

Enhancing Human Capital and Boosting Productivity by Tackling Non-Communicable Diseases

Results of a research initiative

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INTRODUCTION AND OVERVIEW

Non-communicable diseases (NCDs) (especially cardiovascular disease, diabetes, cancer, chronic respiratory disease, and mental health disorders) increasingly threaten countries' health achievements and economic future. WHO estimates that 71 percent of all deaths in 2015 were due to NCDs. Over one billion persons suffer from hypertension, which alone is responsible for over 10 million deaths worldwide each year, more than all infectious diseases combined prior to COVID-19. The burden of NCDs continues to rise disproportionately in low-income countries (WHO 2018). NCDs also contribute to 80 percent of the global burden of disability (IHME 2018). Many non-communicable conditions strike working adults during their most economically fruitful years: cutting short lives and careers, undermining productivity, bankrupting families, diverting public resources from more productive uses to cover treatment costs, and preventing society from recouping its investments in workers' training and skills. In low- and middle-income countries (LICs and MICs), NCDs tend to affect people at younger ages, reducing educational attainment and lifetime earnings.

Political mobilization around the NCD threat is increasing but still not commensurate with the scale of the challenge. The United Nations political declaration on NCDs, adopted in 2011, broke the silence at top levels. The 2013 WHO Global Action Plan established a framework for coordinated efforts to counter NCD epidemics nationally and internationally. In 2015, the Sustainable Development Goals (SDGs) placed NCDs prominently on the global development agenda, with a dedicated NCD target (SDG 3.4).

Despite increased attention to NCD issues, however, investment and action at country level continue to fall short. NCD epidemics are growing explosively in many low- and middle-income countries (LMICs), while influential policy makers, particularly in ministries of finance, remain poorly informed about the implications of NCD burdens for their countries' economic development.

NCDs and human capital – clarifying a critical relationship

Against this backdrop, in 2017, the WHO Director-General established a High-Level Commission to advise on means of accelerating action against NCDs. One of the Commission's recommendations was to seek to incorporate NCDs into global policy discussions on human capital.

Countries increasingly recognize the critical importance of human capital—the health, education, and skills of the population—for economic growth and competitiveness. Since 2017, more than 80 countries have joined the World Bank's Human Capital Project, signaling high momentum for investment in the creation, protection, and enhance-

ment of human capital. The Human Capital Project aims to improve human capital at country level through investment in health and education. The Project's human capital index (HCI) is an advocacy tool that quantifies the contribution of health and education to the productivity of the next generation of workers. Countries are using the HCI to assess how much income they forego because of human capital gaps, and how much faster they can turn these losses into gains if they act now.

Countries' growing recognition of the importance of human capital represents an unprecedented opportunity to accelerate progress on NCDs, particularly in LICs and MICs. NCDs pose a powerful threat to human capital. They damage and devalue it in the short term, mainly through impacts on adult survival and productivity. They also compromise future human capital creation, in particular by impacting educational performance. Countries can reap substantial economic rewards via improved human capital, both short- and long-run, by taking bold action to prevent and control NCDs.

Growing concern about human capital creates a window of opportunity for collaboration between the World Bank, WHO, and other partners to help countries enhance their human capital by tackling NCDs.

The NCDs and Human Capital Research Initiative: research to inform policy

Human capital is emerging as a pivotal concern for countries and a powerful lens to guide public policy and investment. Yet important knowledge gaps on human capital persist. Today, most countries are not clear on the opportunities that exist to strengthen human capital by tackling NCDs, the rewards such

efforts may yield, the levels and types of investment needed, and the specific policy and implementation steps that will work best.

To respond, in April 2019, the World Bank, in partnership with WHO, launched a time-limited research initiative on NCDs and human capital. The work was situated within the World Bank's Human Capital Project. It engaged leading academic researchers and policy experts in a collaboration to answer priority questions on NCDs' human-capital impacts and entry points for an effective policy response. The effort pursued four main tasks:

1. Evaluate the impact of NCDs on education, as it relates to human capital
2. Evaluate the impact of NCDs on human capital understood as effective labor supply
3. Estimate the impact of NCDs on longevity
4. Consider what measurement systems are needed to buttress the arguments for investing in human capital at country level and to monitor progress

The NCDs and Human Capital Research Initiative commissioned original research from five scientific teams at major universities and international organizations.¹ Research teams began their work in May 2019, shared preliminary results in July 2019, and finalized their contributions in the following months, completing their work in December 2019. An executive report summarizing preliminary initiative findings served as an input to the concluding deliberations of the WHO High-Level Commission on NCDs and informed its final recommendations.

Methods developed and results obtained by the NCDs and Human Capital Research Initiative have subsequently been integrated into the World Bank's Healthy Longevity Initiative (HLI), launched in April 2021. The HLI is jointly led by the World Bank and the University of Toronto, with support from Access Accelerated. Several of the investigators whose findings from the NCDs and Human Capital Research Initiative are summarized in this chapter have gone on to contribute additional original research to the HLI.

The Toronto workshop and the role of this chapter

To review emerging results from the NCDs and Human Capital Research Initiative and reach consensus on their interpretation, project leaders convened a workshop in Toronto on July 9-10, 2019. The event was sponsored by Access Accelerated and hosted by the Centre for Global Health Research of the University of Toronto Dalla Lana School of Public Health. Participants included members of the project research teams, along with other distinguished scholars and representatives of organizations including Access Accelerated, the Pan-American Health Organization (PAHO), the United Nations Development Programme (UNDP), WHO, and the World Bank. The detailed workshop agenda appears in Annex 1.1 of this chapter. Annex 1.2 presents a full list of workshop participants.

This chapter summarizes the main findings emerging from the five core papers commissioned by the NCDs and Human Capital Research Initiative, together with the analysis, interpretation, and key messages for policy and practice jointly formulated by participants at the July 2019 Toronto workshop. All data and analysis in this chapter are pre-COVID-19.

The chapter follows the structure of the Toronto workshop. It provides an initial overview and contextualization based on the keynote address by Sir George Alleyne. It summarizes the five scientific inputs from project research teams and the discussion sparked by each paper in Toronto. The chapter then synthesizes policy lessons and recommendations from the workshop debates. Concluding sections describe the subsequent agenda of the NCDs and Human Capital Research Initiative and outline a future research and practice agenda to strengthen human capital through action on NCDs. This agenda has helped to shape the subsequent activities of the Healthy Longevity Initiative.

1 Participating research teams came from the Graduate Institute, Geneva; the Harvard T.H. Chan School of Public Health; the University of Toronto Dalla Lana School of Public Health; WHO; and the World Bank Group.

BOX 1.1 Key messages

- Rising non-communicable disease (NCD) burdens threaten countries' human capital, a critical determinant of their economic success.
- Policymakers' growing concern with human capital marks an unprecedented opportunity for the World Bank, the World Health Organization (WHO), and other partners to collaborate in supporting country action to prevent and control NCDs.
- By tackling NCDs with proven, cost-effective interventions, including intersectoral measures, countries can reap substantial economic benefits, while improving health. Economic gains from strengthening human capital through NCD control and prevention will come mainly from improved productivity. Some gains can be obtained rapidly (1-5 years).
- NCD prevention and control also lay foundations for longer-term improvements in human capital and economic competitiveness, notably through gains in young people's educational performance. New research is uncovering strong associations between NCDs and educational outcomes.
- NCDs are major drivers of impoverishment and inequality. Tackling NCDs will improve human capital most among the least well off. This will reduce inequalities, reinforce social stability, and ensure that countries harness talent from their whole populations, an advantage for competitiveness.
- Private firms across multiple industries could draw productivity benefits from action on NCDs. Private sector co-leadership can boost the speed and impact of the global NCD fight.
- Strong, country-owned measurement systems are crucial for countries to prevent and control NCD epidemics and reap the associated human-capital benefits.
- Knowledge gaps hamper countries' efforts to fight NCDs. NCD and human capital research—including research on prevention, the economic burden of disease, and how to measure productivity gains—needs to be aggressively ramped up.

RESEARCH INPUTS AND POLICY DISCUSSIONS

Non-Communicable Diseases and Human Capital Analytic Work and Key Messaging Workshop: Toronto, July 9-10, 2019

Workshop Day 1, morning session

Daniel Dulitzky (World Bank) and **Prabhat Jha** (University of Toronto) chaired the meeting's first session. Following their welcoming remarks, **Sir George Alleyne** (Director Emeritus, Pan American Health Organization) delivered the keynote address.

Workshop keynote address: health, NCDs, and human capital

Sir George Alleyne

Dr. Alleyne began his talk by paying tribute to three persons whose work has powerfully informed his understanding of health, NCDs, and human capital: Professor Dean Jamison, Professor Prabhat Jha, and the late Philip Musgrove. Acknowledging these colleagues' foundational contributions, Dr. Alleyne then reflected on his own lifelong concern with

health, which has two principal roots. First, his work as a physician and practitioner of public health policy has convinced Dr. Alleyne that the achievement of health equity is possible and technically feasible, whereas equity in other domains of human life is more difficult, perhaps impossible, to attain. This circumstance gives health a special status.

A second reason for Dr. Alleyne's enduring concern with health is his acceptance of health's instrumental value, as complementary to its intrinsic or constitutive value. In this connection, Dr. Alleyne evoked the conceptual framework developed by Par-

tha Dasgupta and colleagues (2017). Dasgupta views health as having four major dimensions in relation to human agency. Good health is important because it: (1) enhances human productivity, (2) enables persons to live longer lives (longevity), (3) enables better quality of life and well-being, and (4) yields positive externalities at individual and population levels.

This framework offers a conceptual armature for the work of the NCD and Human Capital Research Initiative. If Dasgupta's basic theorems are valid, Dr. Alleyne affirmed, then we should be able to frame an appropriate argument to convince policy makers of the salience of NCD prevention and control.

Dr. Alleyne noted that the Toronto workshop and the broader political process of which it is part "represent a tide in the NCD affairs which, hopefully, we can take at the flood." To justify such optimism, he cited the ongoing work of the WHO Director-General's High-Level Commission on NCDs, of which he was a member. The drafting of the High-Level Commission's final report was in progress at the time of the Toronto consultation. Dr. Alleyne had received the assurance that the results of the Toronto workshop would be reflected in the High-Level Commission's report. He pointed to the World Bank's Human Capital Project and related technical work on the "Changing Wealth of Nations" as further evidence of a rising tide of global concern with health and human capital that signals an exceptional political opportunity.

While much discussion of the Human Capital Project has focused on the foundations of human capital in early childhood, Dr. Alleyne observed:

My view is that the focus on early childhood is a necessary but not sufficient rationale for an interest in human capital. I contend that our concern must be for the actual as well as the potential human capital. Our concern must be for the loss of human capital through premature mortality due to NCDs. Our concern must be for the billions, yes, billions of adults who suffer from one or more NCDs which impair their human capital.

In this light, he argued, one of the novel NCD approaches to be suggested to the WHO Director-General is that WHO make common cause with the World Bank at country level, ensuring that investment in human capital include not only future capital, but also the quality and quantity of the present stock of human capital, through prevention and control of NCDs.

In this respect, Dr. Alleyne concluded, "We have the opportunity to demonstrate that investing in

prevention and control of NCDs represents a potent mechanism for preserving or restoring the productivity of human capital." Furthermore, we have the chance to project this message just as human capital is being promoted with renewed vigor by the World Bank, as a factor critical for countries' economic performance.

In closing, Dr. Alleyne signaled a concern of methodological and philosophical significance for human capital discussions, regarding whether scientists can "separate the asset of the individual from his or her person." With health and human capital, scientists measure, not health itself as the asset, but the factors (in this case NCDs) which diminish the asset; they then correlate these factors with labor productivity. Dr. Alleyne underlined his hope that the day comes "when economists find some measure of health which they can use to relate to the labor market outcomes they currently estimate."

Highlights of workshop discussion: In the discussion that followed, Dr. Alleyne posited that health as a state of being similar to happiness might be assessed using a metric derived from qualitative research. Regarding the relatively slow progress on NCDs to date, he urged that the NCD community frame its arguments more persuasively, and referred particularly to the need to address NCDs and their risk factors in children. An opportunity for progress is emerging through the confluence of current interests among major institutions: the World Bank in human capital; WHO in NCDs; and UNDP in inequality, along with the burgeoning engagement of civil society.

Summary and discussion of research papers

Paper 1: The human capital impacts of investing in interventions to reach the SDG-related targets for non-communicable diseases: an analysis of 10 low- and lower-middle income countries

Seoni Han*, Jean-Louis Arcand*, Jeremy Addison Lauer**
 (*) The Graduate Institute, Geneva; (**) World Health Organization, Geneva

Top-line messages: Expanding coverage of NCD interventions in low- and lower-middle income countries can raise countries' effective labor supply, boosting the economy.

