooms for Sleeping	1.92***	1.78	1.86***	2.29
Shared Toilet	0.56***	0.48	0.57***	0.34
Electricity from Grid	0.32***	0.55	0.49***	0.69
Piped water	0.17**	0.32	0.26***	0.41
Finished Walls	0.68***	0.82	0.78***	0.81
Finished	0.59***	0.77	0.72***	0.88

	Other Regions	Kampala	Lower Quintile (Q1 –Q4)	Highest quintile (Q5)
Floors				
Perception about self and community				
Want to Change Work Situation	0.44***	0.55	0.50***	0.32
Job Satisfaction: 1-4	2.41**	2.34	2.31	2.34
Victim of Any Crime	0.24	0.26	0.29	0.28
Health system				
Doctor Consultation	1.00	1.00	1.00	1.00
Private Hospital Attendance	0.00	0.00	0.00	0.00
Attends Govt. Office	0.00	0.00	0.00	0.00
Distance to Hospital <5 KM	0.00	0.00	0.00	0.00
Distance to Hospital >5 KM	0.00	0.00	0.00	0.00
Health Insurance Coverage	1.00	1.00	1.00	1.00
suffers Diabetes	0.00	0.01	0.01	0.01
Suffers HBP	0.02***	0.03	0.03	0.03
Heart Disease	0.01*	0.01	0.01***	0.02
Health Status	0.57***	0.59	0.61	0.33
Health related problems	0.01	0.01	0.01	0.01

Table 5: LMP of health outcomes by socioeconomic definitions and by comparison with the highest income quintile

	(1) Health Status	(2) Health Status	(3) Health Status	(4) Life Expectancy
HH characteristic				
Sex	-0.109***	-0.0956***	-0.0865***	
	(0.0207)	(0.00894)	(0.00988)	
Age	0.00295***	0.00365***	0.00347***	
	(0.000901)	(0.000317)	(0.000365)	
Marital Status	0.000633			
	(0.00816)			
Household Size	-0.00350			
	(0.00535)			
Dependency Ratio: All	0.0557			
	(0.0600)			
Dependency Ratio: Children	-0.0711			
	(0.0622)			
Education				
Literate	-0.0158			
	(0.0256)			
Completed Primary	0.0644***		-0.0181*	
	(0.0229)		(0.0102)	
Completed Post-Primary Training	-0.0522			
	(0.0414)			
Institutional				
Registered Business	-0.0445			
	(0.0347)			
Has Official Documentation	-0.0170			
	(0.0342)			

	(1)	(2)	(3)	(4)
Wealth				
Earnings in Past Month	6.06e-08***	-1.63e-08***	-1.38e-08***	
	(2.33e-08)	(4.72e-09)	(4.96e-09)	
Total Asset Value	-7.13e-10**	1.09e-11	-2.86e-11	
	(3.45e-10)	(9.48e-11)	(9.47e-11)	
Total Cons. per Adult Equiv.	-0.000000671			
	(0.00000409)			
HH Cons. per Adult Equiv.	0.00000100			
	(0.00000408)			
Food Cons. per Adult Equiv.	-0.000000611**	0.000000177**	0.000000249***	
	(0.000000259)	(8.09e-08)	(8.65e-08)	
Housing				
Live in Public Housing	-0.123*	-0.0649*	-0.0645*	-0.0539
	(0.0673)	(0.0364)	(0.0380)	(0.0421)
Number of Rooms for Sleeping	0.00816	-0.00799*		0.0153***
	(0.0117)	(0.00435)		(0.00569)
Shared Toilet	0.0476**	0.0475***	0.0496***	0.0257*
	(0.0216)	(0.00999)	(0.0104)	(0.0146)
Electricity from Grid	-0.0851***	-0.0593***	-0.0545***	0.0365*
	(0.0304)	(0.0150)	(0.0158)	(0.0219)
Piped water	0.0358			0.0290
	(0.0369)			(0.0246)
Finished Walls	-0.0677***	-0.0618***	-0.0635***	0.0387**
	(0.0261)	(0.0116)	(0.0125)	(0.0167)
Finsished Floors	-0.0680**	-0.0420***	-0.0411***	0.00827
	(0.0284)	(0.0134)	(0.0143)	(0.0188)
Perception				
Want to Change	0.0877***	0.0902***	0.0750***	

	(1)	(2)	(3)	(4)
Work Situation				
	(0.0231)	(0.0103)	(0.0102)	
Job Satisfaction: 1-4	-0.0179	-0.0208***		
	(0.0126)	(0.00543)		
Victim of Any Crime	0.105***	0.0858***	0.0929***	
	(0.0211)	(0.00985)	(0.0106)	
Observations	2499	11682	10101	70223
R^2	0.049	0.039	0.035	0.000

Notes: Marginal effects, standard errors in parentheses, for discrete change of dummy variable from 0 to 1 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 6: LMP of health outcomes by socioeconomic definitions and by comparison with Kampala

	(1) Health Status	(2) Health Status	(3) Health Status
HH characteristic			
Sex	-0.114***	-0.109***	-0.109***
	(0.0199)	(0.0207)	(0.0207)
Age	0.00244***	0.00295***	0.00295***
	(0.000859)	(0.000901)	(0.000901)
Marital Status	0.00416	0.000633	0.000633
	(0.00795)	(0.00816)	(0.00816)
Household Size	-0.00542	-0.00350	-0.00350
	(0.00435)	(0.00535)	(0.00535)
Dependency Ratio: All	0.0526	0.0557	0.0557
	(0.0589)	(0.0600)	(0.0600)
Dependency Ratio: Children	-0.0649	-0.0711	-0.0711
	(0.0609)	(0.0622)	(0.0622)
Education			
Literate	-0.0174	-0.0158	-0.0158
	(0.0244)	(0.0256)	(0.0256)
Completed Primary	0.0478**	0.0644***	0.0644***
	(0.0224)	(0.0229)	(0.0229)

	(1) Health Status	(2) Health Status	(3) Health Status
Completed Post-Primary Training	-0.0521	-0.0522	-0.0522
	(0.0411)	(0.0414)	(0.0414)
Institutional			
Registered Business	-0.0569*	-0.0445	-0.0445
	(0.0345)	(0.0347)	(0.0347)
Has Official Documentation	-0.0222	-0.0170	-0.0170
	(0.0338)	(0.0342)	(0.0342)
Wealth			
Earnings in Past Month	5.09e-08**	6.06e-08***	6.06e-08***
	(2.30e-08)	(2.33e-08)	(2.33e-08)
Total Asset Value	-7.63e-10**	-7.13e-10**	-7.13e-10**
	(3.37e-10)	(3.45e-10)	(3.45e-10)
Total Cons. per Adult Equiv.	0.00000161	-0.000000671	-0.000000671
	(0.00000358)	(0.00000409)	(0.00000409)
HH Cons. per Adult Equiv.	-0.00000130	0.00000100	0.00000100
	(0.00000357)	(0.00000408)	(0.00000408)
Food Cons. per Adult Equiv.	-0.000000603**	-0.000000611**	-0.000000611**
	(0.000000254)	(0.000000259)	(0.000000259)
Housing			
Live in Public Housing		-0.123*	-0.123*
		(0.0673)	(0.0673)
Number of Rooms for Sleeping		0.00816	0.00816
		(0.0117)	(0.0117)
Shared Toilet		0.0476**	0.0476**
		(0.0216)	(0.0216)
Electricity from Grid		-0.0851***	-0.0851***

	(1) Health Status	(2) Health Status	(3) Health Status
		(0.0304)	(0.0304)
Piped water		0.0358	0.0358
		(0.0369)	(0.0369)
Finished Walls		-0.0677***	-0.0677***
		(0.0261)	(0.0261)
Finished Floors		-0.0680**	-0.0680**
		(0.0284)	(0.0284)
Perception			
Want to Change Work Situation		0.0877***	0.0877***
		(0.0231)	(0.0231)
Job Satisfaction: 1-4		-0.0179	-0.0179
		(0.0126)	(0.0126)
Victim of Any Crime		0.105***	0.105***
		(0.0211)	(0.0211)
Observations	2653	2499	2499
R^2	0.025	0.049	0.049

Notes: Marginal effects, standard errors in parentheses.

Table 7: Market performance by stratum—health status vs. life expectancy

	(1) Wage Employee	(2) Government Sector	(3) Has Written Contract	(4) Log Earnings in Past Month	(5) Hours Worked
main					
Life Expectancy	0.369***	0.457**	0.103		
	(0.0502)	(0.186)	(0.129)		
Health Status	-0.0834***	0.0870	-0.0167	-0.175	-4.117***
	(0.0319)	(0.0860)	(0.0949)	(0.107)	(0.532)
Observations	18494	15838	2841	18510	15837

Notes: Marginal effects, standard errors in parentheses, for discrete change of dummy variable from 0 to 1 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Recovery and Resilience in a Post-Pandemic Uganda

Wamala Edward

Introduction

Karl Popper (1902-1994), in his magnum opus The Logic of Scientific Discovery (1959), conceptualises problems as starting points for new ways of thinking, theorising, experimenting, and constructing new forms of knowledge. Climate change, leading to drought and hunger, or floods and displacement; war leading to poverty, death, and impoverishment; economic turbulence leading to inflation, trade deficits, and unemployment, etc., are all so many different problems that spur us to look for solutions, theories, and new knowledge, as old forms of knowledge become dysfunctional in the face of new, complex, and complicated challenges.

This paper focuses on the Coronavirus Disease of 2019 (COVID-19), a pandemic whose reach and impact may be similar in proportion to climate change and war, a problem that, as scientists are starting to fear, may be with us for a considerable span of time, like HIV/AIDS has been and the effects of climate change may be. The emerging fears raise a question, namely, can we meaningfully talk of recovery and the post-pandemic when we do not know when the end will come? Is it rational to think about recovery when we are likely to be locked in a protracted struggle with the pandemic as the virus mutates? Besides, how do we know that resilience will be the most rational approach to deal with the pandemic during its course and after?

