Socioeconomic burden of main diseases in eight Latin American countries

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Table of Contents

Glossary

Key Definitions

- Direct Effects: Immediate economic impact resulting from paid work which is generated by people becoming healthier. His/her participation in labor supply would increase the output produce in his/her economic sector when the other required inputs are available (e.g., capital, intermediate inputs, technical, organizational and efficiency change, and economies of scale).
- Gross Value Added (GVA): It is a measure used in economics to assess the contribution of each individual producer, industry, or sector to the overall economy. It represents the total value of goods and services produced by an industry, sector, or producer after deducting the cost of inputs and raw materials used in the production process.
- Human capital: It is the combination of innate capabilities and acquired skills, knowledge, and motivation used to produce goods and services and to realize unpaid care and domestic work
- Indirect Effects: An increase in the intermediate consumption of goods and services from suppliers in adjacent economic sectors triggered by direct generated GVA. In other words, effects that arise in the value chain triggered by procurement (intermediate consumption) in other sectors.
- Induced Effects: Effects caused by expenditures of the directly and indirectly generated household incomes which in turn lead to induced consumption effects
- Paid work refers to employment activities for which individuals receive monetary compensation in exchange for their labor or services.
- Socioeconomic (SoC) Burden: SoC burden is the extent to which a disease deteriorates individuals' capacity to use their capital, which is translated into a decrease in labor supply .
- Unpaid work: It encompasses only the activities that can be replaceable by another third person (e.g., gardening, preparing meals , improvements and home repair, informal care, maintenance of dwelling).
- Years Lived with Disability (YLDs): It is a metric used to quantify the impact of non-fatal health conditions on individuals and populations. It represents the total number of years lived with a disability, taking into account the severity and duration of the disability.
- Years of Life Lost (YLLs): It is a key metric in public health and epidemiology, quantifying the impact of premature deaths on a population. It reflects the number of years lost due to premature mortality, comparing the age at death to a standard life expectancy, often set at a specific age or the average life expectancy for the population.

Abbreviations

DALYs	Disability-adjusted life year
FCA	Friction Costs Approach
GBD study	Global Burden of Disease Study
GDP	Gross domestic product
GVA	Gross Value Added
HCA	Human capital approach
SoC	Socioeconomic Burden
YLDs	Years Lived with Disability
YLLs	Years of Life Lost

Summary

Objective

Scientific evidence highlights the interconnectedness of health and economic growth, yet governmental budget allocations often neglect these dynamics. In this regard, health investments play a direct role in a country's labor supply, as the quantity and capabilities of workers depend on their health. The socioeconomic burden (SoC) measures how diseases diminish individuals' ability to contribute to the labor force. Our goal is to quantify the monetary value of the SoC burden for seven diseases—cardiovascular, neoplasms, ischemic heart disease, lower respiratory infections, breast cancer, type 2 diabetes, and migraine—in eight countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, and Peru.

Method

We employed a novel approach combining input-output analysis (value chain effects) with health economics to examine how investments in health drive economic development by enhancing population health. Healthier populations yield direct benefits and generate spillover effects in adjacent economic sectors, as well as induced effects along value chains. We accounted for health-induced gains in both paid and unpaid work activities, considering years lost due to disability or mortality as nonproductive. Years Lived with Disability (YLDs) captured presenteeism and absenteeism, while Years of Life Lost (YLLs) measured productivity losses from mortality.

Results

In 2022, labor supply decreases linked to the specified diseases accounted for between 2.5% (Peru) and 6.4% (Argentina) of GDP. Economic losses from 2018 to 2022 ranged from $12.5 billion (Costa Rica) to $367.4 billion (Brazil). Migraines and type 2 diabetes emerged as the top contributors to the SoC burden, with diabetes showing an upward trend over the past decade. Cardiovascular diseases and neoplasms consistently imposed a substantial SoC burden, which is particularly higher when we consider that the work of certain skilled workers cannot be easily substituted. Healthier populations yield significant spillover effects beyond their direct employment sectors.