- NCD interventions increase GDP by about 0.5% annually over 5 years

- NCD interventions increase GDP per capita by about 0.7% annually over 5 years
- NCD prevention and control are a major determinant of human capital and must figure prominently in universal health coverage (UHC) in the near term

Study background and aims: To support WHO's 2018 *Investment Case*, the researchers investigated the impact of scaling up NCD interventions on economic outputs in 10 low- and lower-middle income countries (LICs and LMICs) for the period 2019–2023. The countries were: Angola, Bangladesh, Brazil, China, the Democratic Republic of Congo, Ethiopia, India, Indonesia, Nigeria, and Pakistan.² The study aimed to calculate the GDP and GDP per capita gains these countries might obtain, if they successfully reached 60 percent population coverage of key NCD interventions, as stipulated under SDG targets.

Methods: The researchers used WHO's Economic Projections of Illness and Cost of Treatment (EPIC) model, which relates market-valued economic output in human-capital terms to the direct and indirect effect on human capital of the burden of non-communicable disease averted.³

The paper can be seen as presenting development-accounting mechanisms for the impact of improved health status on economic performance in the countries studied, since “human capital” is conventionally understood as a stream of future earnings (as a component of overall economic output). The authors take changes in overall economic output attributable to increases in labor supply due to improved NCD control (i.e., as estimated through the “labor share”) as their measure of the improvement in human capital due to implementation of a package of NCD interventions.

The study considered the following NCDs: cardiovascular diseases, endocrine disease (diabetes), chronic obstructive pulmonary disease (COPD), asthma, anxiety, depression, bipolar disorder, psychosis, conduct disorder, attention deficit disorder, alcohol dependence, epilepsy, and colorectal,

breast, and cervical cancer. NCD-related interventions included in the model were: policy and population-wide interventions; periodic outreach campaigns; primary care screening, treatment, and management; and limited specialized care (e.g., treatment of ischemic heart disease, COPD treatment, and cancer treatment). Cost estimates included the programmatic investments necessary for intervention delivery that do not generate economic returns on the selected time horizon.

The paper focuses on two main channels through which NCD interventions affect a country's economic outcomes: the cost effects of NCD interventions on the accumulation of manufactured capital, and the demographic and health impacts of NCD interventions on effective labor supply via improvements in human capital. This approach foresees that, when an NCD intervention takes place: (1) a decrease in the stock of physical capital is incurred because of the cost of the intervention⁴; while (2) an increase in labor supply results from a decline in the mortality and disability due to illness.

The researchers allow for heterogeneity at a country level, using country-specific economic and disease assumptions. It is necessary to take into account country-specific responses to changes in health status following intervention to control certain pathological conditions, because countries have experienced different stages of epidemiological transition (Deaton 2006). The model also takes into consideration the fact that the improved health status of children impacts on the productivity of their caregivers of working age.

Analyzing changes in health outcomes and the consequences of NCD investments for manufactured capital and the labor force, the authors compared gains and losses in terms of economic output for a “business as usual” scenario and an “ambitious realization of UHC” scenario from 2019 through 2023 (Sternberg et al. 2017). Under business as usual, population coverage rates for relevant interventions remain constant at 2015 levels. Under the ambitious scenario, countries reach their SDG coverage targets (for NCD services, 60 percent population coverage).

2 Together, these countries account for 67 percent of all expected global deaths for the period 2019–2023 that could be averted by specified advances toward universal health coverage (UHC). For details of the UHC scenarios considered, see Sternberg et al. (2017).

3 The EPIC model is based on a human-capital augmented Solow model and incorporates a recursive production function and exogenous equations of motion for the two production factors – stocks of physical capital and effective labor as modified by human capital.

4 Interventions reduce the funds available for investment because private savings are diverted to pay for interventions. (This is equivalent to out-of-pocket payments.) It is assumed that some portion of the total cost of treatment is funded from domestic savings, with the remainder displacing other consumption expenditures. There is no public sector in this model.

Key results: The findings suggest that investing in better prevention and control of NCDs would generate average annual gross domestic product (GDP)

gains of 0.5 percent and average GDP per capita gains of 0.7 percent over baseline for these countries over the five-year period 2019–2023.

FIGURE 1.1 GDP and GDP per capita gains, average for 10 countries, with an NCD package

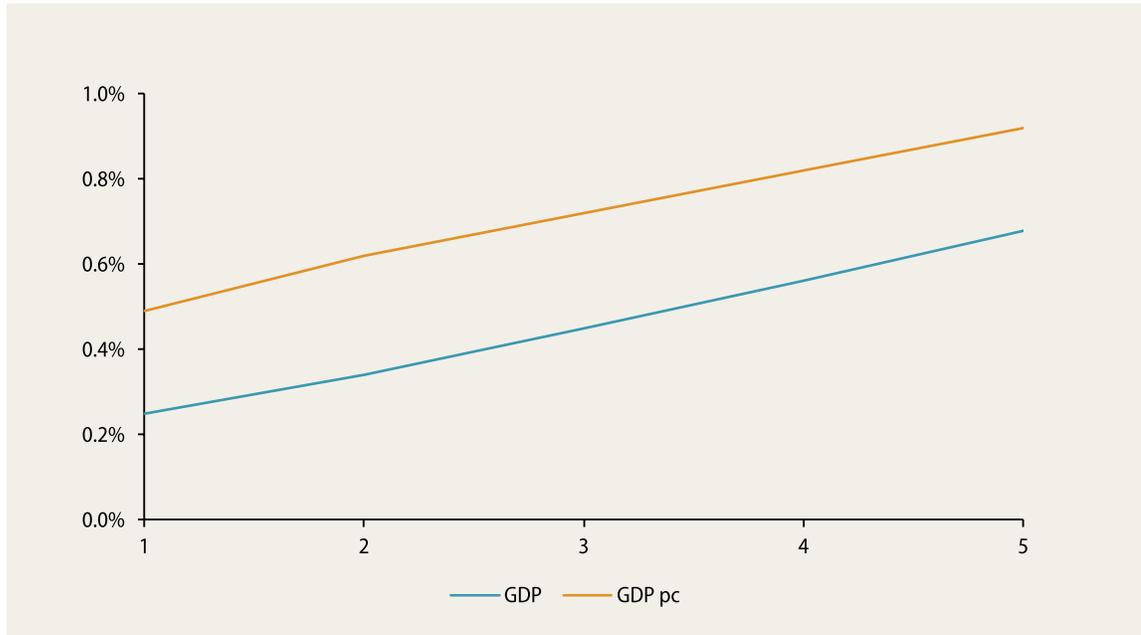
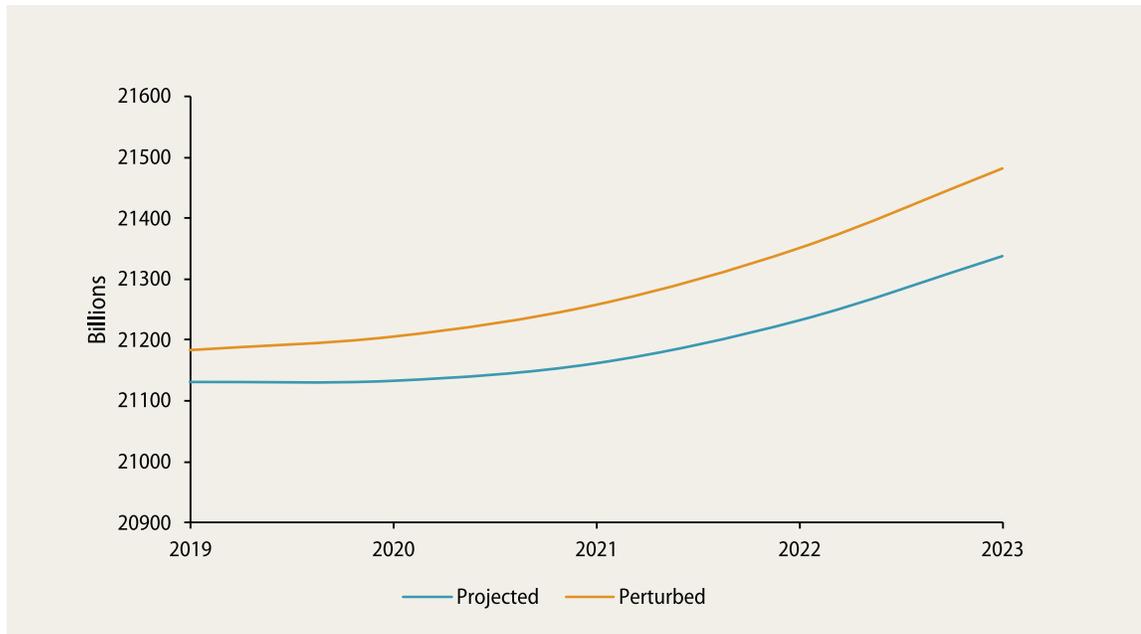


FIGURE 1.2 GDP with (perturbed) and without (projected) an NCD package



Discussion, interpretation, and next steps: Among other practical policy lessons, the results of this analysis suggest that economic gains from strengthened NCD prevention and control measures could manifest rapidly, within politically pertinent time-frames (1-5 years).

The model used in this study is flexibly applicable for different packages of disease conditions and various coverage of health interventions for different countries. The authors plan to explore for more countries the impacts of investing in prevention and control of NCDs through UHC. One important aspect for future work is to incorporate dynamics between the costs of a health intervention and its consequential health outcomes, in order to link the laws of motion of physical capital and labor in the model (that is, how these variables evolve over time). This work will follow amelioration of the law of motion for human capital.

Highlights of workshop discussion: Professors **Prabhat Jha** (University of Toronto) and **Sue Horton** (University of Waterloo) served as lead discussants for the day's first two papers. Deferring in-depth discussion until after the presentation of Paper 2 (see below), they asked participants for questions of clarification regarding Paper 1. Further explanation was sought on two main issues: (1) what the researchers mean by "physical capital"; and (2) whether the NCD interventions included in the model incorporated forms of multi-sectoral action.

Dr. **Jeremy Lauer** responded. On physical capital and its relation to human capital in the model, he referred participants to the equations included in the World Bank's recent *Human Capital Primer* (Flabbi and Gatti 2018). He noted that research generally considers human capital in terms of impact on national income, such as GDP. Human capital is in the labor term of the relevant equations. NCD interventions lead to a diminution of physical capital because of the costs involved, but they simultaneously improve the quantity and quality of human capital, yielding economic benefits. On the question of interventions outside the health sector, Dr. Lauer explained that the researchers' full model included 188 interventions, some of which go beyond clinical health care to encompass, for example, public policy choices affecting issues like road safety. Meanwhile, the focus here clearly remains on the first of the "three billions" highlighted in WHO's 2018 *Investment Case*: that is, expanding the number of people with access to universal health coverage (UHC). Dr. Lauer proposed that an appropriate way to restate

the researchers' conclusions would be to say that: "Reaching NCD targets that are embedded within UHC should be expected to produce an increase in GDP of about 0.5 percent" annually across countries over the five-year period under consideration.

Paper 2: Health capital, economic growth, and the burden of disease

Jean-Louis Arcand*, Daniele Rinaldo*

(* The Graduate Institute, Geneva)

Top-line messages:

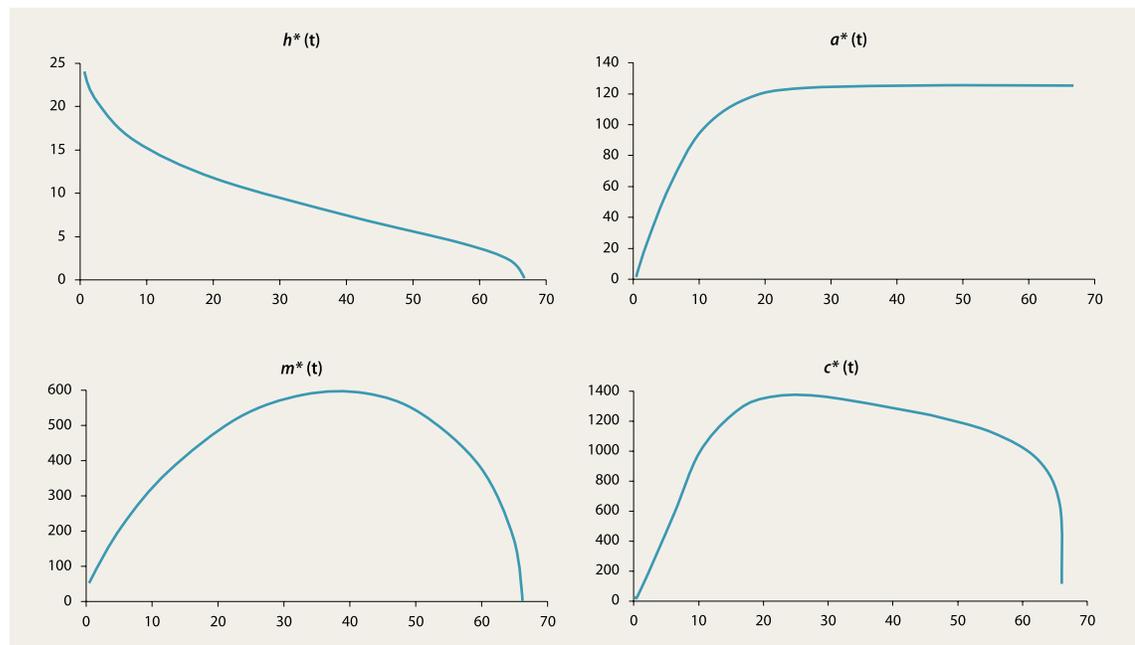
- Complementing empirical analyses, theoretical research in economics may yield new tools that will ultimately enable policymakers to better understand the links between health and economic conditions
- The theoretical model proposed here allows researchers to compute a stock of health capital, which can be measured in dollars, and which is compatible with individual optimizing behavior, for all countries in the world; this enables investigations and comparisons that were not achievable with previous tools
- Early results with the model include the observation that countries' health capital per capita tends to grow significantly faster than GDP per capita
- The model can be used to run counterfactual exercises that yield, for example, estimates of the reduction in global effective labor supply caused by NCD burdens

Study background and aims: In the field of health economics, Grossman (1972) is the canonical dynamic model of the demand for health. In this model, rational individuals are assumed to divide their income between (i) consumption, (ii) saving, and (iii) investing in health capital. Their welfare is assumed to depend solely on consumption: this, therefore, is a world in which health is a pure investment good. In the study summarized here, Arcand and Rinaldo develop an analytically tractable Grossman-type model, which they solve using standard dynamic programming methods, and which they are then able to fit to actual data, allowing them to run a number of interesting counterfactual exercises. They can do so because the theoretical model allows them to compute a stock of health capital, which can be measured in dollars, and which is compatible with individual optimizing behavior, for all countries in the world.