A key issue as we progress through the pandemic is recovery from the stresses, destruction, loss, and bereavement that have affected nearly every segment of life. In the economy, many businesses have been stressed (and some collapsed), resulting in job losses and unemployment. In the socio-cultural sphere, social gatherings like weddings, funerals, prayers, clan and family meetings, etc., have been restricted, and in some cases (like beer parties) banned. Even when allowed, participants had to observe social distancing and a host of other SOPs. Until January 10th, 2022, schools were closed, and although a few urban students were able to study online, for many others—especially those of rural and poor backgrounds—there has been no study for close to two years. The question we are trying to raise in this paper is how shall we move forward, and what will it take for individuals, communities, and the larger society and global community to pull ourselves up together, step over what has happened, and move on? And are we being overly ambitious when we talk about stepping over what has happened and moving on?

There is a risk of dealing simplistically and in a shallow and superficial way with a problem whose magnitude, extent, and implications are far reaching and deeper than we have hitherto fathomed. First, except for the HIV/AIDS pandemic, which

has for over thirty years been a global health hazard, we do not have a precedent (in living memory) of a health hazard of the magnitude of COVID-19. HIV/AIDS fades in magnitude when compared with COVID-19, because its mode of transmission has a lot to do with personal behaviour and deliberately chosen or as is sometimes the case, culturally determined lifestyles. COVID-19 also has much to do with personal behaviour—whether individuals follow SOPs like physical distancing, masking, and vaccinating. But when these personal elements have been appreciated for what they are worth, there is much about COVID-19 that is beyond personal control. With HIV/AIDS, we know for instance that unprotected sex will result into contracting the disease. But with COVID-19, we are dealing with a far more invincible hazard to the extent that even after all SOPs have been observed there is no assurance that we are safe. Even after vaccination, we are called upon to take more jabs! What this all boils down to is that with COVID-19 we have a new health threat without precedent

The lethal nature of COVID-19 apart, there is the equally unfathomed impact of the pandemic on other diseases, which proliferated as medical experts focused on COVID-19, leading us to ask how much did other diseases proliferate because of the pandemic? In their paper titled Long-term Cardiovascular Outcomes of Covid-19, Yan Xie et al. (2020:1) note that "…the cardiovascular complications of acute corona virus disease 2019 (Covid-19) are well described, but the post-acute cardiovascular manifestations of Covid-19 have not yet been comprehensively characterised." That statement from experts points to possibilities of serious problems emerging in the future, but which we have not yet fully fathomed. COVID-19 negatively impacted people who had had previous heart-related diseases and diabetes. What will happen in the future to those who had those conditions but somehow recovered from COVID-19? Only research will tell. As for now, we do not know how things are going to unfold.

What Yan Xie and colleagues are raising is part of a complex scenario unfolding. The more sobering aspect of the COVID-19 dialectic is that we are reflecting on a pandemic whose end is not yet in sight. A realisation starting to emerge is that we may have to live with this pandemic like we have learnt to live with HIV/AIDS. In this context, our reflections emphasise not so much the recovery (as recovery assumes an end to the pandemic and a new start—the recovery phase); rather, emphasis is on resilience—adapting and learning to live with the new challenge.

Recovery: A Historical Perspective

This is not the first time we have talked of recovery in Uganda. We engaged in spirited discourse on the issue from 1987 up to 1991 in the wake of the 1980-85 Luwero Triangle civil war. Among the major works that came out of those reflection were: Wiebe D. Paul and Cole. P. Dodge (Eds.) (1987), Development Issues in Uganda: Beyond Crisis; Holer Bernt Hansen and Michael Twaddle (Eds.) (1988), Uganda Now; Kumar Rupesinghe (Ed.) (1989), Conflict Resolution in Uganda; and Holer Bernt Hansen and Michael Twaddle (Eds.) (1991), Changing Uganda.

The 1987/88 recovery discourse was an attempt to take stock of what had happened, to recover, and to reconstruct the economy. At that time, there was no allusion to resilience because the disruptions suffered had been largely precipitated by political mistakes and economic brinksmanship. The thinking then was that once proper governance structures and rational economic policies had been instituted, recovery and reconstruction would smoothly get underway. Coming out of the late 1980s discourse was the Uganda Constitutional Commission, set up in 1989 to develop a new constitution, and eventually the 1995 Constitution and the establishment of economic, human rights, governance, and several other institutions to correct ills the country had previously suffered. It was believed that extant problems were the result of political, institutional, economic, and legislative failures, and that if these could be fixed reconstruction and recovery would be possible.

In the wake of the COVID-19 pandemic, we are again talking about recovery. But this time, there is an additional element not raised in the recovery and reconstruction phase—namely, resilience. Historically, the concept resilience was first mooted in the United Nations Report of the Open-ended Intergovernmental Expert Working group on indicators and terminology relating to disaster risk reduction, where it was defined as:

> The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservations and restoration of its essential basic structures and functions through risk management (United Nations General Assembly, 2016:22).

The Sendai Framework for Disaster Risk Reduction 2015-2030, which was the basis on which the United Nations Report cited above was based, was itself informed by risks associated with climate change leading to food scarcity and human habitant insecurity (owing to floods, landslides, etc.). Emphasis was on preservation and restoration of basic structures and functions of the system or community. In the context of housing units, preservation would mean building structures resistant to weather vagaries. Or, if they are destroyed, simply rebuilding them. In cases of food shortage, resilience could mean ensuring that food varieties resistant to drought would be recommended to farmers. And in the event of drought leading to hunger, then state actors would be readily available to provide and distribute food to those in need.

But the Sendai definition is one among many. The American Psychological Association broadens the definition of resilience to "the process of adapting well in the face of adversity, trauma, tragedy, threats, or significant sources of stress—such as family and relationships problems, serious health problems, or workplace and financial stressors. It means bouncing back from difficult experiences (APA, n.d., Section 2, Paragraph 4)." This definition has been neatly reconceptualised by George Bonano, who has summarised resilience as "a stable trajectory of healthy functioning after a highly adverse event (2014:2)." In this paper, we appropriate Bonanno's definition.

Globalisation and Pandemics

The COVID-19 pandemic, the focus of this paper, is not the first large-scale health hazard to face humankind. The Justinian Plague of 541, which started in Egypt and spread to Europe, Asia and North Africa, was estimated to have killed between 30-50 million people (Horgan, 2014). The next large-scale recorded disease outbreak was the Black Death in the mediaeval period, around 1347, which killed approximately 20 million people (History.com Editors, 2010). The third was the Plague of London in 1667 which killed about 100,000 people (Sloan, 1973). Then came smallpox, which devastated millions and is said to have been used as a biological weapon. It was especially devastating when European travellers to the New World of the Americas transmitted the disease to indigenous communities, who died in their tens of thousands because they did not have the natural immunity that Europeans had acquired. Finally, cholera, which originated in India's Ganges delta, has killed millions across many continents (WHO, 2021; Barua, 1992). According to the Editors of History.com, "the disease came to prominence in the 19th century when a lethal outbreak occurred in India. There have since been numerous outbreaks and seven global pandemics of cholera (2017:1)."

What all the different disease outbreaks have in common is that their modes and extent of spread were a function of extant travel and communication technologies. The Black Death, spread by fleas that were carried by rats, was first experienced in the port cities of Europe and followed the path that cargo from the ports took. Smallpox, which broke out when explorers flocked to the New World, followed the path of the colonialists. Both HIV/AIDS and COVID-19 have brought to the fore a new element. Namely, infectious disease outbreaks in a globalised world. What has especially changed is the speed and reach of disease outbreaks, and the nature and extent of the coordinated global responses.

Lessons So Far About the Pandemic and Resilient Ways to Cope

The pandemic is not yet over and according to some health experts, we may have to learn to live with it longer than we had anticipated. Again, this is not new. Over the years, we have learnt to live with yellow fever, cholera, and more recently HIV/AIDS. Learning to live with COVID-19 means, first and foremost, integrating the COVID-19 SOPs—washing hands, masking, and desisting from close bodily contact with others—all become part of our daily activities and culture. Vaccination ceases to be a mass campaign issue, and instead becomes a regularised exercise administered at regular intervals as recommended by medical experts.

We pointed out in the introduction that COVID-19 has afflicted nearly every sector of the economy. For the purposes of this paper, we are focusing on the effects of COVID-19 on the girl child, and resilient ways for her to move forward and cope. We look further

at the economics of COVID-19 treatment, and again make some recommendations on resilient ways to cope. In all these cases, we have raised the problematics, and also recommended ways affected parties can meaningfully move forward.

The Health of the Girl Child in the Covid-19 Era: Resilient Ways to Cope

We are picking on the girl child because she, more than any other category, has suffered most severely because of the prolonged stay out of school that was occasioned by the COVID-19 outbreak. Richard Kabanda (2021:13), in his article titled *Rise in Teenage Pregnancy: Is it Effects of Covid-19?*, has reported that:

> The emergency measures and realities resulting from the pandemic expose women and other vulnerable groups to negative impacts such as the rise in maternal mortality rates, challenges in accessing sexual reproductive health services, domestic violence, gender-based violence and escalating teenage pregnancies… Before Covid-19, there were 98 million girls worldwide who were not in school and research conducted by the Malala Fund estimates that a further 20 million secondary school-age girls could be out of school after Covid-19 crisis has passed. Concerning health, adolescent pregnancies are associated with a higher likelihood of death due to childbirth complications. Similarly, many people have indicated that lack of support and guidance to the young people has left many young girls vulnerable to teenage pregnancy, gender-based violence and early marriages. The rise of teenage pregnancies registered during Covid-19 has implications for healthcare and the aspirations of the adolescents affected.

The global picture highlighted above has not spared the Ugandan girl child, many of whom have become mothers, and others still pregnant and out of school. Traditionally, the girl chid was not given equal opportunities (as the boy child) in matters of education, because it was assumed that whether educated or not her destination was home making and raising children. Even as western feminist influences have changed that thinking, many girls still do not go to school, and many of those who did dropped out for a host of reasons: entrenched family preferences for the education of boys, poor and sometimes non-existent sanitary facilities in schools, teenage pregnancies that were criminalised in the traditional religious environment. And we should also not forget that the girl child can easily be thrown out of school if she was suspected of being involved in some sexual relationships.

The unfortunate pattern recounted here has been compounded by the COVID-19 lockdown that saw many teenage girls (some as young as 12 years old) drop out of school because they had become mothers or were soon to be, and in some cases because they were impregnated by close family associates or relatives. That development has had several health and social ramifications that need to be carefully thought through. First, as soon as they get pregnant, they immediately face ostracism as families look at them as a disgrace to be banished or married off, facing hardships and abuses that have been extensively documented.

But social ostracism and consequent abuses are the lighter side of a grim picture. There are also physical dangers such as fistula and uterine ruptures that child mothers are likely to experience because of their immature bodies performing tasks that they are not ready for. Their future economic prospects also become grim if they do not continue with any form of education (Govender et al., 2020).

The fate of pregnant girls and child mothers attracted public attention, and as schools opened the government issued guidelines to allow them back to school to pick up where they had stopped. This policy shift away from dismissing pregnant girls and child mothers from school is a classic instance of a resilient strategy to deal with a challenge that COVID-19 has wrought to some of the most vulnerable members of society—the girl child. For that guideline to be fully realised, teachers, school administrators, and school governors were all sensitized, and even fellow students were taught about the new development.

There were some misgivings about the guideline, as it needed resource support so that schools could have breastfeeding spaces, and even babysitters because in some cases (for example, during experiments or examinations), they would be needed. There were others whose misgivings were ethical, arguing that allowing pregnant girls back to school would look like giving a licence for other girls to seek casual sex and suffer related consequences. Both arguments were rational and incontestable. But to look at the matter that way and to advance those arguments would be to miss a very important point: namely, that the guideline was a progressive and resilient way to handle a challenge that COVID-19 has wrought to the girl child.

Problems of implementation and resource mobilisation are valid concerns, but a distinction has to be made between the rationale of the guideline and the resources needed to effect it. The important point, at least from a human rights point of view, and from the perspective of developing resilient frameworks for coping with the pandemic, is that an accommodating strategy to move forward had to be made. The alternative of leaving child mothers and pregnant girls out in the open, was likely to be more expensive in terms of health and education costs than accommodating them in school environment. The guideline could be progressively improved, but a start has been made. As a resilient strategy to deal with the problems of the girl child, we can sum up the advantages as follows:

First, the guideline is going to help the girl child to not hide away from society, but rather to confront her fears more constructively. By a constructive engagement with her fears, I mean that instead of seeking unsafe abortions, for example (which has been a common practice for many teenage girls who get pregnant and yet want to continue their schooling), they will be able to continue and save their lives, which would otherwise be in danger if they were to tamper with their pregnancies in some crude way.

Second, there is a sense in which allowing pregnant teenage girls back to school helps them to mature, and to know that life will always throw challenges at them. The lesson here is that when challenges come, there can be some rational way they can be met, and solutions that can be sought. Pregnancy is not fatal, or a source of societal ostracism, but is instead an aspect of the complex nature of life and of growing up generally.

Third, when a pregnant girl or child mother is in the public view—that is, at school—whatever happens to her can be easily monitored and help and support more easily mobilised than if she were to be left alone and incognito in the larger community. NGO help will be easier to mobilise when girls are in an institutional setup and accessible environment, than if they were on their own in the countryside. Services like antenatal care and related health support will also be easier to organise for teenage girls in school than when they were out. School nurses have traditionally checked girl children (for pregnancy) when they come back from holidays, and their motives were always invariably to identify the "culprits," and eject them from school. The policy is now turning full circle, and a pregnant girl will only be identified so that she can be assisted with medical support. This will of course require school support, but we have noted that teachers were already sensitised about child mothers returning to school. Now, the task of mobilising resources to support these mothers must start.

Fourth, whatever additional knowledge they get in school will not only be valuable to mothers, but to babies as well. The saying "when you educate a woman you educate a nation" gets renewed impetus as schools now deal with mothers who were on the verge of a descent into the abyss. The presence of teenage mothers in schools will likely accelerate the need for sex education, which for cultural reasons has been rejected, ignored, downplayed, and hushed away. Parents can now see that if their children have had sexual education, they would have possibly been more informed and better prepared for the challenges they were to meet along the way. As earlier pandemics led to the development of different forms of practice, we can see COVID-19 enabling new leases on life for pregnant girls and child mothers that have been closed since the inception of schooling in Uganda.

Costs of Health Care in the Covid-19 Era and Beyond

The fate of the girl child apart, the high costs of medical care have been compounded by the COVID-19 pandemic. Since the economic restructuring of the economy at the insistence of the IMF and the World Bank, government has withdrawn from several public service delivery systems and left them to private actors, health being one of them. According to the Privatization Process and its Impact on Society (2001:2), it is stated that:

> Since 1993, the objectives of PERD (Public Enterprise and Reform and Divestiture) have been to reduce the role of the public sector and to promote the development of an efficient market-led private sector. The overall goal is to improve the

> performance of the remaining public sector enterprises, and to reduce the financial burden of PEs upon the treasury and to generate revenues from privatization proceeds (Ddumba & Mugume, 2001:2).

Of all East African states, Uganda went to the farthest extreme of privatizing economically strategic enterprises like the Uganda Commercial Bank, Uganda Airlines, and the Coffee Marketing Board. Private actors have invested in schools, hospitals, the transport sector, etc. While these developments led to some efficiency gains and increased the number of small- and medium-scale enterprises in the economy, national interests have not been served by the divesture. Kenya also liberalised and privatized, but they did so scientifically, by floating shares on the stock exchange so that enterprises like Kenya Airways have remained functional, while Uganda Airlines is only now resurrecting itself. The Kenya Commercial Bank operates in up-country towns in Uganda, while the Uganda Commercial Bank remains in limbo. The former national transport company Uganda Transport Company has been replaced by *matatus* and *boda bodas*.

While the state kept the major national hospital at Mulago, and in some other districts, the same government through its privatization and liberalization programme allowed private actors to enter in essentially unlimited numbers. In this regard, public officers have been incentivized to manage public enterprises while also running private businesses on the sides. Head teachers, for example, head government schools but also oversee the operations of their own private schools. Medical doctors serve in public hospitals, but also run private clinics in the precinct of the major hospitals where they officially work. While this arrangement has worked for many years without serious challenges, the COVID-19 outbreak has raised many issues that have compounded an otherwise complicated affair. The anti-climax was the setting up of a private pharmacy within the major public referral hospital at Mulago.

A report about privatizations in Uganda pointed out that, "Although the government view is that privatization policy has had a positive impact on the economy in terms of increased output, tax revenue and employment levels, the public's perception about the privatization process seems to be mixed (Ddumba & Mugume, 2001:2)." We are here quoting a dated report, but what was expressed then is still the same perception today. The reasons why the public has mixed perception of the privatization drive are obvious but have come out most prominently during the pandemic when medical costs have become a nightmare.

The facts of the case are clear: first, at the height of the pandemic, the cost of COVID-19 treatment became prohibitive, often shooting up as high as $20,000 for a patient lucky to be admitted to the intensive care unit (ICU). That figure would be outrageous for even the well off, meaning that for the ordinary Ugandan it was completely out of reach. Costs were that prohibitive because, in a privatised and liberalised environment, business actors will only invest in items or commodities and services that promise

quick returns on their investments. Items like oxygen and gas cylinders that are key components in CVODI-19 treatment but are not ordinarily in high demand on the Ugandan market. COVID-19 broke out at a time when supplies were limited, and the sudden surge put pressure on available resources to meet skyrocketing demand. These pressures necessitated extra orders, often at heavily inflated prices.

Hiring doctors to manage patients in intensive care units was equally expensive because they were few in the face of spiralling demand. And intensive care beds fully equipped for COVID-19 patients were also few, again for the same economic reason—namely, that in ordinary "peacetime" demand for them is limited, and investors will only invest if they were sure to realise a return on their investment. The fact that there were no known drugs for the treatment of COVID-19 meant that doctors had to look around for possible cures, adding to the costs of treatment and further complicating an already complex situation. Emergency costs were in addition to the regular costs of running hospitals and health facilities, like the payment of utility bills such as electricity and water, along with taxes and ground rents to local authorities.

So far, we have focused on patients who contracted COVID-19 and went to health facilities. But there were many others who for economic or other reasons could not access such services as recommended by health professionals, or who thought they could handle the ailment better by using herbal medicines and concoctions. Resorting to herbal medicine in the face of new disease outbreaks is not new. When HIV/AIDS struck in the early 1980s we scampered around with no known cure, as patients sought reprieve from charlatans who recommended soil concoctions as a cure. Nanyonga of Ssembabule district is on record for the soil concoction. But why do people in the situations described here resort to unknown concoctions? There are several reasons.

First, strange disease outbreaks are characterised by a paucity of knowledge about what they are and their modes of transmission. Speculation about their origins, as was the case with HIV/AIDs and COVID-19, both of which are said to be the unintended consequences of chemical or biological laboratory experiments, went haywire. Because the strange diseases ambushed all concerned parties, including trained medical personnel, the sick felt very much on their own. When charlatans in the neighbourhood promised instant cures, they got legions of followers. In times of anxiety and panic, people will listen to anybody, and will believe anything, and so the need for accurate and timely information to educate the public about how best to handle strange disease outbreaks becomes essential.