Methods: In contrast to standard dynamic macroeconomic models, individuals in Arcand's and Rinaldo's model are endowed with two stocks of capital: (i) assets which generate interest income and (ii) health capital, an important component of human capital, the latter being equated with effective labor supply. In accordance with human physiology, health capital is assumed to depreci-

ate at an increasing rate as an individual ages, leading to finite lifetimes becoming both inevitable and optimal. The final analytical task is to derive average behavior in the economy at a given time by aggregating over all those individuals who happen to be alive. Remarkably, the expressions for aggregate behavior turn out to be almost as tractable as their individual components.

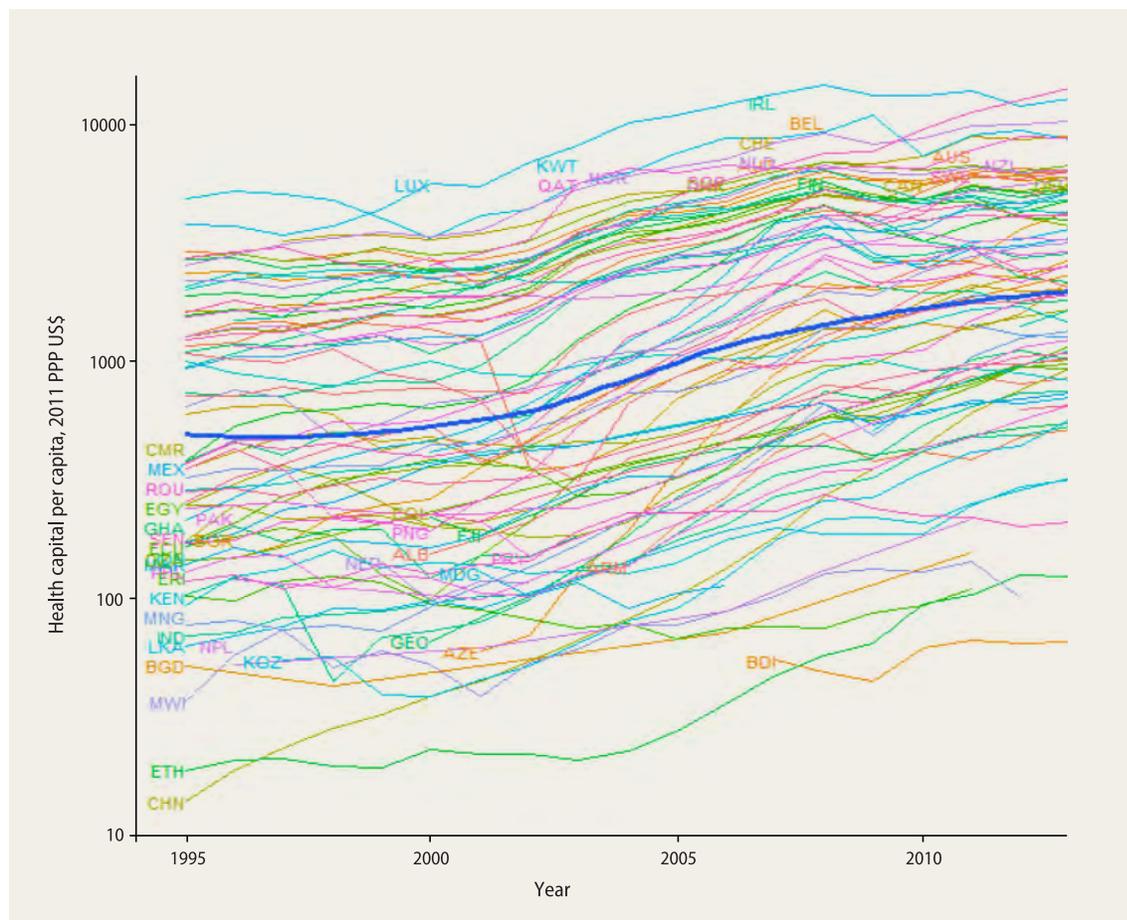
FIGURE 1.3 Illustration of the theoretical model in terms of individual optimizing behavior



The basic intuition of the theoretical model in terms of individual optimizing behavior is illustrated in Figure 1.3. The optimal health capital $h^*(t)$ of an individual is high at birth and gradually decreases, as the health depreciation rate increases with age t . This is also the path followed by effective labor supply, which falls to zero when health capital reaches the horizontal axis (which corresponds to death). Concomitantly, optimal health expenditures $m^*(t)$ initially increase with age (in order to smooth the path of health capital), but eventually fall, as the effect of the increasing depreciation rate of health capital become sufficiently large: this yields an inverse U-shaped pattern over time; optimal consumption expenditures $c^*(t)$ follows a similar path. Finally, individual assets (which through the usual national income accounting identity drive the behavior of the physical capital stock available to firms) increase at a decreasing rate: they cannot fall to zero until the time of death, because the individual's ability to finance consumption is increasingly dependent upon interest income, as labor income falls along with her health capital and effective labor supply.

The empirical calibration of the model relies on five types of data: (i) life expectancy at birth, which corresponds to the optimal finite lifetime of an individual blessed with perfect foresight and which corresponds, in Figure 1.3, to the point where the health capital curve intersects the horizontal axis; (ii) health expenditures per capita which, *ceteris paribus*, increase the stock of health capital; (iii) the difference between life expectancy at 60 and life expectancy at birth, which allows researchers to obtain a rough measure of the time-varying component of the depreciation rate of health capital; (iv) information on the labor share (measured by wages and salaries divided by value-added), which allows researchers to characterize the production technology that produces output using physical capital and effective labor input, and which is a key ingredient determining the optimizing behavior of producers; and (v) information on disability-adjusted life years (DALYs) lost to various pathologies, which allows researchers to parameterize the baseline (invariant) depreciation rate of health capital and, later, to conduct counterfactual simulations.

FIGURE 1.4 Estimated health capital per capita (logarithmic scale), for 92 countries, 2011 US\$ PPP



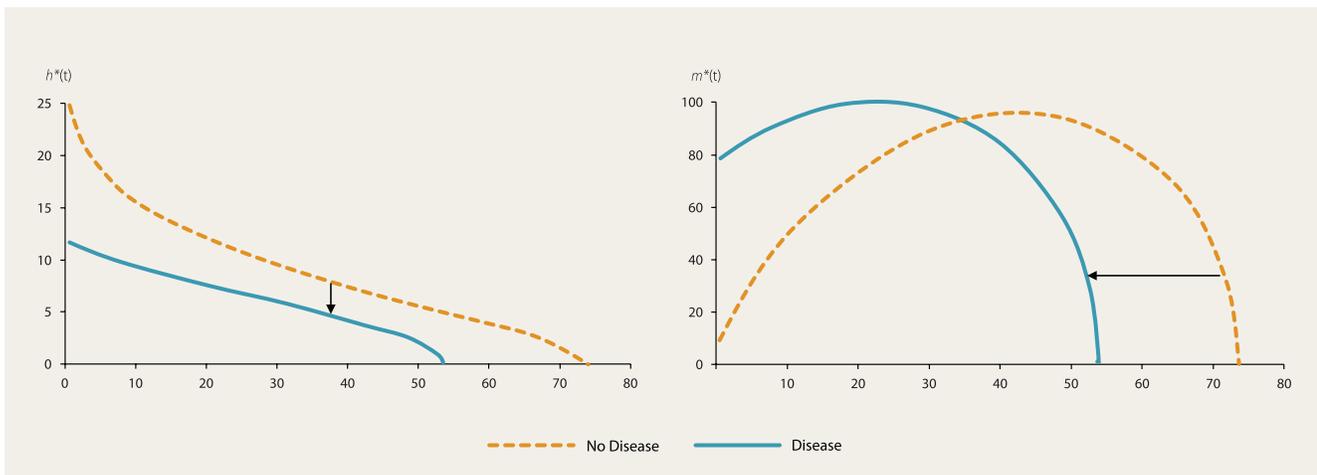
Note: The dark blue line corresponds to a nonparametric smooth of the average behavior in the sample. PPP = Purchasing Power Parity.

Results: Longevity, investment in health capital through health expenditures, and the depreciation rate of health capital are intimately tied together in the model by the fetters of optimizing behavior. Applying standard generalized methods of moments techniques, and the restrictions implied by the theoretical model, the researchers are able to estimate two key parameters: (i) the efficiency with which health expenditures are translated into increases in health capital and (ii) the sensitivity of effective labor supply to changes in health capital. With these two parameters in hand, they are then able to simulate, using the theoretical model, the path of the stock of health capital per capita for every country in their sample. This is illustrated in Figure 1.4 (note the logarithmic scale on the vertical axis). The paths followed by health capital per capita are computed by aggregating the optimal behavior of all generations of individuals alive in a given country in a given year, where the longevity of each generation is also determined endogenously in the underlying theoretical model.

Several interesting empirical regularities emerge. First, as one would expect, the stock of health capital per capita is positively correlated with GDP per capita, though the researchers' estimation procedure does not anchor the former on the latter – this is an important point, in that they are not deriving their estimate of health capital by a procedure that is in any manner linked to an estimate of the value of a statistical life. Second, health capital per capita tends to grow significantly faster than GDP per capita. A noticeable example in the above figure is China (see the CHN code in Figure 1.4), where health capital per capita goes from just above \$10 in 1995 to almost \$1,000 in 2013 – a far larger proportional increase than that of GDP per capita.

Applying the model: a counterfactual on NCDs. What are the implications of this model when it comes to the impact of NCDs on health capital? Figure 1.5 compares the paths of optimal individual health capital and health expenditures with and

FIGURE 1.5 Effect of NCDs on health capital and health investment



without NCDs, where the latter are assumed to increase the rate at which health capital depreciates. When the disease burden is reduced, individual optimal health capital unambiguously shifts upwards, whereas the inverse U-shaped path of optimal health expenditures shifts to the right: as one would expect, optimal longevity is also increased.

Highlights of workshop discussion: Professors **Prahat Jha** and **Sue Horton** again led the conversation. The discussants noted broad consistency between the research presented and existing work on topics such as the “Portfolios of the Poor.” Health capital growth appears to be faster than GDP growth, which again is consistent with existing work by Dean Jamison, Charles Kinney and others. It is thought-provoking that the world is growing more unequal in terms of income, yet may be improving in terms of health capital and its distribution. The discussants and work-

shop members encouraged Professor Arcand and his team to provide readers with a clearer feel for what the numbers represent and to proceed pedagogically in spelling out the implications for policy makers.

Workshop participants went on to note that, while the empirical analysis undertaken by Han, Arcand, and Lauer (Paper 1) could usefully be extended to 2030, there is value in focusing on a five-year timeframe, which approximates the electoral cycles that drive political decisions in many settings. That NCD investments can generate benefits in a timeframe of <5 years is an important political message. On the other hand, some felt that the actual GDP and GDP per capita benefits calculated might appear modest to policymakers. Participants discussed whether the model could be adjusted to more fully reflect the vast economic burden of mental health conditions, for example, and the benefits that would stem from effectively treating them.

Workshop Day 1, afternoon session

Erica Di Ruggiero (University of Toronto) and **Daniel Dulitzky** (World Bank) chaired the first day’s afternoon session.

Paper 3: Estimating the longevity benefits of non-communicable disease mortality reductions in low- and middle-income countries over 2017-2030: findings from a modeling study

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(*) Department of Global Health and Population, Harvard T.H. Chan School of Public Health

Top-line messages: By aggressively tackling non-communicable diseases (NCDs), and in particular reducing mortality from cardiovascular diseases (CVD), low- and middle-income countries can score substantial longevity gains that carry high monetary values.