But in liberalised markets, information will only be circulated when the media houses are paid to do so. Moreover, charlatans selling fake drugs will also advertise and sell their products, unencumbered but using the same channels. There will thus be a jostling for space between legitimate and fake news, and advertisements about disease outbreaks and cures. Internet skeptics about the efficacy of COVID-19 vaccines fit the description

here. The short end of the liberalisation and privatization stick has been that rather than increasing efficiency and improving service delivery, it has simply exacerbated graft, greed, and exploitation—challenges that have manifested in the climax of the COVID-19 pandemic.

Second, although COVID-19 has ravaged the West just as it has ravaged sub-Saharan states, many in Western countries have fallen back on elaborate insurance coverage networks that put them in good standing during the pandemic. In Uganda, COVID-19 treatment strained family resources, leading families to sell-off valuables like land, animals, or even their houses because treatment costs in some cases went as high as $20,000—a totally outrageous figure for many Ugandans. There have been reports of money lenders also getting into the picture to bail out patients from hospitals, but at the risk of losing family property to them.

The anti-climax has been hospitals refusing to release bodies of the deceased until bills are cleared, turning dead bodies into commercial commodities to be traded between families and health practitioners. Bodies became commodities, first in hospitals where relatives had to pay huge bills, and then in funeral homes, which hiked prices for embalming, transportation, and conducting burial services because they alone had the "competence" and monopoly to do so. Privatisation in the context of Uganda has meant that the winner takes it all; God for all of us, and every man for himself.

While hospitals and the rest of the economy became commercial entities, charging fees for the services they are supposed to offer free-of-charge, many people did not do what was required in the circumstances—that is, buying insurance or putting aside savings to cater for hard times. In short, they did not develop a commercial mindset, which was required in the circumstances. They continued to rely on traditional cultural sentiments, drawing on the support of kin and family, all of which buckled under the weight of demands thrown at them by the tumultuous COVID-19 outbreak.

In developed market economies, robust insurance institutions and a culture of saving cushioned many in times of adversity. A lesson we can draw from the COVID-19 experience, and something to be appropriated as a resilience strategy in the COVID-19 and post-COVID-19 period, is for Ugandans to start thinking in radically new ways. We need to learn the theory and practice of insurance, and gradually appropriate it as part of our culture. But for insurance to become part of the culture, insurance companies must cease to be elitist, and get down to communities in ways that are accessible to all. We can think about insurance operating like the traditional poll tax system, in which every single household head paid a tax, and was issued with a tax ticket. In times of sickness, family heads took the patient to hospital, and flashing their tax ticket authoritatively demanded the services they were owed. The tax system operated like an insurance scheme in that people could demand services because they were taxpayers. We are taxpayers even today, but for many there are no visible indicators of their status. A

key element here is that as we wait for national social protection services to work, we have personal responsibilities to fend for ourselves and our families. The state can only supplement these strategies. Insurance companies would do well to carefully study how the traditional poll tax system worked and how we could transform it into an insurance system.

Overhaul of Institutional, Policy and Legal Frameworks in the Wake of the Covid-19 Pandemic

What has happened concerning COVID-19 treatment costs should act as a clarion call for the state to rethink its privatization and liberalization policies, both of which have been exposed in the wake of the pandemic, due in large measure to the lack of regulation. We need to appropriate market principles, but also bear in mind how they are implemented in the context of local cultures and ways of living. The state needs to fund social service delivery more scientifically, by focusing on an empirical assessment of needs.

As the pandemic surged with no immediate cure or remedy, government instituted lockdowns, then quarantine and self-isolation protocols, both intended to stem the spread of the virus. But the pandemic struck a fast-paced world, where whether sick or not the world had to move on. When the plague afflicted Europe in the mediaeval age, a major challenge faced then, and which delayed containment of the epidemic, was that traders could not afford to be locked up in quarantine centres for days on end. The internet has changed that, and today people could be quarantined and isolated but remain in touch with others. Quarantine and isolation mean something quite different today from what they meant two or three centuries ago.

While internet connectivity has ushered in new ways of handling isolation and quarantine, supporting soft and hardware infrastructure have not adequately spread to meet ever-increasing demand—a challenge that was glaringly experienced by schools during online teaching during the lockdowns. As COVID-19 has sharply demonstrated, internet connectivity is no longer an option but an indispensable part of relating. As programs like rural electrification get underway, in equal measure a strategy of "rural digitalization" should be programmed and similarly rolled out. An important element in recovery and resilience is the provision of social, economic, legal, and political infrastructure and institutional support. Lillian B. Rubin makes an insightful point when she says:

> Society and personality live in a continuing reciprocal relationship with each other. The search for personal change without efforts to change the institutions within which we live and grow will, therefore, be met with only limited reward. And the changes we seek will not be fully ours unless and until we understand where the roots of our problems lie (Rubin, 1984).

While there is a need to provide things like ambulances, mobile laboratories, even health centres—all of which have emerged as indispensable equipment in the COVID-19 pandemic—there will also need to be improved legal and policy frameworks, like those relating to privatization and liberalization. The legal frameworks governing insurance, private, public enterprises, and business must be re-organised or strengthened in response to the COVID-19 pandemic. For example, if we realise that internet has become a key element in teaching and learning, not to mention in locating and dispatching patients to hospital, then the government programme of rural electrification can be supplemented or conjoined with an equally ambitious programme of rural digitalization.

Dealing with the pregnant girl and child mother issue will require engagement at the rehabilitation stage, and a re-orientation not only of the girl child but also of their teachers, fellow learners, and the entire community, all of whom tend to have harshly judgmental attitudes towards girls who give birth while at school. The time has come to now re-orient all stakeholders to new ways of thinking and relating about pregnant girls and those who have become mothers. This may take some time to change, but the first step must be taken now. Beyond orientation and sensitization, we shall need to invest heavily in capabilities training, where the focus will be training learners "to be" and "to do" in sustainable ways. The capabilities framework, as elaborated by Amartya Sen (1999) and Martha Nussbaum (1995; 2004) comes in handy here because the focus is not so much on what people have, but rather on what they can be and can do. Capabilities can be seen here as internal powers of judgement, integrated into the lives of the girl child to enhance what she can do and be.

Conclusion: Individuals Changing Mind Sets

As state parties work on enabling frameworks to reach different areas, individuals and communities for their part will need to change their mindsets and take advantage of new developments and options that come along. There is a need to take stock of what has happened, and to craft appropriate and timely responses. Rigidity, followed by a laidback attitude in the face of emerging complexities must be jettisoned. In education, for example, there is a need to invest heavily in new technologies, without seeing them as luxuries. In health, mobile telephone have reported cases of COVID-19 outbreaks to facilitate the instant deployment of ambulances to get patients to hospital.

The new realities that we have encountered while battling COVID-19 require that people learn to draw on their internal resources to manage their lives. Article 2 of the Right to Development, sub section (1) states that, "The human person is the central subject of development and should be the active participant and beneficiary of the right to development." Sub section (2) adds a community element, thus:

All human being have a responsibility for development, individually and collectively, taking into account the need to full respect for human rights and fundamental freedoms as well as their duties to the community, which alone can ensure the free and complete

fulfilment of the human being, and they should therefore promote and protect an appropriate political, social, and economic order for development (The Right to Development, Article 2).

The human rights instrument above brings to the fore an important notion relevant for resilience and crafting a meaningful way forward. Namely, that human beings need to be central agents in matters concerning their own lives. Whatever developments government may initiate, they will be meaningfully and effectively executed only if people individually and collectively participate actively to bring about the desired change.

References

American-Psychological-Association. (n.d.). The Road to Resilience. Retrieved from https://uncw.edu/studentaffairs/committees/pdc/documents/the%20road%20to%20resilience.pdf

Barua, D. (1992). History of Cholera. In D. Barua, & W. B. Greenough, Cholera. Current Topics in Infectious Disease. Boston, MA: Springer, https://doi.org/10.1007/978-1-4757-9688-9_1.

Govender, D., Naido, S., & Taylor, M. (2020). "I have to Provide for Another Life Emotionally, Physically and Financially": Understanding Pregnancy, motherhood and the Future Aspirations of Adolescent Mothers in Kwazul-Natal South Africa. BMC Pregnancy and Childbirth, 2-21, Vol. 20, no. 620, https://doi.org/10.1186/s/2884-020-03319-7.

History.Com-Editors. (2010, September 17). Black Death. Retrieved from History: https://www.history.com/topics/middle-ages/black-death, accessed on March 5, 2022 History.com-Editors. (2017, September 12). Cholera. Retrieved from History: https://www.history.com/topics/inventions/history-of-cholera

Horgan, J. (2014, December 26). Justinian's Plague (541 - 542 CE). Retrieved from World History Encyclopedia: https://ww.worldhistory.org/article/782/justinians-plague-541-542-ce

Nussbaum, M. C. (1995). Human Capabilities, Female Human Beings. In M. N. (Eds.), Women, Culture and Development: A Stuy of Human Capabilities (pp. 61-139). Oxford: Clarendon Press, https://doi.org/10.1093/0198289642.003.0003.

Nussbaum, M. C. (2004). Beyond the Social Contract: Capabilities and Global Justice. Oxford Development Studies Vol. 32, No. 1, 4-18, https://doi.org/10.1080/136008 1042000184093.

Richard, K. (2021). Rise in Teenage Pregnancy: Is it effects of COVID-19? Kampala: New Vision, Vol. 36.

Rubin, L. B. (1984). Intimate Stranger: Men and Women Together. London: HarperCollins 1st Edition.

Sen, A. (1999). Development as Freedom. New York: Anchor Books.

Sloan, A. W. (1973). Medical and Social Aspects of the Great Plague of London in 1665. History of Medicine, 270-276.