The study shows:

- Potentially large, sustained longevity gains for

controlling NCDs (particularly CVD) and injuries

- Potentially substantial, sustained longevity losses (high cost of inaction) if countries fail to tackle NCDs (particularly CVD) and injuries

This work also establishes a priority-setting paradigm. It opens the way to a monetized assessment of the global burden of mortality by cause that will enable comparing health-sector and intersectoral investments.

Study background and aims: To best set priorities and allocate investments toward the health sector, it is essential to understand the respective contributions of different diseases and conditions to changes in longevity over time. The researchers estimate the longevity changes induced by various mortality trajectories between 2017 and 2030, the end date of the Sustainable Development Goals, for major disease groups including NCDs for low-income countries (LICs), lower-middle-income countries (LMICs), and upper-middle-income countries (UMICs). In addition, they quantify the monetary value associated with the changes in the mortality schedule that lead to these longevity changes. This effort can be thought of as contributing a “first brick” toward the construction of a money-metric priority setting framework for health sector investments, building on the momentum of “Global Health 2035,” and drawing from the Copenhagen Consensus exercise.

Methods: The study’s goal was to estimate money-metric values of longevity changes per disease category between 2017 and 2030 in two steps:

- **Step 1:** estimate changes in longevity (changes in mortality rates, hence life years) under different mortality scenarios
- **Step 2:** assign monetary values to the underlying changes in the mortality schedule responsible for changes in longevity by using value of statistical life (VSL) methods

Accordingly, the researchers model survival curves for 29 LICs, 50 LMICs, and 50 UMICs under three mortality scenarios between 2017 and 2030: a base-case trajectory that draws from annual age-sex-disease-country-specific mortality forecasts by the Global Burden of Disease study; a “high-performance” trajectory that is defined, for each country income group, as achieving (by 2030) age-sex-dis-

ease-specific mortality rates that correspond to the 90th percentile of the lowest mortality rates of the next-higher country income group in 2016; and a “low-performance” trajectory that relies on 2030 age-sex-disease-specific mortality rates that correspond to the 10th percentile of the next-higher country income group rates in 2016.

All three trajectories are examined for eight broad disease categories: neoplasms; CVD; chronic respiratory diseases; diabetes and other endocrine diseases; mental disorders; injuries; communicable diseases; and maternal, neonatal, and nutritional diseases. The study estimates per-person changes in longevity at all ages between base-case, low-performance, and high-performance trajectories as differences in age-sex-year-specific life expectancy per disease category. Using VSL methods, the researchers derive associated monetary values (in 2011 USD adjusted for Purchasing Power Parity). To assess the robustness of the estimated monetary values, they conduct several sensitivity analyses.

Key results: The high-performance scenario of CVD mortality control would be associated with impressive gains in longevity that carry a high monetary value for LICs, LMICs, and UMICs. The analysis shows potentially large per-person period-specific changes in longevity under the high-performing scenario for CVDs for both females and males by 2030; for LICs, LMICs, and UMICs, the monetary values associated with changes in the age-sex-disease-year-specific mortality schedule for females are estimated at about \$1,700, \$11,000, and \$30,000 in 2030 respectively; for males, the associated monetary values in 2030 are estimated at \$1,700, \$15,000, and \$42,000 respectively. Longevity benefits and the monetary value of the underlying changes in the mortality schedule would be smaller, albeit still substantial, for other NCDs and injuries considered in the analysis. In both LICs and LMICs, large longevity gains via continued reduction of mortality from communicable diseases could also be achieved in the short term.

Critically, the findings highlight potentially large longevity losses under the low-performance scenario for CVDs across all three income groupings: for females in 2030, the per-person monetary value associated with the change in mortality schedule leading to these losses is estimated to be of about \$4,000, \$15,000, and \$42,000 in LICs, LMICs, and UMICs, respectively; for males, the respective per-person monetary values are projected to be of about \$6,000, \$31,000, and \$55,000. Lon-

gevity losses due to injuries and their associated monetary value were especially high for males in LICs and LMICs, relative to other NCDs: in 2030, the per-person monetary values are projected to be around \$6,000 and \$28,000 in the two respective country income groupings.

Discussion, interpretation, and future work: The study finds that large longevity gains, as measured by life years and associated monetary values, could materialize via curbing NCD- and injury-related mortality. For women, the greatest gains would come from addressing CVDs and neoplasms; men's longevity gains would be greatest from better control of CVDs, neoplasms, and injuries. Furthermore, this study points to important setbacks if NCD control is not scaled up: substantial longevity losses could result, particularly for CVDs and injuries across all three country income groups. In addition, largely due to the unfinished agenda of infectious diseases, the researchers observe that, in the short term, much longevity could be gained via communicable disease mortality reduction in LICs and LMICs.

Generally, the analysis stresses that LICs and LMICs could see large longevity gains in the short term while focusing on the unfinished agenda of infectious diseases and maternal and child health. Yet, given the potentially large longevity losses of a low-performance trajectory for major NCDs like CVDs, LICs and LMICs should urgently address NCDs and injuries, where great sustained benefits lie ahead. UMICs, too, should prioritize reducing the burden of mortality due to NCDs and injuries, as the analysis highlights large potential losses in the case of inaction.

Nevertheless, the researchers found wide variations in the estimated per-person monetary values under various sensitivity analyses, which highlights the need to conduct more robust analyses in eliciting mortality risk valuations in LICs, LMICs, and UMICs, in terms of estimating the value of a statistical life. Future work can also build upon this study by replicating the approach in other countries and settings (e.g., sub-Saharan Africa, South Asia). Replications which rely on micro-data or administrative data collected in these countries and regions may provide an important point of comparison for the results presented in this analysis.

Future work should also examine within-country inequalities in the distribution of these longevity effects along the socioeconomic gradient and age groups. Likewise, disease-specific mortality reductions including from NCDs, mental disorders, and

injuries should be viewed with their respective contributions toward reducing the burden of illness-related impoverishment and alleviating poverty.

This research shows that, by systematically monetizing the global burden of mortality by cause, one can conceive a priority-setting paradigm to best allocate investments toward the health sector, which can then be evaluated in terms of returns on investment and be compared across other sectors outside the health sector.

Highlights of workshop discussion: Professor **Dean Jamison** (UCSF) served as main discussant for the paper. Professor Jamison observed that the work presented could advance the generation of an “economic burden of disease by time and place,” which would be highly informative for policy deliberations. The “economic burden of disease” would in a sense be complementary with the existing epidemiological GBD. Among other benefits, it would help stop the confusion spawned by the proliferating “Investment Cases” now regularly produced by many disease-specific programs and constituencies (including for NCDs!). This work could also, Professor Jamison suggested, be interpreted as a major step towards challenging the models of DALYs and QALYs.

The idea of a “global economic burden of disease” sparked the interest of workshop participants, who explored potential implications for policy and practice. Several participants requested that researchers orient the community in understanding how practitioners can best use these tools to assess and prioritize interventions (including prevention). Rewards will come from identifying anchoring points in these models where policy can engage.

Participants also asked how the monetized results obtained by Professor Verguet related to the calculations of GDP and GDP per capita gains presented earlier by Dr. Lauer and team (Paper 1 in this chapter). In the course of extended follow-up discussions, Professor Verguet explained that it is, in fact, difficult to directly compare the results from the two analyses. Fundamentally, the Khadka and Verguet (KV) analysis differs from the Han, Arcand, and Lauer (HAL) study in that KV estimate monetary values associated with changes in mortality risk, whereas HAL estimate changes in GDP and GDP per capita as a result of changes in the composition of the skill-augmented labor force and productivity. For HAL, GDP and GDP per capita estimates are the key outcomes, whereas for KV, gross national income (GNI) per capita (of which GDP is a component) is

an input in their analysis to ultimately estimate the monetary value of changes in mortality risk.

While not directly comparable, the two methods can be thought of as complementary approaches to putting a value on the health gains that countries can obtain by addressing the NCD epidemic. Both can provide potentially motivating information for decision-makers. Both expand the current toolkit of instruments for NCD analysis and policy dialogue.

Paper 4: Measurement and determinants of NCDs and their impact on adult survival

*Daphne Wu**, *Jeremy Veillard***, *David Watkins****, *Ryan Hum**, *Dean T. Jamison#*, *Prabhat Jha**

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Top-line messages:

- Reducing adult mortality (probably) improves income growth
- Consider 40q30 (mortality from age 30 to 69) as the main metric of adult survival for the Human Capital Index and the SDGs
- Adult mortality is generally falling worldwide, but rising vascular mortality in some settings raises concerns
- Costs for reducing adult mortality, at the margin, are rising
- Increasing income and increasing spending on health are effective means of reducing adult NCD mortality
- An expanded package of NCD interventions would go a long way toward achieving the relevant SDGs

Study background and aims: The research being pursued under Paper 4 encompasses the following questions:

1. Does better adult health increase income growth?
2. Can we move from the current 45q15 adult mortality metric to 40q30?

3. What are the key trends in adult and NCD mortality?
4. Which macro-level policies reduce adult mortality?
5. By how much could stronger NCD interventions speed SDG progress and reduce premature deaths?

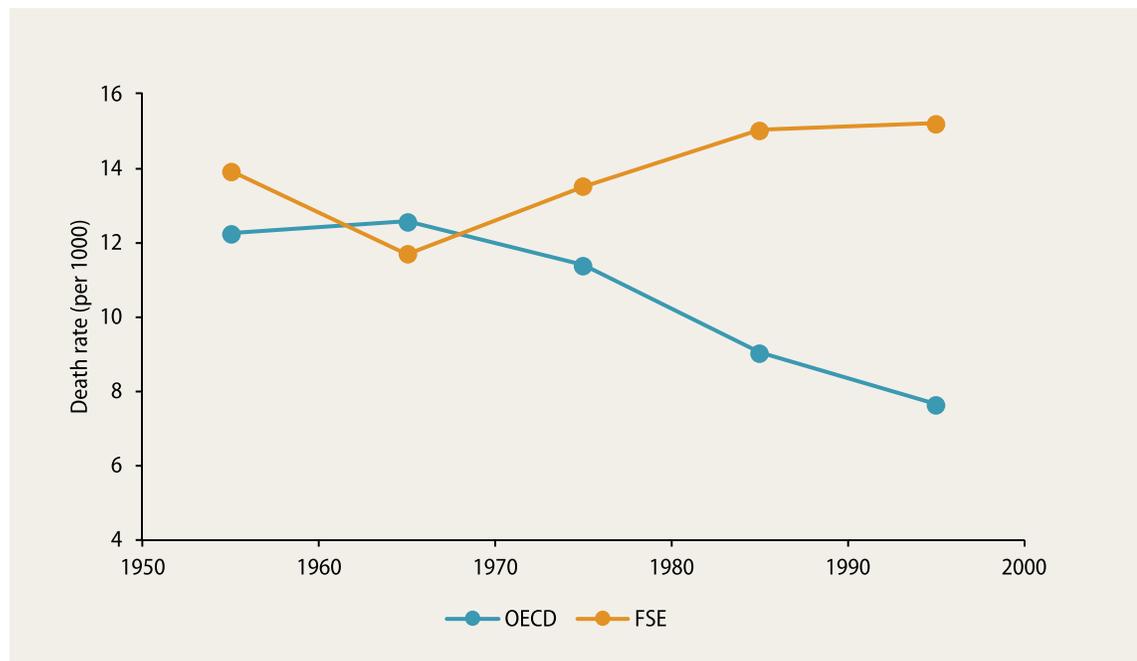
This summary focuses on questions 1, 4, and 5, which have particular salience for engaging policy makers (notably ministers of finance) around NCDs and human capital. Question 2 provoked lively discussion in the workshop, reflected in the section of this chapter on measurement challenges.

Economic benefits of reduced adult mortality

Ms. Wu and Professor Jha began by approaching from a new angle the question of potential economic payoffs from adult mortality gains, a key theme of the workshop's earlier papers. Wu and Jha argued that substantial evidence can be drawn from the existing public-health literature to bolster the case that gains in adult life expectancy can deliver major economic benefits for countries.

Earlier unpublished analysis of data from the former states of the Soviet Union provides one illustration. It is well known that adult male life expectancy in the former Soviet states declined sharply in the years preceding and after the dissolution of the USSR, with NCDs (particularly alcohol-related) among the drivers of increased mortality. Trends in adult male mortality in the former Soviet region and in Organization for Economic Co-Operation and Development (OECD) countries have diverged sharply over recent decades (Figure 1.6).

Building on earlier work by Jamison, Lau, and Wang (2005), Wu and Jha showed that it is possible to calculate the economic benefits that former Soviet states might have obtained by reducing their adult male mortality during the period. In 1990, the average 15-year-old male living in the former Soviet republics had a 72 percent likelihood of surviving to age 60. The corresponding probability in OECD countries was 86 percent. If adult male life expectancy in the former Soviet states had matched the OECD average from 1990 on, the ex-Soviet countries would have enjoyed a substantial boost in economic growth: growing at 1.4 percent per year, on average, over the past three decades, rather than the 1 percent average rate they actually experienced.

FIGURE 1.6 Worsening adult male mortality in former Soviet states, 1950-2000

Source: Peto et al. 1994.

Determinants of adult mortality (including macro-level policies)

Lowering adult mortality can yield substantial economic payoffs. But what are the policy levers that countries can use to bring mortality down? Wu and Jha explained that a key task for their paper is to shed light on this question by examining the macro-level determinants of adult mortality. The following notes briefly summarize the methodology that Wu, Jha, and team have used to analyze macro-level determinants, and the findings obtained to date.

Methods: The researchers examine the macro-level determinants of adult mortality (mortality at age 30-69, or 40q30), using a random effects regression model. In Wu's and Jha's model, the macro-level determinants of adult mortality are as follows: mean years of female education (FeEd), GDP per capita (GDPPC), health expenditure as a percentage of a country's GDP (health_exp), percentage of health expenditure that is borne out of pocket (OOP), malaria incidence per 1,000 population at risk (malaria), HIV prevalence as a percentage of the population age 15-49 (HIV), urban percentage (urban), and access to electricity (electricity). The model allows for differences across countries, such as the dif-

fusion and adoption of new technologies, to affect the outcome. The model is given by:

$$\ln 40q30_{i,t} = \beta_0 + \beta_1 \text{FeEd}_{i,t} + \beta_2 \ln \text{GDPPC}_{i,t} + \beta_3 \text{health_exp}_{i,t} + \beta_4 \text{OOP}_{i,t} + \beta_5 \text{malaria}_{i,t} + \beta_6 \text{HIV}_{i,t} + \beta_7 \text{urban}_{i,t} + \beta_8 \text{electricity}_{i,t} + \mu_i + \varepsilon_{i,t}$$

The researchers used data from 163 countries for 2000, 2010, and 2016. They examined the association between the macro-level variables and adult mortality attributed to (1) NCDs, (2) communicable, maternal, and perinatal conditions (CMPs), and (3) injuries.

Results: The researchers found that, other things being equal, female education is not significantly associated with all-cause adult mortality, while a 10 percent increase in income is associated with a 1.5 percent reduction in all-cause adult mortality, and a 10 percent decrease in HIV prevalence is associated with a 34 percent reduction in adult mortality, respectively (Table 1.1).

The finding that there is no significant association between female education and adult mortality contrasts with the results of Pradhan and others (2017), as they did not control for the impact of other macro-level variables. Female education, however,

is significantly associated with CMP- and injury-attributable mortality: An additional year of female education decreases CMP- and injury-attributable mortality by 6 percent and 2.9 percent, respectively.

Income is significantly associated with all four categories of mortality: A 10 percent increase in income reduces both all-cause adult mortality and NCD-attributable mortality by 1.5 percent, CMP-attributable mortality by 2.5 percent, and injury-at-

tributable mortality by 3.1 percent. An increase in health expenditure of 2.5 percent of GDP would reduce all-cause mortality by 3.8 percent, NCD-attributable mortality by 8.5 percent, and injury-attributable mortality by 5.7 percent. Lower out-of-pocket health expenditure (OOP) is associated with a reduction in adult mortality: a 10 percent decrease in OOP reduces all-cause adult mortality by 2 percent, though it does not affect NCD mortality.

TABLE 1.1 Determinants of log adult (40q30) mortality and effect of intervention on adult mortality

	Coefficient	Intervention	Reduction in adult mortality (%)
All-cause adult mortality			
Female education	-0.004		
ln GDP per capita	-0.145*	10% increase	1.45%
Health expenditure	-0.015*	2.5% GDP increase	3.78%
OOP	0.002*	10% decrease	1.95%
Malaria	0.000(1)		
HIV	0.034*	10% decrease	34.13%
Urban	0.000		
Electricity	-0.002*	10% increase	2.09%
NCD-attributable adult mortality			
Female education	0.000		
ln GDP per capita	-0.153*	10% increase	1.53%
Health expenditure	-0.033*	2.5% GDP increase	8.45%
OOP	0.001		
Urban	-0.003*	10% increase	2.62%
Electricity	0.005*	10% decrease	4.82%
CMP-attributable adult mortality			
Female education	-0.058*	1 additional year	5.95%
ln GDP per capita	-0.248*	10% increase	2.48%
Health expenditure	-0.020†	2.5% GDP increase	5.05%
OOP	-0.002		
malaria inc	0.000(2)		
HIV prev	0.090*	10% decrease	94.69%
Urban	0.001		
Electricity	-0.011*	10% increase	10.89%
Injury-attributable adult mortality			
Female education	-0.028*	1 additional year	2.86%
ln GDP per capita	-0.309*	10% increase	3.09%
Health expenditure	-0.022*	2.5% GDP increase	5.65%
OOP	-0.001		
Urban	0.004		
Electricity	0.005*	10% decrease	4.74%

Note: *p<0.05. Effect of intervention only indicated for variables with p<0.05.

Assessing implications for policy and programming. Initial analysis suggests that effective means to reduce adult mortality from NCDs include: increasing income and increasing spending on health. Of note, the researchers also found that a 10 percent decrease in out-of-pocket health expenditure (OOP) reduced 40q30 by 2 percent.

Further work is underway to deepen this analysis and clarify policy and program-delivery options. One clear conclusion from the investigation to date is the importance of robust health spending, guided by strong evidence. This approach is embodied in Disease Control Priorities 3 (DCP3), a key practical resource for country policy makers, their advisers, and partners. DCP3 defined an Essential Universal Health Coverage (EUHC) package, which consists of a list of 218 interventions that were deemed to provide good value for money in multiple settings, address a significant disease burden, and be feasible to implement in low- and middle-income countries (LICs and MICs) (Watkins et al. 2018). The package covers nearly all major health conditions from birth to death, including maternal and child health conditions, infectious diseases, NCDs, injuries, and health services such as surgery and rehabilitation. It even goes beyond direct health services to cover the health system interventions used for monitoring and surveillance.

Watkins and colleagues estimated that, for 80 percent population coverage, the EUHC package would cost a total of US\$65 billion in low-income countries and US\$270 billion in lower middle-income countries. Based on a total population of 0.90 billion and 2.7 billion in 2017, respectively, this would mean US\$72 per capita in low-income countries and US\$101 per capita in lower middle-income countries.

Of the total service delivery cost, which accounts for 60 percent of the total EUHC cost (while the remaining 40 percent consists of costs of ancillary services and programs to support health services), prevention and treatment of NCDs would account for about US\$17 billion (or 41 percent) in low-income countries and about US\$86 billion (or 51 percent) in lower middle-income countries.

Based on an estimated US\$18 billion and US\$73 billion in current spending, the additional cost to cover 80 percent of the population in low- and lower middle-income countries (“incremental cost”) would be about US\$46 and US\$160 billion, respectively. Of the total incremental cost for service delivery, which

accounts for 60 percent of the total EUHC cost, prevention and treatment of NCDs would account for about US\$15 billion (or 52 percent) in low-income countries and about US\$55 billion (or 56 percent) in lower middle-income countries.

With the implementation of EUHC, about 1.2 million deaths and 2.9 million deaths due to all causes could be averted in low- and lower-middle-income countries, respectively. The number of deaths averted due to NCDs, CMPs, and injuries would be about 0.53 million, 0.65 million, and 0.06 million respectively in low-income countries, and about 1.9 million, 0.94 million, and 0.1 million respectively in lower-middle-income countries. In terms of progress towards the 40q30 target, low-income countries would achieve greater progress in all-cause mortality reduction, as well as in all of the three areas of condition-specific mortality, compared to lower-middle-income countries (80 vs. 60 percent in all-cause mortality reduction, 88 vs. 70 percent in mortality reduction due to NCDs, 86 vs. 63 percent in mortality reduction due to CMPs, and 46 vs. 19 percent in mortality reduction due to injuries).

Similar analyses done in partnership with the Asian Development Bank for urban areas of Indian and Bangladesh also suggest significant benefits (Wu et al. 2020).

Highlights of group discussion. The principal discussants for the paper were **Adriana Blanco** (PAHO) and **Jeremy Veillard** (World Bank). A key topic of interest concerned the balance to be found between focusing on adult mortality and morbidity, in relation to NCDs. In terms of mortality as a proposed best measure of NCD impacts, some participants remained skeptical, in light of the magnitude of burdens imposed by non-fatal diseases such as mental health conditions, diabetes, obesity, and others. For many, disability remains a crucial measure for communicating the importance of NCD epidemics and the human and economic damage they inflict. Participants cited, for example, the rising tide of neurodegenerative disorders (e.g., Alzheimer) and mental health conditions. In the near future, in some settings, resources on the order of 5-7 percent of GDP may have to be channeled towards public-sector management of these burdens. Costs of such magnitude should catch decision makers’ attention. Some participants noted that the human capital framing enables this discussion to be positioned in the context of how we can most intelligently invest in people.

In considering how governments and societies can respond, the promise of technology to alter the current equations has not been adequately grasped. Large-scale new investment in NCD interventions and technologies is needed. In this respect, some argued, digital health could mark a revolution, including in mental health and NCD care.

As co-chair, Dr. **Jeremy Veillard** summed up

the discussion by observing that the challenge remains of turning the NCD story into a narrative that demands urgent action, a “narrative of crisis.” He noted that education experts at the World Bank and elsewhere have been successful in communicating around the idea of an education crisis. The human capital framing may help the NCD community achieve comparable impact.

Workshop Day 2, morning session

Tim Evans (World Bank/McGill University) and **Rachel Nugent** (RTI) co-chaired the first session of Day 2. The session began with a review of main results from the first day of the workshop, summarized by **Sir George Alleyne** and Professor **Dean Jamison**.

Recapping results from Day 1

Health perspective

Sir George Alleyne

Dr. Alleyne prefaced his comments by noting that, while many aspects of the previous day’s rich discussion would merit attention, he would focus on the workshop’s core theme: links between NCDs and human capital. Through this lens, notable contributions emerged from each research paper.

Paper 1, presented by **Jeremy Lauer**, brought a powerful message on the GDP gains that countries could achieve by scaling up NCD interventions. The paper specified key avenues of intervention on NCDs, from primary care services to population-level and policy measures. Bringing relevant interventions to 60 percent coverage would lead to a decrease in physical capital concomitantly with an increase in the effective labor supply. The net result for countries would be an average annual increase of 0.5 percent in GDP and 0.7 percent in GDP per capita over five years.

From Paper 2, presented by **Jean-Louis Arcand**, the most critical message for Dr. Alleyne was the demonstration of a valuation of health capital which had two possible measurements – dollars or years. The key contribution of this approach is the ability to quantify the impact of NCDs on health capital and to validate that health capital grows faster than GDP.

Stéphane Verguet, in Paper 3, had proposed a novel monetized assessment of the longevity benefits of interventions to decrease NCDs. Dr. Alleyne noted that much of the workshop discussion of this paper turned around the merit of a conjoined measure such

as DALYs, which minimize the importance of disability—a key facet of NCD impacts on human capital.

Prabhat Jha and Daphne Wu, in Paper 4, had argued persuasively for adopting the 40q30 measure—rather than or in addition to 45q15—to assess the effect of NCDs on adult mortality. The subsequent conversation had again highlighted the importance of considering disability in setting priorities for NCD prevention and control.

Dr. Alleyne noted that, at various points throughout the day, the issue of a whole-of-government approach to NCDs arose, and the point was made that a human capital perspective makes the fiscal demands of dealing with NCDs easier to accept, because it opens a clear line of sight from NCD spending to economic gain.

Economics perspective

Dean Jamison

Professor Jamison reported three main reactions to the research findings and discussion on Day 1.

First, on the **economic benefits of NCD action**, he observed that the community is now close to being able to assemble a robust account of the economic benefits of the gains in NCD prevention and control and the dollar values that will be achieved. The literature on this issue is generally consistent, and workshop contributors have that literature well in hand.

The **intersectoral dimension of NCD challenges** is a second key topic, where consensus within the community appears more elusive. On this topic, important choices (including for the workshop group)

remain outstanding. Pressing problems around intersectoral action include at least two sub-issues:

1. **Intersectoral policies to manage behavioral and environmental risks.** What policies are effective, and how would we know? What avenues of research should be prioritized, to provide the answers policy makers need? Professor Jamison cited the control of obesity as an example: evidence-based policy recommendations are generally lacking; the obesity problem still belongs more to the research agenda than to the domain where policies can be chosen from a set of proven options, with well-understood costs and benefits. In general, Professor Jamison argued, the economics of risk factors lags far behind the economics of health.

2. **The financial impacts of NCD epidemics outside the health sector.** An example concerns the costs of long-term care. Professor Jamison noted the case of the Netherlands, where an aging population with increasingly complex NCD comorbidities is propelling a cost explosion in long-term care.