Southwick, S. M., Bonanno, G. A., Masten, A. S., Panter-Brick, C., & Yehunda, R. (2014). Resilience Definitions, Theory, and Challenges: Interdisciplinary Perspectives. European Journal of Psychotraumatology, 1-14, http://dx.doi.org/10.3402/ejpt.v5.25338.

Ssentamu, D. J., & Mugume, A. (2001, July). The Privatisation Process and its Impact on Society. Retrieved from http://www.saprin.org<research>Uga-privatisation

United-Nations-General-Assembly. (1 December 2016). Report of the Open-Ended Intergovernmental Expert Working Group on Inicators and Terminology Relating to Disaster Risk Reduction . Washington, DC: United Nations.

United-Nations. (2015). Sendai Framework for Disaster Risk Reduction 2015 - 2030. Sendai, Miyagi, Japan: United Nations.

WHO. (2021, Febraury 5). Cholera. Retrieved from World Health Organization: https://www.who.int/news-room/fact-sheets/detail/cholera

Xie, Y., Xu, E., Bowe, B., & Al-Aly, Z. (2020). Long-term cardiovascular outcomes of COVID-19. Nature Medicine, 1-22,https://doi.org/10.1038/s41591-022-01689-3.

SECTION II: INDUCTED FELLOWS

This section presents the profiles of distinguished scientists who were inducted into the Academy Fellowship on October 29, 2021, during the Annual Scientific Conference. Prof. Joseph Obua, the Chairperson of the Fellows and Membership Committee of the UNAS Council, presented the following rigorously selected candidates to the President:

Health and Medical Sciences

Prof. Pontiano Kaleebu, MBChB., PhD in immunology/virology
Director of the UVRI, the most prominent Government Research institution dealing in viral infections, and hosting many reference laboratories, including SARSCoV2. In particular, he is recognized for his role as the founding director of the UVRI-IAVI HIV vaccine program, which led numerous studies to examine HIV-1 diversity and phenotypic differences between HIV-1 subtypes such as disease progression and protective immune responses and ART resistance development. Prof. Pontiano Kaleebu was inducted as a Fellow of the Uganda National Academy of Sciences in the health and medical sciences category.

Prof. Rhoda Wanyenze, PhD., MPH., MBChB.
Professor and Dean at Makerere University School of Public Health (MakSPH). She is recognized for over 25 years of leadership in public health, over 170 peer-reviewed publications, her service in numerous technical committees with government and beyond, and her management of major global research projects. Prof. Rhoda Wanyenze was inducted as a Fellow of the Uganda National Academy of Sciences in the health and medical sciences category.

Dr. Jennifer E. Adair, PhD., B.S.
Professor of Genomics, whose research has focused on developing novel strategies to make gene and cell therapy treatments broadly available to patients in need. She is recognized in particular for her work on translating the first successful drug resistance gene therapy trial in patients with terminal cancer of the brain (glioblastoma multiforme), the first clinically viable manufacturing protocol for gene therapy to treat Fanconi's anaemia and her work on clinically translated blood cell gene therapy to treat inherited HIV infections. Dr. Jennifer E. Adair was inducted as a Fellow of the Uganda National Academy of Sciences in the health and medical sciences category.

Dr. Wilson Winstons Muhwezi, Mphil., BA.
Associate Professor at Makerere University College of Health Sciences, where his research focuses on mental health promotion, social work, and social policy. In particular, he is recognized for his interdisciplinary research on the linkages between mental health and social policy, his over 45 scholarly publications, his work in mainstreaming psychosocial responses to Ebola, and his leadership as the Director of Research at the Advocates Coalition for Development and Environment (ACODE). Dr. Wilson Winstons Muhwezi was inducted as a Fellow of the Uganda National Academy of Sciences in the health and medical sciences category.

Dr. Scovia Nalugo Mbalinda, PhD., MSc., PGDE., BNSc.
A nurse-midwife and lecturer in the Department of Nursing, Makerere University. She is recognized in particular for her scholarly work on adolescents living with HIV and their long-term health, her leadership as an Afya Bora Global Health Leadership Fellow, and Fellow of the sub-Saharan Africa Foundation for Advancement of International Medical Education and Research, and her tireless work in improving the conditions for mothers and children in sexual and reproductive health. Dr. Scovia Nalugo Mbalinda was inducted as a Fellow of the Uganda National Academy of Sciences in the category of health and medical sciences.

Agricultural Sciences

Dr. David Kalule Okello, PhD., MSc., BSc.
Plant Breeder-Geneticist with over 16 years of applied plant breeding and genetics experience with the Uganda National Agricultural Research Organization. In particular, he is recognized for his work to commercialize 12 groundnut varieties freely shared globally throughout Africa, Haiti and the USA, his scholarly research, and his leadership in agricultural genomics. Dr. David Kalule Okello was inducted as a Fellow of the Uganda National Academy of Sciences in the agricultural sciences category.

Dr. Ivan Muzira Mukisa,
Food Microbiologist/Scientist and Associate Professor at Makerere University, and current Head of the School of Food Technology, Nutrition, and Bioengineering. In particular, he is recognized for his scholarly work on food safety, fermented foods, and functional foods (34 publications), his research leadership as a reviewer for several journals, and his work with

the Uganda National Bureau of Standards. Dr. Ivan Muzira Mukisa was inducted as a Fellow of the Uganda National Academy of Sciences in the agricultural sciences category.

Dr. Yusuf B. Byaruhanga
Associate Professor in the School of Food Technology Nutrition and Bioengineering, Makerere University. He is recognized in particular for his work on a new processing and preservation method for obushera, his work in developing food quality and safety management systems in the commercial world, and his research leadership on improving local communities' ability to add value to their crops and agricultural produce. Dr. Yusuf B. Byaruhanga was inducted as a Fellow of the Uganda National Academy of Sciences in the agricultural sciences category.

Prof. Vincent Kakembo
Vice Chancellor of Edward Mutesa I Royal University of Buganda Kingdom and Professor of Geography. In particular, he is recognized for his work on land use, vegetation change, and erosion processes using various spectral and modelling techniques, his scholarly work with over 46 published articles, and his research leadership in supporting local communities to better understand the dynamics of geological and geographic change. Prof. Vincent Kakembo was inducted as a Fellow of the Uganda National Academy of Sciences in the agricultural sciences category.

Veterinary Sciences

Dr. Enock Matovu, PhD., MSc, BSc.
Professor of Entomology at Makerere University. He is recognized in particular for his distinguished work on trypanosomiasis, in which he identified molecular mechanisms of drug resistance in African trypanosomes, his research work on genetic determinants of trypanosomiasis and schistosomiasis susceptibility, and his research leadership as the Associate Editor of the Public Library of Science Neglected Tropical Diseases journal. Dr. Enock Matovu was inducted as a Fellow of the Uganda National Academy of Sciences in the veterinary sciences category.

Dr. Maxwell Otim Onapa, PhD., MSc., MBA., BVM., Dip.
Veterinary surgeon and Director of Science, Research and Innovation at the Ministry of Science, Technology and Innovation (MoSTI). He is recognized in particular for his career achievements with over 28 years facilitating and supporting the development of Science, Technology and Innovation (STI) in

Uganda, his research work on biosecurity and biosafety, his work on the discovery of the genetic coding for the virulence of the Newcastle Disease Virus isolates from Uganda, and his research leadership both at UNCST and in his role today. Dr. Maxwell Otim Onapa was inducted as a Fellow of the Uganda National Academy of Sciences in the category of veterinary sciences.

Biological Sciences

Dr. Moses Chemurot, PhD., MSc., BSc.
Lecturer and entomologist at the Department of Zoology, Entomology and Fisheries Sciences, Makerere University. He is recognized in particular for his leadership as the current Secretary General of the Entomological Association of Uganda, his research contributions in apiculture (the science of bees), and his scholarly work with over 17 publications. Dr. Moses Chemurot was inducted as a Fellow of the Uganda National Academy of Sciences in the category of biological sciences.

Dr. Godwin Anywar Upoki, PhD., MSc, PGD, BSc., PPM.
Ethnopharmacologist and Lecturer at Makerere University in the Department of Plant Sciences, Microbiology and Biotechnology. In particular, he is recognized for his research on the cytotoxic, antiviral, and immunomodulatory properties of medicinal plants used by herbalists treating HIV/AIDs and his research leadership serving on various internationally recognized peer-reviewed journals. Dr. Godwin Anywar Upoki was inducted as a Fellow of the Uganda National Academy of Sciences in the biological sciences category.

Physical Sciences

Dr. Allen Kabagenyi, PhD., MDemo., BA.Educ.
Demographer/Population Scientist and Lecturer in Population Studies at Makerere University. In particular, she is recognized for her distinguished research work on population and reproductive health, her leadership as a Fellow of Cambridge University and a Fellow of Wolfson College, and her efforts to promote reproductive health and population research towards improved policy. Dr. Allen Kabagenyi was inducted as a Fellow of the Uganda National Academy of Sciences in the physical sciences category.

Dr. Dorothy Kabagaju Okello, PhD., MSc., BSc.
Dean, School of Engineering at Makerere University and Professor of Engineering, and the Director of ResilientAfrica Network (RAN). She is recognized in particular for her leadership in her role as the first female President of the Uganda Institute of Professional Engineers, to her current role as Dean at the School of Engineering, her research work on innovation, infrastructure, and future systems, and her tireless efforts to promote innovation nationally across several major projects. Dr. Dorothy Kabagaju Okello was inducted as a Fellow of the Uganda National Academy of Sciences in the physical sciences category.

Dr. John Mango Magero, PhD., MSc., BSc.
Professor of Mathematics at Makerere University. He is recognized in particular for his extensive work in curriculum development in mathematics both nationally and regionally, his research leadership as Dean of the School of Physical Sciences and Deputy Principal of the College of Natural Sciences, and his research work in the field of biomathematics. Dr. John Mango Magero was inducted as a Fellow of the Uganda National Academy of Sciences in the physical sciences category.

Social Sciences

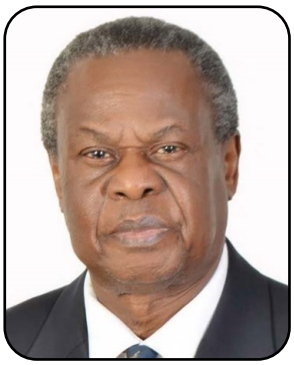
Dr. Rebecca Mirembe Nyonyintono
Professor of Sociology, educationist, and child protection advocate at Bugema University. In particular, she is recognized for her leadership at Ndejje University and Nkumba University, her research on child and maternal health, and her service as a reviewer with various notable academic journals. Dr. Rebecca Mirembe Nyonyintono was inducted as a Fellow of the Uganda National Academy of Sciences in the social sciences category.

Prof. Samuel K. Sejjaaka
Principal of MAT Abacus Business School and Associate Professor of Accounting. He is recognized in particular for his career achievements, over 25 years in public finance management and systems design, his research on professionalism and public sector management, his leadership at the Uganda Development Bank (UDB), and as Deputy Principal of the Makerere University Business School, in addition to his management of several major research projects. Prof. Samuel Sejjaaka was inducted as a Fellow of the Uganda National Academy of Sciences in the social sciences category.

ANNEX 1: SPEAKER BIOGRAPHIES

DR. SALLY STANSFIELD is a globally recognized leader in public health and development strategies. She currently works as a Senior Advisor to Inform Health, the eShift Network, and other startups in global health. Previously, she served as Deloitte Consulting's lead health systems strengthening specialist, focusing on health research, policy, and global governance. In her more than 35 years of professional experience, Dr Stansfield has been a trusted advisor at the highest levels to philanthropies, governments, commercial entities, and international agencies. Dr Stansfield holds a Doctorate of Medicine from the University of Washington and is a Fellow of the Uganda National Academy of Sciences.

DR ANTONIO LUIS EVORA FERREIRA QUERIDO, a national of Cabo Verde, holds a Ph.D. in Tropical Plant and Soil Science from the University of Hawaii, Honolulu, USA; a Master's Degree in Environmental Systems Analysis and Monitoring from ITC, Enschede, The Netherlands; and a Bachelor's degree in Plant Science-Agronomy from the University of California, Davis, USA. He started his career in 1993, as Researcher/Head of Environmental Science Department at the National Institute for Agricultural Research and Development (INIDA), Praia, Cabo Verde, and was appointed President of INIDA in 2001. From 2008 to 2010, he served as Dean of the Science and Technology Department at the University of Cabo Verde, Praia. He joined UNDP in 2010 as Head of the Environmental, Energy and Disaster Prevention Unit, Praia, Cabo Verde. He joined FAO in 2016 as Chief Technical Advisor, FAO Representation in Angola, Luanda. He was appointed FAO Representative in Uganda on 27 October 2018.



PROF. FRANCIS G. OMASWA is the Executive Director of the African Centre for Global Health and Social Transformation (ACHEST). He has qualifications in health services management and education. He is the Board Chair of the Portfolio and Procurement Committee of the Global Fund, Chair of the GAVI Independent Review Committee, and a member of the steering committee of the High-Level Forum on Health-Related MDGs and has been an adviser to governments on health policy and strategy in developing and developed countries. Prof. Omaswa is a graduate of Makerere

Medical School, Uganda, a Fellow of the Royal College of Surgeons of Edinburgh, founding President of the College of Surgeons of East, Central and Southern Africa, and a Senior Associate at the Johns Hopkins Bloomberg School of Public Health. Prof. Omaswa is a Fellow of the Uganda National Academy of Sciences.

MR. CORTI PAUL LAKUMA is a Research Fellow in the macroeconomics department at the Economic Policy Research Centre in Uganda. Mr. Lakuma is an established forecaster, economic model builder, and adviser with more than a decade of service to government and international organizations. Most recently, Mr. Lakuma has been involved in the conduct of several firm-level surveys to establish the socio-economic impact of COVID-19 on the productivity of Ugandan employees, firms, and industries. He holds an MSc in Economics with distinction from the University of Essex, United Kingdom, and a BA in Social Science from Makerere University, Kampala, Uganda.

DR. TOM O. OKURUT is the former Executive Director at the National Environment Management Authority. During his tenure, he institutionalised public dialogue as one of the key public education, awareness, and knowledge sharing means for increasing appreciation of the environment as integral in social and economic development planning. His efforts were instrumental in the initiation of the Lake Victoria Civil Society Network, enabling the activities and programs of civil society organizations in countries bordering Lake Victoria as full partners in line with protocol provisions. His efforts as Executive Director only aided the development of Uganda, but also across East Africa. Dr. Okurut studied at IHE Delft (IHE) from 1991 to 1999, completing his MSc and PhD degrees in Environmental Science and Technology, with a focus on the adoption of the Framework Strategy for the Management and Development of the Lake Victoria Basin by the East African Community Council of Ministers as a planning tool by all Lake Victoria Stakeholders, at IHE Delft.

PROF. EDWARD WAMALA is a Professor of Philosophy at the Department of Philosophy, School of Liberal and Performing Arts, College of Humanities and Social Sciences, Makerere University. He holds graduate degrees from Delhi University and Makerere University. He has been a visiting researcher at the Catholic University of America in 1996 and 2001, and at the University of Bergen in 2005.

ANNEX 2: CONFERENCE AGENDA

Sciences For Prosperity

UGANDA NATIONAL ACADEMY OF SCIENCES 2021 ANNUAL SCIENTIFIC CONFERENCE

THEME: ***Uganda's Health: Transcending Sectors, Looking to the Future***

DATE: Friday, October 29, 2021

VENUE: Zoom Meeting Room

MEETING ID: 971 3238 4742

PASSCODE: UNAS@21

AGENDA

SESSION 1: Annual Scientific Conference

The overall objective of the Annual Scientific Conference (ASC) is to provide a neutral platform for the exchange of ideas, knowledge, and experiences on topical issues that foster national development.

MODERATOR: Philippa Musoke, FUNAS, Chair, Publications & Conferences Committee

08:00 – 08:05	**Welcome and Opening Remarks** *Peter N. Mugyenyi, President, Uganda National Academy of Sciences*
08:05 – 08:20	**Guest of Honor** *Monica Musenero, Honourable Minister, Ministry of Science, Technology and Innovation, Uganda*

08:20 – 08:50	**Health in Context: Beyond Traditional Conceptions of Health** *Sally K. Stansfield, FUNAS, Former Managing Director, Social Impact Practice, Deloitte LLP*
08:50 – 09:20	**Applications of the One Health Concept in Uganda** *Querido Antonio Luis Ferreira, Country Representative, Food and Agriculture Organization of the United Nations*
09:20 – 09:50	**Vital Tools for Improved Health in Uganda** *Francis G. Omaswa, FUNAS, Executive Director, African Center for Global Health and Social Transformation*
09: 50 – 10:30	**DISCUSSION**
10:30 – 10: 40	**BREAK**
10:40 – 11:10	**Healthy Air: Combatting Air Pollution in Uganda** *Tom Okurut, Former Executive Director, National Environment Management Authority*
11:10 – 11:40	**Health Beyond Health Systems: Implications for a Healthy Economy** *Paul Lakuma, Head, Macroeconomics Department,, Economic Policy Research Center*
11:40 – 12:10	**Recovery and Resilience in a Post-Pandemic Uganda** *Edward Wamala, Professor, Department of Philosophy, Makerere University*
12:10 – 12:50	**DISCUSSION**
12:50 – 12:55	**Closing Remarks** *Philippa Musoke, FUNAS, Chair, Publications & Conferences Committee*

SESSION II: *Induction of New Fellows of the Academy*

The Academy inducts eminent scientists into the Fellowship of the Academy at the Annual Scientific Conference. These scientists are nominated, shortlisted and vetted through a rigorous process by the Fellows and Membership Committee and a Select committee that makes recommendations to Council. In this session the successful candidates (Inductees) will be inducted into the Academy Fellowship and will join high level independent distinguished experts of the country who serve voluntarily. The Inductees are from both within and outside the country.

MODERATOR: Joseph Obua, Chair Fellows and Membership Committee

13:00-14:00 **Induction Process**

The activities below apply to each Inductee. (10 minutes each)

- Introduction by the nominator
- Oath taking by the Inductee
- Acceptance Remarks by the Inducted Fellow

No	INDUCTEE	NOMINATOR	SECONDER
	CATEGORY- HEALTH AND MEDICAL SCIENCES		
1	**Prof. Pontiano Kaleebu** Health and Medical Sciences	Prof Alison Elliott MD FRCP FAAS, FUNAS	Prof. Harriet Mayanja-Kizza, FUNAS
2	**Prof. Rhoda Wanyenze** Health and Medical Sciences	Prof. David M. Serwadda, FUNAS	Prof. Nelson K. Sewankambo, FUNAS
3	**Dr. Jennifer E. Adair** Health and Medical Sciences	Dr. Cissy M. Kityo, FUNAS	Prof. Peter N. Mugyenyi, FUNAS
4	**Dr. Wilson Winstons Muhwezi** Health and Medical Sciences	Prof. Denis K. Byarugaba, FUNAS	Prof. Francis Ejobi, FUNAS
5	**Dr. Scovia Nalugo Mbalinda** Health and Medical Sciences	Dr. Rose Chalo Nabirye, FUNAS	Prof. Pauline Byakika-Kibwika, FUNAS
	CATEGORY- AGRICULTURAL SCIENCES		
6	**Dr. David Kalule Okello** Agricultural Sciences	Prof. Archilleo Kaaya Natigo, FUNAS	Prof. Samuel Kyamanywa, FUNAS
7	**Dr. Ivan Muzira Mukisa** Agricultural Sciences	Dr. Donald Rugira Kugonza, FUNAS	Dr. Robert Fungo, FUNAS
8	**Dr. Yusuf B. Byaruhanga** Agricultural Sciences	Prof. John H. Muyonga, FUNAS	Prof. Archilleo Kaaya Natigo, FUNAS
9	**Prof. Vincent Kakembo** Agricultural Sciences	Dr. Mary Goretti Nakabugo, FUNAS	Prof. Grace Ndeezi, FUNAS
	CATEGORY- VETERINARY SCIENCES		
10	**Dr. Enock Matovu**	Prof. Francis Ejobi,	Prof. Denis K. Byarugaba,