As a third and final point, Professor Jamison evoked the **perspective of ministries of finance on the fiscal consequences of NCD burdens.** He noted what appears as an inevitable trend in many countries, whereby NCD-related services that had been informally provided in households are being shifted onto the public sector (relevant diseases include mental health conditions and neurodegenerative disorders). The fiscal consequences of this shift are likely to be very substantial in many settings.

As a result, Professor Jamison noted that his personal takeaway from the first day's discussion was the opportunity for a "pithy focus on the crisis." The major social problem we are facing, he argued, is the fiscal consequence for government of managing the growing burden of NCDs—linked to the fiscal opportunities that may arise from better management of these diseases.

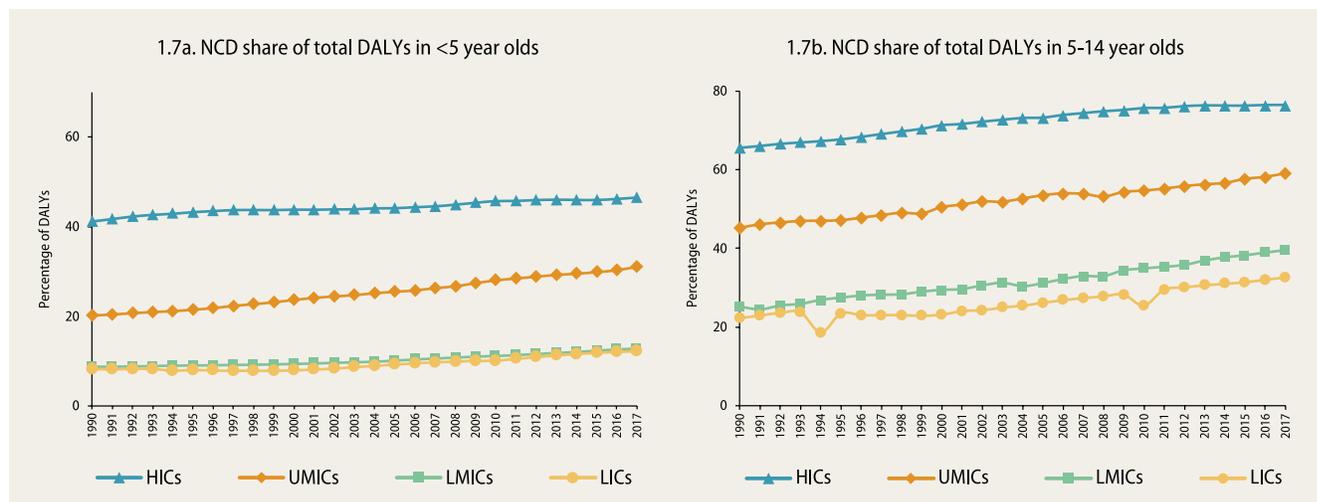
Paper 5: NCDs, education, and human capital: how do NCDs interact with education to affect human capital accumulation?

Sanam Roder-DeWan*, Ojaswi Pandey**, Aakash Mohpal**
 (*) Harvard University (**) World Bank Group

Top-line messages: The research is ongoing and currently points to five main preliminary results:

1. The prevalence of NCDs among children is non-trivial and rising. Globally, NCDs accounted for 10 percent of all deaths in children under 5 years of age in 1990 and 18 percent among children aged 5 to 14 years. By 2017, these figures had increased to 14 percent and 23 percent, respectively.
2. Yet much of the existing research evaluating the impacts of poor health on educational attainment and subsequent labor market outcomes has focused on issues of nutrition and early childhood development (low birthweight, stunting, and psychosocial stimulation) and common acute conditions (parasitic infections and deworming).
3. Preliminary analysis of survey data from the UK and India shows that NCDs in childhood are correlated with lower test scores and lower educational attainment. The impacts of NCDs in childhood appear to accumulate into adult life. Experiencing NCDs in childhood is correlated with lower employment and earnings.
4. Education does appear to mitigate some of the adverse associations between NCDs and labor market outcomes. Nevertheless, productivity losses in adults who had NCDs as children appear to be large and warrant attention.
5. These preliminary associations underscore the need to pay attention to NCDs in children, identifying interventions to mitigate their adverse effects. The observed associations also highlight the need for further research to causally identify and quantify the impacts of NCDs on education and subsequent labor market outcomes.

Study background and aims: The overarching objective of the research is to understand the relationships between NCDs in children and their parents, educational attainment, and wealth accumulation. Education positively impacts health, and good health and nutrition can improve both the quantity and quality of education (Behrman 1996; Pradhan et al. 2018). There is, without doubt, reverse causality between health, education, and wealth, and this has generated substantial research attempting to disentangle causal impacts (Strauss and Thomas 1998; Glewwe and Miguel 2008). However, the literature has mostly focused on in utero and early childhood conditions, nutrition in infants and children, communicable diseases such as parasit-

FIGURE 1.7 Substantial NCD burdens among children in low- and middle-income countries

Note: 15.5% of DALYs for children <5 years globally (7a) and 42.4% for children ages 5 to 14 years (7b) are from NCDs. Even in LICs, NCDs accounted for 13.2% of DALYs for children <5 years old and 32.5% for 5- to 14-year-olds. In HICs, the corresponding figures are 44.4% and 72.3%.

ic infections, vision problems in adolescents, and energy supplementation in adults. NCDs constitute 62 percent of DALYs worldwide and 42.4 percent of DALYs among those aged 5-14 years.

However, little direct evidence exists evaluating the impact of NCDs on educational attainment and wealth accumulation (Figures 1.7a and 1.7b).

This study looks specifically at the impact of NCDs (of child and parent) on educational attainment in childhood and on the ability to accumulate wealth, maintain savings, and avoid poverty in adulthood. The paper is broadly premised on a life-course approach that links early life experiences, starting in the preconception phase, to a variety of outcomes throughout life (WHO 2013; Baird et al. 2017). The researchers hypothesize that an NCD shock in childhood creates cumulative disadvantage both through lower educational attainment and through additional, independent health pathways that compromise adult capacity to accumulate human capital.

Methods: To test this hypothesis, the ongoing research began with a literature review on the potential pathways through which NCDs and education may jointly affect human capital accumulation. The study is now proceeding to analyze survey data from four countries (India, Indonesia, Mexico, and the UK) to investigate the prevalence of NCDs among children and how NCDs in children may affect school enrollment, educational attainment, and labor market outcomes. Extensions of the work also look at whether education can mitigate the adverse

effects of NCDs on labor market outcomes. A final piece of analysis considers the impacts of NCDs in adults (parents) on the education of children in households. Since NCDs impose a significant economic burden on households in the form of workplace absenteeism, reduced employment, and lower incomes, it is possible that children who grow up in households where adults are chronically ill face greater challenges in accumulating education.

Given that among the countries and data sets selected, NCDs in children are reported only in the UK and India, the first part of the analysis is restricted to these data. The UK data is a cohort study of 17,000 children born in 1958 who were followed to age 55 (National Childhood Development Study). The India data is a nationally representative panel household survey with two rounds – 2005 and 2012 (Indian Human Development Survey). Data from Mexico and Indonesia are panel surveys and are used only to assess the impacts of NCDs in parents on the educational accumulation of the children. Currently, analysis is well advanced for India and the UK; analysis for the other countries is in earlier stages.

Research assessing the effects of health on education faces formidable econometric identification challenges (Behrman 1996; Glewwe and Miguel 2008). This study attempts to address the methodological challenges by using a panel data household fixed effects estimation strategy. The panel data helps remove time-invariant individual and household level unobservable characteristics, while the household fixed effects ensure that all the identifying vari-

ation comes from siblings in the household (which to some extent controls for genetic variation). Nevertheless, while these methods provide an improvement over analysis of cross-sectional data, as is well attested in the literature, such methods do not overcome all econometric identification issues. Addressing all identification issues is beyond the scope of the paper. Therefore, the results should be interpreted as correlations and not as causal parameters.

Key results: While analyses are still in progress, suggestive early findings have emerged. These include:

- In the UK, the prevalence of NCDs in children aged 7 years in 1965 was high. 6.6 percent of children suffered from chronic respiratory illnesses, 2.4 percent had a heart disease, and 15 percent suffered from neurological, developmental, or mental health disorders. Finally, 13.7 percent of children reported having visual difficulties, and 4.8 percent had hearing difficulties.
- In India, the figures are much lower. In 2012, 0.12 percent of children aged 0-14 years reported having chronic respiratory diseases, 0.34 percent suffered from neurological, developmental, and mental health disorders, 0.30 percent had vision difficulties, and 1.63 percent had hearing difficulties. The low prevalence of NCDs may partly reflect poor access and diagnostic quality in the health sector, as well as the nature of the survey, which relies on recall data (as opposed to direct measurement in the UK).
- NCDs in childhood are strongly associated with school absenteeism in the UK. Children with NCDs report 0.9 percentage points lower attendance rates at age 7 and 0.07 percentage points lower attendance at age 11, compared to their counterparts. In India, most of the effects are seen on the extensive margin. NCDs in childhood are correlated with a 15-percentage-point lower school enrollment rate (estimations with household fixed effects). Conditional on going to school, there is no significant correlation with absenteeism.
- In both countries, having NCDs is associated with lower educational performance. In the UK, NCDs are correlated with 11 percent lower math scores at age 7, and with 16 percent lower math scores at age 11. Similarly, NCDs are correlated with 10 percent lower reading scores at age 7 and 11 percent lower scores at age 11. In India, having NCDs is correlated with a reduction of 0.75 standard deviation in overall test scores.
- Having NCDs in childhood is associated with lower educational attainment in both the UK and India. In the UK, NCDs in childhood are associated with 1.7 fewer years of completed education at age 23 (compared to the average of 8.6 years, statistically significant at 1 percent). In India, the effects are even larger, considering the average duration of education is 7.9 years. Having NCDs at ages 15-24 in India is correlated with 1.3 to 1.8 fewer years of education seven years later (measured at ages 22-31).
- NCDs also have a significant detrimental effect on labor market participation and outcomes. In the UK, people who had NCDs as children are 3.3 percentage points less likely to be employed at age 23 and 4.9 percentage points less likely to be employed at age 50. Education does appear to play a mitigating role. The coefficient on the interaction term of having NCDs as children and years of schooling is positive, suggesting that children with NCDs who acquire more education are less likely to be unemployed.
- Results from India are similar to those observed in the UK. Youth aged 15-24 who had NCDs are 8 to 11 percentage points less likely to be employed seven years later (at ages 22-31). Adults aged 25-44 are also 7 percentage points less likely to be employed seven years later (at ages 32-51).
- NCDs in childhood are associated with lower adult height in both countries studied. Children with NCDs in the UK grow up to be 0.64cm shorter at age 23 than their counterparts (the mean is 169.7cm). Children in India with NCDs are 0.66 to 2.57cm shorter, compared to their counterparts (the mean is 142.6cm).
- These emerging correlations suggest that NCDs in childhood and adolescence may substantially lower subsequent adult productivity through their impact on education.

Discussion and future work: Results to date underscore the urgent need to take NCDs in childhood seriously, as they could have a large detrimental impact on human capital. Preliminary findings, although correlational, suggest that policies to mit-

igate the potential adverse impacts of NCDs in children on educational outcomes could substantially improve future productivity, when today's children reach adolescence and adulthood. The research also looks at intergenerational impacts of NCDs and the potential role of education in this relationship. Specifically, it seeks to understand if education can mitigate the transmission of adverse impacts of NCDs in adults to children in the household. This component of the research is ongoing.

Limitations and caveats: While the preliminary findings point to the possibility of large adverse educational and labor market impacts of NCDs in children, these findings are subject to several caveats and need to be interpreted with caution.

- First, the estimates are correlational and do not represent causal parameters. The panel data household fixed effects approach in India alleviates this concern to some extent, but still leaves room for criticism (see Glewwe and Miguel (2008) for a review of this literature). In addition, given the low prevalence of NCDs, we are also left with little variation.
- Part of the reason for the low prevalence of NCDs in the India data is probably that the data are self-reported. Self-reported data are subject to recall bias and measurement error. It is also possible that the reported positive cases are those of the most-affected children, which could lead to large and upward-biased estimates.
- While data in both countries have high follow-up rates, we have not yet attempted to account for attrition over survey rounds, which could lead to biased estimates. Preliminary analysis of the data from both the UK and India shows that those with NCDs are more likely to drop out of the survey, which will lead to downward-biased estimates.
- So far, we have grouped all NCDs into a single category. However, the biomedical literature suggests that different NCDs could have very different effects on educational attainment (for example, mental disorders vs. type I diabetes). More work is needed to parse out the effects of specific NCDs of interest.

Future work:

- Assess the impacts of NCDs in parents on the educational accumulation of children. This is also where

the data from Mexico and Indonesia will be analyzed.

- Consider specific categories of NCDs, as opposed to grouping them all together.
- Survey the literature for additional methods to overcome the endogeneity problem and use best available practice for panel data.