	Veterinary Sciences	FUNAS	FUNAS
11	**Dr. Maxwell Otim Onapa** Veterinary Sciences	Prof. Peter Olupot-Olupot, FUNAS	Prof. Paul Waako, FUNAS
	CATEGORY- BIOLOGICAL SCIENCES		
12	**Dr. Moses Chemurot** Biological Sciences	Dr. Donald Rugira Kugonza, FUNAS	Dr. Charles Masembe, FUNAS
13	**Dr. Godwin Anywar Upoki** Biological Sciences	Prof. Esezah K. Kakudidi, FUNAS	Prof. Hannington Oryem-Origa, FUNAS
	CATEGORY- PHYSICAL SCIENCES		
14	**Dr. Allen Kabagenyi** Physical Sciences	Dr. Betty Nanyonga Kivumbi, FUNAS	Prof. Livingstone S. Luboobi, FUNAS
15	**Dr. Dorothy Kabagaju Okello** Physical Sciences	Prof. Mary J.N. Okwakol, FUNAS	Prof. Henry Mwanaki Alinaitwe, FUNAS
16	**Dr. John Mango Magero** Physical Sciences	Dr. Betty Nanyonga Kivumbi, FUNAS	Prof. Livingstone S. Luboobi, FUNAS
	CATEGORY- SOCIAL SCIENCES		
17	**Dr. Rebecca Mirembe Nyonyintono** Social Sciences	Prof. Maud Kamatenesi Mugisha, FUNAS	Dr. Rose Chalo Nabirye, FUNAS
18	**Prof. Samuel K. Sejjaaka** Social Sciences	Prof. Grace K. Bantebya, FUNAS	Prof. Paul Edward Mugambi, FUNAS

14:00 **Closure of the Conference.**

ANNEX 3: LIST OF PARTICIPANTS

No	Name	Designation & Organization
1	Prof. Peter N. Mugyenyi	President, Uganda National Academy of Sciences
2	Hon. Dr. Monica Musenero	Minister of Science, Technology & Innovation, Office of the President
3	Dr. Querido Louis Antonio	Country Representative, Food & Agriculture Organization of the United Nations
4	Prof. Edward Wamala	Professor of Philosophy, School of Liberal Arts Makerere University
5	Prof. Francis G. Omaswa	Executive Director, African Centre for Global Health & Social Transformation (ACHEST) Uganda
6	Dr. Tom O. Okurut	Former Executive Director, National Environment Management Authority(NEMA)
7	Mr. Lakuma Paul	Head, Macroeconomics Department, Economic Policy Research Centre
8	Dr. Sally K. Stansfield	Former Managing Director, Social Impact Practice, Deloitte LLP,FUNAS
9	Dr. Abel Wilson Walekwa	Research Associate, Presidential Scientific Initiative on Epidemics (PRESIDE)
10	Eng. Aloysius Kittengo	Program Officer, Financing for Development, Southern and Eastern Africa Trade Information and Negotiations Institute (SEATINI)Uganda
11	Dr. Eng. Abel M S Katahoire	FUNAS, Advisor to the Board of Directors, Multi-Konsults Limited
12	Dr. Amy Kakiza Rwahikembo	Senior Manager, Business Development, Living Goods Uganda
13	Dr. Anywar Godwin	Lecturer, Department of Plant Sciences, Microbiology, Makerere University
14	Dr. Arnold Ezama	Manager, Epidemics and Pandemic Preparedness and Response, Uganda Red Cross Society

15	Dr. Arthur Fitzmaurice	Senior Program Advisor, Centre for Disease Control (CDC) Uganda
16	Ms. Baireete Jennipher	Coordinator, African Agency for Integrated Development
17	Mr. Bernard Maghuda	Communications Assistant, Network of African Science Academies (NASAC)
18	Dr. Betty Kivumbi Nanyonga	Senior Lecturer of Mathematics, Department of Natural Sciences, Makerere University
19	Ms. Betty Kyakuwa	Communications Officer, College of Engineering, Design, Art & Technology, Makerere University
20	Ms. Betty Mbolanyi	Senior Environment Officer, Directorate of Environment Affairs, Ministry of Water & Environment
21	Ms. Amanda Birungi	Uganda National Health Research Organization
22	Ms. Brenda Nakazibwe	School of Public Health, Makerere University
23	Ms. Caroline Munyiri	College of Agriculture and Veterinary Sciences, University of Nairobi
24	Dr. Cissy Kityo	Executive Director, Joint Clinical Research Centre
25	Dr. Daniel Babikwa	Director, District Support Coordination and Public Education, NEMA
26	Dr. David Okello-Owiny	Vice Chancellor, Academic Affairs, Gulu University
27	Dr. David Serukka	Senior Research Associate, Presidential Scientific Initiative on Epidemics (PRESIDE)
28	Prof. Denis K. Byarugaba	Professor of Microbiology, College of Veterinary Medicine, Animal Resources & Biosecurity, Makerere University
29	Dr. Donald R. Kugonza	Associate Professor, College of Agricultural & Environmental Sciences, Makerere University
30	Dr. Agaba Marianna Nyangire	Occupational Physician & Health Research Associate, Department of Occupational Safety and Health, Ministry of Gender, Labour and Social Development
31	Dr. Moses Osiru Omongin	Manager, Regional Coordination Unit (RCU), Regional Scholarship and Innovation Fund(RSIF), International Centre of Insect Physiology and Ecology

32	Dr. Alfred Driwale	Program Manager, UNEPI
33	Dr. Allen Kabagenyi	Lecturer, Department of Population Studies, School of Statistics, Makerere University
34	Dr. Angelina Kakooza-Mwesige	Senior Lecturer, College of Health Sciences, Makerere University
35	Dr. Connie Nshemereirwe	Director, African Science Leadership Programme (ASLP), Pretoria, Independent Consultant & Member, Uganda National Young Academy
36	Dr. David Okello Kalule	Geneticist, Uganda National Agricultural Research Organization
37	Dr. Dominic Venture Mundrugo –Ogo Lali	Assistant Secretary General. UNESCO
38	Dr. Donna Kabatesi	Centre for Disease Control, Uganda
39	Dr. Enock Matovu	Professor of Entomology, Makerere University
40	Dr. Gerald Banaga-Baingi	Assistant Commissioner, Technical Planning, Ministry of Energy & Mineral Development
41	Dr. Ivan Muzira Mukisa	Assoc. Prof. Head of Department of Food Technology and Nutrition, College of Agricultural and Environmental Sciences, Makerere University
42	Dr. Jennifer E. Adair	Professor of Genomics, University of Washington
43	Dr. John Mango Magero	Professor of Mathematics, College of Natural Sciences, Makerere University
44	Dr. Juliet Kiguli	Senior Lecturer, School of Public Health, Makerere University
45	Dr. Fulgencio Kayiso	Director of Research, Documentation & Strategic Information, Inter-Religious Council of Uganda
46	Dr. Komiljon Akhmedov	Fast Track Adviser, UNAIDS Uganda Office
47	Dr. Maggie Kigozi	President, Business and Professional Women of Uganda
48	Dr. Mary Goretti Nakabugo	Vice President, UNAS. Executive Director, Uwezo

		Uganda
49	Dr. Maxwell Otim Onapa	Director Research & Innovation, Ministry of Science, Technology & Innovation
50	Dr. Moses Chemurot	Lecturer, Department of Zoology, Entomology and Fisheries Sciences, College of Natural Sciences, Makerere university
51	Dr. Patrice Mawa	Immunologist, Uganda Virus Research Institute
52	Dr Patrick Y Kadama	Director, Policy & Strategy, ACHEST, Kampala
53	Dr. Peter Olupot-Olupot	Senior Lecturer, Department of Public Health, Busitema University
54	Dr. Rebecca Mirembe Nyonyintono	Professor of Sociology, Bugema University
55	Dr. Rose Chalo Nabirye	Senior Lecturer, College of Health Sciences, Makerere University
56	Dr. Yusuf Byenkya Byaruhanga	Assoc. Professor, School of Food Technology Nutrition and Bioengineering, Makerere University
57	Dr. Sabrina Bakeera-Kitaka	Senior Lecturer, Department of Pediatrics, College of Health Sciences, Makerere University
58	Dr. Scovia Nalugo Mbalinda	Lecturer, College of Health Sciences, Makerere University
59	Eng. Dr. Dorothy Kabagaju Okello	Dean, School of Engineering, College of Engineering, Design, Art and Technology, Makerere University
60	Eng. Nyakabwa Ralph Atwoki	Technical Director, Sustnersol Uganda
61	Dr. Esezah K. Kakudidi	Associate Professor, Department of Plant Science & Microbiology, College of Natural Sciences, Makerere University
62	Ms. Esther Nakkazi	Founder**,** Health Journalists Network Uganda
63	Mr. Zebosi Nicholas	Principal Policy Analyst, Ministry of Science, Technology & Innovation
64	Prof. Wilson Truman Okaka	Senior Lecturer, Research Communication Department,