Highlights from workshop discussion: The lead discussant for the paper was Professor **Sue Horton** (University of Waterloo). Professor Horton urged the researchers to be circumspect in formulating results and not “overpromise,” as some of the language used in presenting early findings had appeared to suggest a demonstration of causality. (The researchers have subsequently worked to address these concerns.) Professor Horton suggested that the researchers might experiment with alternative models to incorporate additional factors potentially affecting outcomes, considering patterns among siblings, exogenous shocks, and other factors. Professor Horton recalled the important work done at Sweden's Karolinska Institute on multi-directional interactions between parents and children with regard to NCDs.

Some participants emphasized the relevance of the life-course literature, with its attention to critical windows of vulnerability – certain periods that are more sensitive to shocks. Colleagues endorsed the value of carefully separating out the different kinds of NCDs, noting that the policy implications for distinct disease types may be very different. (The researchers have again taken this guidance on board.) Finally, some participants urged that the researchers ultimately not decline to offer their own causal interpretations, even though, with the available data, they cannot establish the magnitude of impacts.

Key messages from research papers and workshop discussions

With the facilitation of the co-chairs, workshop participants reflected on the learning that had emerged over the course of the event, both from the research papers and presentations and from group discussions. Each participant was invited to formulate key learning points in writing. The ideas were then reviewed, grouped under a series of emerging thematic headings, and further discussed. Key topics and messages that garnered substantial consensus included the following:

Enhancing human capital through NCD control will yield economic benefits for countries

Countries can reap substantial economic benefits by strengthening their human-capital base through action on NCDs. New research for this initiative suggests the magnitude of possible gains and shows that countries may obtain benefits within relatively short timeframes (1-5 years). Key mechanisms driving the gains include improvements in effective labor supply and longevity.

Better human capital means higher productivity, short- and long-term

Most economic benefits of improved NCD prevention and control will stem from productivity gains. Some benefits will be felt rapidly, as survival and productivity rise among current workers. This initiative is finding evidence that, by reducing NCDs in children and caregivers, countries will also improve human capital and boost productivity in future generations, through improved educational outcomes.

The price of inaction will be high

Successfully controlling NCDs will bring countries major fiscal rewards through human capital gains. Conversely, if countries fail to adequately protect their human capital from NCD epidemics, the economic consequences will be severe—including soaring health expenditures and foregone government revenues. Khadka's and Verguet's "poor-performing" scenario has helped to quantify this threat.

The up-front investments needed to manage NCD burdens may be substantial, but they are dwarfed by the costs that loom, if necessary action is postponed (Bertram et al. 2018; Nugent et al. 2018).

Tackling NCDs can reduce poverty and inequality and promote social stability

Analyzing 283 studies, Niessen and colleagues (2018) found overwhelming support for a positive association between low incomes, low socioeconomic and/or educational status, and NCDs, including: tobacco use, obesity, hypertension, cancer, and diabetes. Global health equity gaps are likely to widen further as the share of premature death and disability caused by NCDs rises in LICs and LMICs. Tackling NCDs is an effective way to improve human capital among the least well off, reduce inequalities, reinforce social stability, and ensure that countries fully harness talent from their whole populations, an advantage for competitiveness.

The power of a life-course approach

The focus on specific needs and interventions for adult survival underscores the power of an approach to health tuned to the stages of the life course. This includes gestation, infancy, childhood, and adolescence, with their specific windows of vulnerability and opportunity for developmental processes, as well as the diverse stages of adult life. A life-course perspective is implicit in the analysis of human capital and further enhances human capital's value as a frame for analysis and action on NCDs.

Intergenerational effects

As they affect multiple stages of the life course, so NCD impacts also cascade from one generation to the next. By definition, non-communicable diseases are not transmitted by infectious "bugs" from person to person. But NCDs' negative economic and social effects can spread within households and permeate neighborhoods and communities (Jan et al. 2018). Indeed, one reason why NCDs are so important, in addition to their direct impact on income and well-being, is that adults who are compromised by NCDs may have trouble executing their intergenerational responsibilities to children and the elderly. In this way, NCDs cause human capital losses that perpetuate themselves across generations.

Increased efficacy through action across sectors

DCP3 and other research efforts have highlighted the promise of intersectoral action in NCD prevention and control. NCD prevention strategies, in particular, are vital to build and protect human capital. Priorities include improving child and adult nutrition, promoting healthy mobility, and using excise tax measures to discourage consumption of health-damaging products, most prominently tobacco. For these and many other approaches, collaboration across government sectors is essential for high-impact action on NCDs. Where feasible, a whole-of-government approach may be the most effective way to make progress. Alignment and pooling of know-how among WHO, the World Bank, and other partners at country level may facilitate the delivery of successful intersectoral policies and the evaluation of their impacts.

Toward an "adult survival revolution"?

As this initiative's commissioned studies are disseminated and enrich the NCD and human capital knowledge base, they may help to drive what some workshop participants termed an urgently needed

“adult survival revolution.” UNICEF under James P. Grant spearheaded the Child Survival Revolution in the 1980s and 90s, with remarkable impact. Now, some call for a similar global campaign to focus sustained action on improving adult survival, in partic-

ular through prevention and control of NCDs.

The idea of a revolution in adult survival and wellbeing could capture the imagination and creativity of leaders around the world, and the human capital lens could enable this transformation.

Workshop Day 2, afternoon session

The workshop’s final session was co-chaired by **Sir George Alleyne** (PAHO) and **Daniel Dulitzky** (World Bank). Main discussion topics included measurement issues linked to NCDs and human capital; directions for a future research agenda; and the implications of project findings for key stakeholders, including national governments, multilateral agencies, civil society, and the private sector.

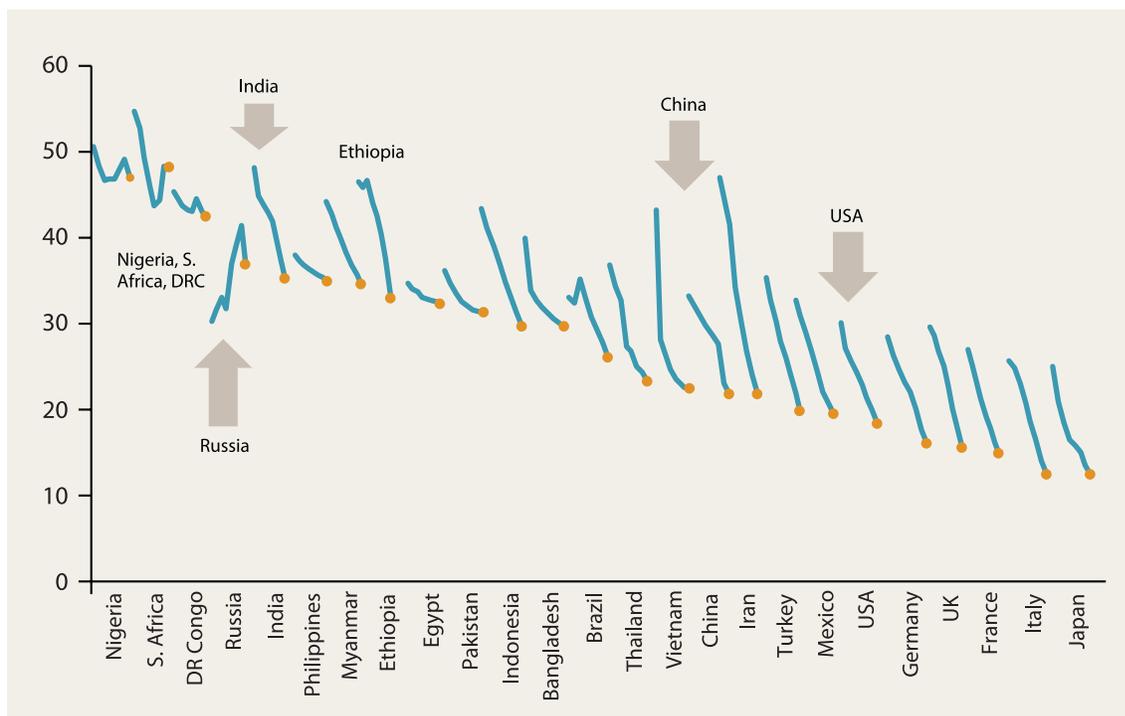
Refining measurement tools and strategies

The case for alternate metrics of adult mortality.

The analysis of adult mortality from Wu, Jha, and colleagues in Paper 4 provided an entry point for measurement discussions. Given global mortality

trends, Wu and Jha argued that the main measure of adult survival now included in the human capital index—the likelihood that a current 15-year-old will die before age 60 (“45q15”)—may be suboptimal. The researchers cited evidence that many countries have registered sustained reductions in the likelihood of adults’ dying between ages 50 and 69 (Figure 1.8). Global life expectancy is now almost 70, such that a large global population of older adults needs to be taken into account in analyzing health and human capital—beyond what the 45q15 measure can accommodate. On this basis, Wu and Jha proposed, possible future versions of the HCI might consider complementing 45q15 with the 40q30 metric: the likelihood of dying between ages 30 and 69.

FIGURE 1.8 Trends in the risk of dying between ages 50 and 69 in 25 countries, 1970-2010



Source: Norheim et al. (2015).

The HCI continues to evolve. Workshop participants appreciated that the HCI is not set in stone and that future enhancements may be possible and desirable. Some argued that, given the acknowledged difficulties in measuring human capital, a valuable activity for the World Bank would be convening a series of broadly inclusive discussions among global experts and stakeholders to systematically work through human capital measurement issues, particularly as they relate to NCDs.

It was acknowledged that, regarding NCDs in the HCI, current concerns are less about the relevance of NCDs than the problem of obtaining a robust, single metric of NCDs, and the possibility of this being reliably sourced in all countries. Some participants emphasized that the HCI is an advocacy tool, not a perfected scientific instrument. It is a means of organizing and communicating information that continues to evolve. The current version, if used strategically, can help get countries and key institutions thinking about NCD investments.

A new metric—the economic burden of disease. Participants observed that research contributions presented to the workshop were helping establish the conceptual and methodologic foundations of what could be a major advance in global health measurement: a rigorous, comprehensive assessment of the global “economic burden of disease.” Such a measure would complement the established epidemiologic burden of disease, and would provide crucial information to policy makers.

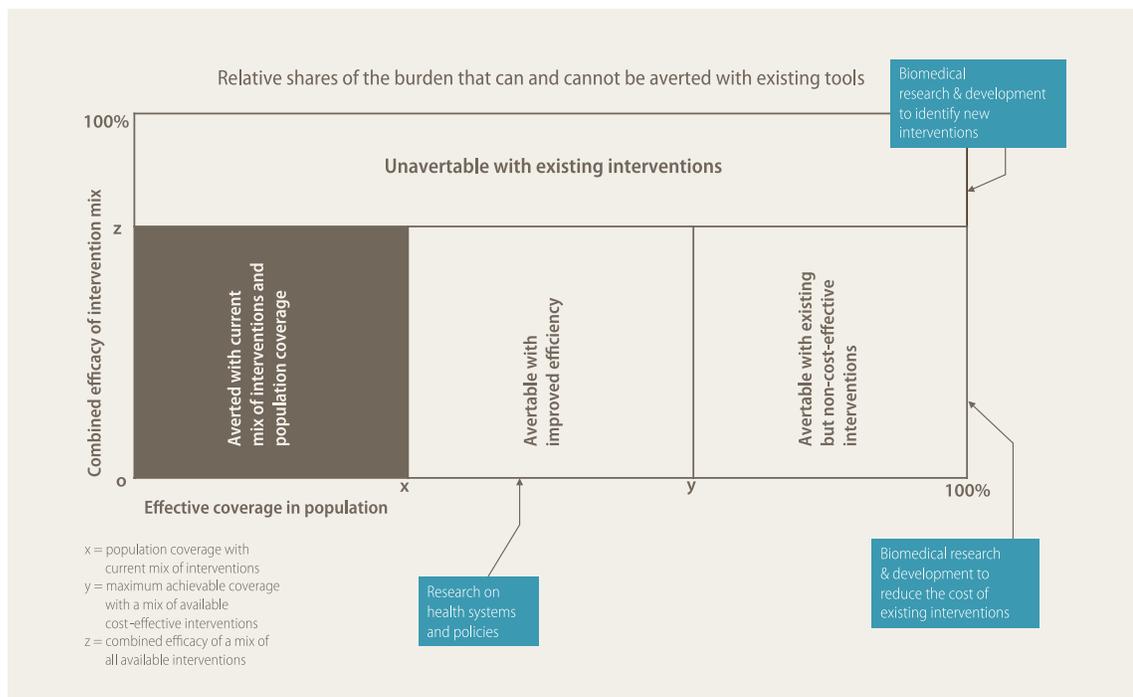
Strengthening measurement systems at country level. The discussion confirmed broad agreement among workshop participants on key principles connected with NCD measurement in countries. NCD data systems should be country-owned and country-led, and reliance on modeling should decrease. An important goal is to nurture NCD measurement systems at country level that are fully integrated with national statistical systems.

Toward a future research agenda

Act now, and keep learning. Participants agreed that countries do not need to await extensive further research before ramping up their action on NCDs. Through resources such as the DCP3 and the WHO Best Buys, an accessible evidence base exists that can guide foundational policy, programming, and implementation choices. Ultimately, however, more research of several types will be needed, to ensure that countries and partners get the best results as they work to strengthen human capital through NCD control.

A systematic approach to setting research priorities. To chart directions for research, proven tools can be adopted, notably the evaluation framework originally developed by Jamison and colleagues for WHO’s Ad Hoc Committee on Health Research Relating to Future Intervention Options (1996) and subsequently refined (Jamison 2009) (Figure 1.9).

FIGURE 1.9 Framework for analyzing health research needs



Source: WHO Ad Hoc Committee (1996). For a revised version, see Jamison (2009).

The framework summarizes a systematic process that can enable analysts to identify and evaluate research lines potentially suited to optimize existing interventions, along with those that may yield new interventions to tackle the segments of disease burdens that cannot be averted with current tools.

Emerging research directions. While awaiting systematic analyses, participants anticipated possible broad directions for a future research agenda. Not intended to be exhaustive, the discussion aimed to surface some areas of early promise for subsequent systematic assessment:

- **Measure human-capital gains from NCD action at country level.** Studies sponsored by this initiative plausibly predict substantial economic benefits for countries that effectively prevent and control major NCDs. These analyses call for further empirical verification. In partnership with countries, research should proceed to analyze the impact of NCD prevention and control on Human Capital Index results in a set of countries with reliable data.
- **Clarify NCD effects on productivity.** The negative impacts of NCDs on productivity offer a potent line of argument for engaging ministers of finance and private sector partners. Targeted research can

better track and quantify these impacts and map their pathways. The focus is on implementation research and research into the communication mechanisms to ensure reception by policy makers.

- **Put a price tag on passivity.** Additional research can sharpen assessments of the cost of inaction or of maintaining the status quo. Important to this effort will be improved measurement tools to capture the impact of non-fatal outcomes and long-term care.
- **Continue the quest for better metrics.** Collaborative work should move forward to establish robust measurement of the global economic burden of disease. In parallel, WHO and partners could lead a consensus process to construct improved NCD metrics.
- **Close the research gap in mental health.** Mental health conditions and effective strategies to address them have been chronically neglected in research. This applies in particular to mental health challenges in low-income settings. The human capital lens can help spur a new wave of research to: (1) better understand the health and economic impacts of mental health conditions (including their reflection in countries' HCI performance); and (2) accelerate the design, deployment, and evaluation of effective interventions.

RECOMMENDATIONS FOR KEY STAKEHOLDERS

During the workshop's concluding discussions, with the facilitation of Co-Chairs Sir George Alleyne and Daniel Dulitzky, participants framed a series of action recommendations for stakeholders in NCDs and human capital.

National governments

Develop a comprehensive national strategy to reduce the impact of NCDs and the disability they cause on human capital and the labor market, incorporating:

- A whole-of-government approach
- Tailored actions across the life course
- An equity lens
- Link to educational outcomes

Act on the evidence that investments in NCD awareness, prevention, and management can:

- Increase GDP and productivity
- Reduce health spending growth
- Decrease health inequity
- Increase social security

Commit to build decentralized data systems for country-level monitoring of NCDs and tracking of their human-capital impacts

WHO and World Bank (joint action)

- Expand the scope of investment cases to assess the impact of NCD control on human capital
- Launch a new agenda of institutional collaboration on NCDs and human capital, driven from the highest levels of both organizations and anchored in joint work in countries
- Move swiftly to identify a group of countries that want to be forerunners in the NCD/human capital effort; work with countries to develop initial plans, mobilize resources, and jumpstart action
- Engage additional partners and jointly establish a TDR/CGIAR-type research program for NCD interventions, to “bend the cost curve”

WHO

- Adopt and share ownership of the human capital index (HCI). Ensure that all WHO country representatives are fully briefed on the concept of human capital and can inform ministers of health on how prevention and control of NCDs affect a country’s human capital
- Disease divisions should use a common template to demonstrate how their work contributes to countries’ human capital
- Highlight NCD prevention and control in universal health coverage (UHC). Advocate impact on human capital as a criterion for including conditions in countries’ essential UHC benefits packages. Ensure countries know that this criterion argues powerfully for incorporating NCDs and related services in benefits packages

World Bank

- Present the investment case for NCD action in Human Capital Project work at country level
- Help countries to “know their NCD burden”; link with projections and impact on labor productivity and economic growth
- In developing a next iteration of the HCI, host consultations to surface the best approaches for

incorporating life-course perspectives, with a focus on NCDs

- Strengthen the analytical underpinnings of multi-sectoral lending operations by systematically assessing NCD impacts on human capital and economic growth
- Support countries to develop robust data systems for tracking and measuring progress on NCDs and integrating NCD data into broader health management information systems

Private sector

- Collaborate in documenting the effects of NCDs on human capital and productivity at the firm level, including issues such as absentee- and presenteeism. Collaborate with academic researchers to design and test interventions to protect and enhance workers’ human capital against NCD risks
- Reward “bottom-up” innovation from within firms that generates promising strategies to protect human capital and boost productivity in the context of NCDs
- Individual business leaders, firms, and industry or regional alliances: participate in multisectoral initiatives to reduce NCD impacts on human capital, including Human Capital Project efforts at country level

Civil society

- Advocate for a sustained NCD/human capital focus in the work of WHO, the World Bank, and other multilateral agencies, as well as in national government policies
- Use social media to popularize the concept of preventing and controlling NCDs to protect and enhance human capital. Engage people living with NCDs as leading voices in this effort
- Utilize data on human capital in calls for accountability at country level.

CONCLUSIONS AND WAY FORWARD

Rising burdens of NCDs threaten countries' human capital—their most precious resource for economic development in a fiercely competitive world, where cognitive skills, productivity, and adaptability are the watchwords of success. NCDs compromise countries' present stock of human capital—notably through their impact on adult life expectancy and productivity. Research also suggests that NCDs in children or among their caregivers jeopardize future human capital formation, through potential negative impacts on educational performance. This undermines the talent and productivity of rising generations, denying them the chance to achieve.

This also means that the stakes for countries in successful NCD prevention and control are high, and the potential rewards immense. New research summarized in this chapter shows that tackling NCDs now can bring countries strong economic gains in relatively short timeframes, for example by boosting effective labor supply and longevity. Additional research for this initiative is finding evidence that effective NCD action can also drive improvements in future productivity and economic growth through better educational outcomes. As these findings are confirmed and shared, more and more countries will be able to seize the opportunities.

The human capital lens holds power to transform global action on NCDs. Viewed through this lens, in particular by finance ministries, NCDs cease to appear as a parochial worry for the health sector. They show themselves for what they are: a potent threat to countries' economic future—and an opportunity for countries to reap exceptional economic benefits while improving health.

Following the Toronto workshop described in this chapter, the NCDs and Human Capital Research Initiative entered its concluding phase. In July 2019, a summary of its findings was submitted to the WHO Director-General's High-Level Commission on NCDs. Initiative results and recommendations were reflected in the final report of the High-Level Commission's Working Group 2, on universal health coverage (UHC). One of the Working Group's top policy recommendation urged countries to adopt “impact on human capital” as a criterion in setting essential health benefits packages. This means giving an important place to the prevention and control of NCDs and mental health

conditions. Through the Working Group 2 report, early results from this initiative informed the High-Level Commission's final recommendations to the WHO Director-General, and the messages he carried to the September 2019 United Nations High-Level Meeting on UHC.

Investigators completed their analyses and write-ups for the NCDs and Human Capital Research Initiative in the closing months of 2019. Results were later published in peer-reviewed journals and/or incorporated into ongoing research programs, notably at the University of Toronto, WHO, and the World Bank. The research summarized in this chapter has informed the World Bank's Healthy Longevity Initiative (HLI). Several of the investigators whose work is presented in these pages have extended their inquiries and produced additional scientific outputs under the HLI.

An unprecedented window exists for the World Bank, WHO, and other partners to join forces in supporting country efforts to build and protect human capital through NCD prevention and control. The human capital agenda offers a clear rationale for such partnership and provides a natural platform for collaboration at country level and globally. The deadly interaction between NCDs and COVID-19, and the health and economic losses that people and countries have suffered as a result, make this agenda more urgent than ever. Joining forces to advance country gains in human capital, the World Bank, WHO, and partners can power an adult survival revolution and youth capability transformation that will drive gains in productivity, longevity, and quality of life where they are needed most.

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ANNEX 1.1

Toronto workshop agenda

AGENDA

Non-Communicable Diseases and Human Capital Analytic Work and Key Messaging Workshop - July 9-10, 2019	University of Toronto Dalla Lana School of Public Health (DLSPH) Health Sciences Building, 155 College Street, Room HS208 (2nd Floor)	Monday, July 8th - Arrival of Participants Hotel: Hilton Toronto, 145 Richmond Street West Toronto ON M5H 2L2; Telephone: 416.869.3456
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Time	Description
DAY 1: Tuesday, July 9th AM Session: 8:15-9:00	<i>Breakfast and Registration</i>
9:00-9:15	Co-Chairs: Daniel Dulitzky (WB) and Prabhat Jha (U of T) Welcome and Overview of meeting objectives
9:15-9:45 9:45-10:00	Keynote Speaker: Sir George Alleyne (PAHO) Health, NCDs and Human Capital Questions and Answers (All)
10:00-10:45	Paper 1: NCDs and labour market returns – Jeremy A. Lauer (WHO)
10:45-11:30	Paper 2: NCDs and labour market returns, cross country regression analyses – Jean-Louis Arcand (Graduate Institute, Geneva)
11:30-12:00 12:00-12:30	Discussants for Papers 1 and 2: Prabhat Jha and Sue Horton (U of Waterloo) Questions and Answers (All)
12:30-1:30	<i>Lunch and Coffee</i>
PM Session:	Co-Chairs: Erica Di Ruggiero (U of T) and Daniel Dulitzky
13:30-14:15 14:15-14:45 14:45-15:15	Paper 3: NCDs and longevity – A long view: Stephane Verguet (Harvard) Discussant: Dean Jamison (UCSF) Questions and Answers (All)
15:15-16:00 16:00-16:30 16:30-17:30	Paper 4: NCD mechanisms to impact human capital – Daphne Wu (U of T), Dean T. Jamison & Prabhat Jha Discussants: Alexey Kulikov (WHO) and Jeremy Veillard (WB) Questions and Answers (All)
18:00-20:00	Evening Reception and Dinner – Location: U of T Faculty Club 41 Willocks Street Vivek Goel, Vice President U of T; Remarks on Human Capital and Knowledge Generation
Day 2: Wed. July 10th AM Session: 7:30-8:30	<i>Breakfast</i>
08:30-09:00	Key Messages from Day 1: Sir George Alleyne (Health perspective) & Dean Jamison (Economics perspective) Co-Chairs: Tim Evans (McGill, by phone) and Rachel Nugent (RTI)
9:00-9:45 9:45-10:15 10:15-10:45	Paper 5: NCDs and education effects – Aakash Mohpal (WB) Discussants: Sue Horton Questions and Answers (All)

Time	Description
Day 2: Wed. July 10th AM Session: 7:30-8:30 <i>(continued)</i>	<i>Breakfast</i>
Toronto 10:45-11:00	<i>Coffee Break</i>
11:00-12:30	Key Messages and narrative from research papers: Alexander (Alec) Irwin (WB) and All
12:30-1:30	<i>Lunch</i>
PM Session:	Co-Chairs: Sir George Alleyne and Daniel Dulitzky
13:30-14:15	Implications of research findings for WB operations: Miriam Schneidman, Jeremy Veillard and Ayo Akala (WB)
14:15-15:00	Implications of research findings for WHO: Alexey Kulikov and Adriana Blanco (PAHO)
15:00-15:30	Next steps and timelines for analytical work and dissemination including Fall 2019 UN Meetings
15:30-16:00	Conclusions and final thoughts: Daniel Dulitzky, Prabhat Jha, Sir George Alleyne
16:00	Meeting concludes, departure for most participants
16:00-17:00	Writing workshop for researchers and writer (researchers and Alec Irwin only).

ANNEX 1.2

Toronto workshop, list of participants

Francisca Akala	World Bank
George Alleyne	PAHO
Jean-Louis Arcand	The Graduate Institute, Geneva
Adriana Blanco	PAHO
Sarbani Chakraborty	Access Accelerated
Pedro Conceicao	UNDP
Erica Di Ruggiero	University of Toronto
Daniel Dulitzky	World Bank
Timothy Evans	World Bank / McGill University
Vivek Goel	University of Toronto
Sue Horton	University of Waterloo
Alexander Irwin	Independent consultant
Dean Jamison	University of California at San Francisco
Prabhat Jha	University of Toronto
Alexey Kulikov	WHO
Jeremy Lauer	WHO
Aakash Mohpal	World Bank
Rachel Nugent	Research Triangle Institute
Miriam Schneidman	World Bank
Daniel Sellen	University of Toronto
Jeremy Veillard	World Bank
Stephane Verguet	Harvard T.H. Chan School of Public Health
Daphne Wu	University of Toronto