		Kyambogo University
65	Dr. Wilber Karugahe	Senior Lecturer, School of Psychology Makerere University
66	Prof. Suki Mwendwa	FKNAS, Professor of Design and Architecture, Technical University of Kenya
67	Mr. Timothy Opobo	Executive Director, AfriChild Centre
68	Dr. Sarah Nakijoba	Lecturer, Department of linguistics, English language studies and communication skills, Makerere University
69	Dr. Sarah Nachuha Kasozi	Senior Lecturer, Department of Environmental Sciences, Faculty of Science, Islamic University in Uganda(IUIU)
70	Prof. Oyewale Tomori	Past President, Nigerian Academy Of Science,Professor of virology, Educational Administrator, and Former Vice Chancellor of Redeemer's University
71	Mr. Odama Peter	Co-Founder & Executive Director, World Action Fund
72	Mr. Peter Ahabwe Babigumira	Global Health Security Program Pharmacist, Infectious Diseases Institute(IDI)
73	Ms. Mary Nantongo	Science, Technology, and Innovation -Office of the President-Pathogen Economy
74	Ms. Eva Akurut	Science, Technology, and Innovation -Office of the President-Pathogen Economy
75	Dr. Mohammad Lamorde	Head, Global Health Security, Infectious Diseases Institute (IDI)
76	Prof. David J. Bakibinga	Professor of Commercial Law, School of Law, Makerere University & Secretary General, Uganda National Academy of Sciences.
77	Prof. Grace Bantebya Kyomuhendo	Professor of Gender & Women Studies, School of Women and Gender Studies, Makerere University

78	Prof. Grace Ndeezi	Professor of Paediatrics & Child Health, College of Health Sciences, Makerere University
79	Prof. John Francis Mugisha	Health Systems Consultant and Vice Chancellor, Cavendish University Uganda
80	Dr. Grace Akello	Associate Professor of Medical Anthropology, Gulu University
81	Prof. Maud Kamatenesi-Mugisha	Vice Chancellor, Bishop Stuart University
82	Prof. Nelson Sewankambo	Professor of Internal Medicine, College of Health Sciences, Makerere University
83	Prof. Joseph Obua	Professor, College of Agricultural and Environmental Sciences, Makerere University
84	Prof. Paul Edward Mugambi	Executive Director, Uganda Vice Chancellors Forum
85	Prof. Paul Waako	Vice-Chancellor, Busitema University
86	Prof. Peter Waiswa	Associate Professor, Department of Health Policy, Planning and Management, School of Public Health Makerere University
87	Prof. Phillipa Musoke	Professor, Department of Paediatrics & Child Health, College of Health Sciences, Makerere University
88	Prof. Pontiano Kaleebu	Executive Director, Uganda Virus Research Institute
89	Prof. Ratemo Michieka	Honorary Secretary, Kenya National Academy of Sciences
90	Prof. Rhoda Wanyenze	Professor & Dean, School of Public Health, College of Health Sciences, Makerere University
91	Prof. Samuel Ssejjaaka	Principal and Country Team Leader, MAT ABACUS Business School
92	Prof Sarah Kiguli	Head, Department of Pediatrics & Child Health, College of Health Sciences, Makerere University
93	Prof. Vincent Kakembo	Vice Chancellor, Edward Mutesa I Royal University
94	Prof. Wilson Winstons Muhwezi	Director of Research, Advocates Coalition for Development & Environment
95	Prof. Raphael Munavu	Chairman, Kenyan National Academy of Sciences

96	Mr. Richard Balikoowa	Lecturer, School of Psychology, Makerere University
97	Prof. Himla Soodyall	Executive Officer, Academy of Science of South Africa (ASSAF)
98	Hon. Victoria Sekitoleko	Former Minister of Agriculture & Vice President, Private Sector Foundation
99	Dr. Isa Kabenge	Department of Agricultural and Bio systems Engineering, Makerere University
100	Ms. Jane Nalunga	Executive Director, Southern and Eastern Africa Trade Information and Negotiations Institute (SEATINI)
101	Ms. Jennifer Kutesakwe	Senior Environment Inspector, National Environment and Management Authority (NEMA)
102	Assoc. Prof. Jesca Lukanga Nakavuma	Associate Professor, Department of Biomolecular Resources and Biolab Sciences, College of Veterinary Medicine, Animal Resources and Biosecurity, Makerere University
103	Prof. Harriet Mayanja-Kizza	Professor of Internal Medicine, College of Health Sciences, Makerere University
104	Prof. John H. Muyonga	Professor of Food Science, School of Food Technology, Nutrition and Bioengineering, Makerere University
105	Dr. Gabriel Kasozi	Senior Lecturer, Institute of Environment and Natural Resources, Makerere University
106	Hasifa Naluyiga	Director, Community Health Partnerships, Living Goods Uganda
107	Ms. Lydia Mulondo Nsibambi	Learning & Development Assistant Commissioner, Uganda Revenue Authority
108	Mr. Marcel Mballa-Ekobena	Managing Director, Temagro Group, United Kingdom
109	Prof. Maria G. N Musoke	Deputy Vice Chancellor, Academic Affairs, Kyambogo University
110	Dr. Julius Kikooma	Associate Professor and Acting Deputy Principal, College of Humanities and Social Sciences, Makerere University
111	Dr. Joyce Nakatumba-Nabende	Senior Lecturer, College of Computing, Makerere University

112	Dr. Livingstone Sewanyana	Executive Director, Foundation for Human Rights Initiative
113	Prof. Livingstone Luboobi	Professor of Biomathematics, Institute of Mathematical Sciences, Strathmore University, Nairobi
114	Ms. Kellen Nyamurungi Namusisi	Public Health Specialist, African Center for Clean Air
115	Mr. Keith Ahumuza	Environment Stastician, Directorate of Agriculture and Environment Statistics, Uganda Bureau of Standards
116	Dr. Esther Katuura	Senior Lecturer, Department of Plant Sciences, Microbiology and Biotechnology, College of Natural Sciences, Makerere University
117	Ms. Juliet Navvuma	Private Sector Development Officer, Private Sector Foundation Uganda (PSFU)
118	Mr. Alvin Labeja	Policy Analyst, Ministry of Education & Sports
119	Ms. Nabirye Eunice	Makerere University
120	Ms. Nakonde Ritah	Labour Officer, Ministry of Gender, Labour & Social Development
121	Mr. Nuwa Wamala Nnyanzi	Visual Arts Practitioner & Consultant
122	Prof. Oswald K. Ndoleriire	Director, Conficus Institute Uganda
123	Ms. Judith Orishaba	Policy Officer, Office of the Prime Minister
124	Dr. Peter Eriki	Director Health Systems & Deputy Executive Director, ACHEST Uganda
125	Prof. Felix B. Bareeba	Professor of Bio-Chemistry, Makerere University
126	Dr. Perpetua Akiite	Senior Lecturer, Department of Zoology, Entomology & Fisheries Sciences, Makerere University
127	Dr. Martha Kibukamusoke	Senior Lecturer, Cavendish University
128	Dr. Daniel Byamukama	Head, HIV Prevention, Uganda AIDS Commission
129	Ms. Lois Bayigga	PhD student, Makerere University

130	Mr. Malcom Twino Mpamizo	Associate Program Consultant, CivSource Africa Limited
131	Mr. Manirakiza Fred	Makerere University
132	Prof. John Baptist Kirabira	Professor of Mechanical Engineering, College of Engineering, Design, Art & Technology, Makerere University
133	Mr. Jonathan Gwaitta	Uganda Bureau of Statistics (UBOS)
134	Mr. Enyimu Joseph	Senior Economist, Ministry of Finance, Planning & Economic Development
135	Dr. Judith Odhiambo	Lecturer of Crops & Soil Sciences, Kiisi University, Kenya
136	Mr. Tumuramye John Bosco	Community Volunteer Initiative for Development. (COVOID)
137	Mr. Vincent Orucho	Kiisi University, Kenya
138	Mr. Willy Bukenya Kyamaganda	Director, Kyamaganda Community Development Organization
139	Mr. Wokwesiga Nyakabwa Job	Makerere University
140	Dr. Roy Mubuuke Gonzaga	Lecturer, Department of Radiology, School of Medicine, College of Health Sciences, Makerere University
141	Ms. Kwagalakwe Carolyne	Makerere University
142	Prof. Henry Alinaitwe	Professor of Engineering & Principal, College of Engineering, Design, Art & Technology, Makerere University
143	Mr. Gilbert Asasira	Agricultural Inspector, Ministry of Agriculture, Animal Industry & Fisheries
144	Mr. Frank Sebalamu	Accounts Officer, Infectious Diseases Institute
145	Dr. Flora Banage	Technical Advisor, Medical & Clinical Services, Centre for Disease Control & Prevention Uganda
146	Mr. Duncan Sematimba	Ag. Principal Officer, Uganda Bureau of Statistics

147	Prof. Elly Sabiti	Professor of Agriculture, College of Agriculture & Environmental Sciences, Makerere University
148	Ms. Bridget Magero	Inter-University Council of East Africa
149	Mr. Christian N. Acemah	Executive Secretary, Uganda National Academy of Sciences
150	Mr. Sydney Sproul	Strategic Initiatives & Development Officer, Uganda National Academy of Sciences
151	Mr. Louis Javuru	Communications Officer, Uganda National Academy of Sciences
152	Ms. Doreen Namara	Research Officer, Uganda National Academy of Sciences
153	Ms. Daphine Ann Abeinemukama	Monitoring, Evaluation & Learning Officer, Uganda National Academy of Sciences
154	Ms. Lucy Ampumuza	Administrative Officer, Uganda National Academy of Sciences
155	Mr. William Bigambwensi	Accounts Officer, Uganda National Academy of Sciences
156	Ms. Margaret Kimuli Nabwami	Assistant Research Officer, Uganda National Academy of Sciences
157	Ms. Hawah Nabweteme	Research & Administrative Assistant, Uganda National Academy of Sciences