<u>Main results by country</u>

In Argentina the total SoC burden in 2022 was equal to 6.4% of the GDP or $38.2 billion. In terms of GDP, Argentina's SoC burden is the highest in the sample. Notably, the younger population is more affected by cardiovascular disease and neoplasms than in other countries in the region, leading to a significant difference between the SoC estimated under substitution and non-substitution assumptions.

The total SoC burden in Brazil was in 2022 4.1% of the GDP or $77.1 billion. In Brazil, the SoC burden of migraines is the highest. Even though migraines are not typically associated with mortality, when the non-substitution assumption is considered, migraine-related losses are comparable to those of neoplasms. Additionally, Brazil's strong value chain connections suggest higher benefits from the spillover effects of a healthier population.

In 2022, the total SoC burden in Mexico was 3.6% of the GDP or $46.7 billion. Mexico is particularly affected by diabetes in both disability and mortality-related SoC burdens, with an increasing trend over time.

In the case of Colombia, the total SoC burden was 3.1% of the GDP or $10.9 billion in 2022. In Colombia, the four main diseases (cardiovascular, neoplasms, migraines, and diabetes) result in similar SoC losses, particularly when we consider the non-substitution assumption. Colombia also has the lowest per-capita losses, reflected in the fewest additional working days needed to offset the SoC burden in the sample.

In Chile, the economy lost 4.1% of the GDP or $11.7 billion in 2022. Unlike most selected countries, in Chile neoplasms became the leading cause of SoC burden under the non-substitution assumption, which indicates a

significant effect of neoplasms in working-age population. Diabetes and migraines also play central roles in creating SoC burdens in Chile, with diabetes surpassing migraines over the last decade.

The losses in Ecuador amounted to 3.5% of the GDP or $3.6 billion in 2022. In Ecuador, similar than Chile, the SoC burden of diabetes has consistently increased over time, surpassing migraines and even overtaking cardiovascular diseases and neoplasms under the non-substitution assumption.

In Costa Rica the SoC burden of the seven disease areas in 2022 were equal to 4.0% of the GDP or $2.8 billion. Together with Ecuador, Costa Rica showed the lowest economic losses in monetary terms in the sample. In Costa Rica, the increasing trend in diabetes SoC burden has led to values surpassing the other three major disease areas (cardiovascular, neoplasms, and migraines).

Finally, in Peru the economic losses summed $5.6 billion in 2022. Peru exhibited the lowest SoC as a percentage of GDP in the sample, with 2.5% in 2022 under the substitution assumption. The lower induced effect potential in Peru's value chain may be attributed to the significant role of the informal sector, which is not captured by the input-output analysis. Additionally, like Chile, neoplasms are the leading cause of SoC under the non-substitution assumption.

Conclusion

The socioeconomic burden of seven major diseases is profoundly significant for Latin American economies. Raising awareness about health's impact on productivity across various economic sectors is crucial. Measuring this burden is the first step toward understanding the value of investing in health and how healthcare strategies can drive economic development.

Investing in the treatment of high-mortality diseases, such as neoplasms and cardiovascular diseases, is paramount. In 2022, these diseases cost the selected Latin American countries between $59.3 billion (substitution assumption) and $196.4 billion (non-substitution assumption). Equally important is addressing conditions that severely impact productivity and absenteeism, such as diabetes and migraines, which are highlighted in this study. Additionally, we must consider other prevalent conditions like obesity, which exacerbates diseases such as diabetes and cardiovascular disease and is often underestimated as merely a condition rather than a disease.

The examples presented in this study illustrate that the healthcare system should be viewed as a long-term investment. Outcomes should be measured not only by the number of patients treated or ICU beds occupied but also by the economic benefits gained through the prevention of productivity losses.

The socioeconomic burden of diseases can significantly hinder economic development and productivity by reducing the workforce's size, efficiency, and overall potential. Therefore, investing in health promotion, disease prevention, and effective healthcare systems is critical for sustaining and enhancing a country’s productivity and economic growth.

1 Introduction

Scientific evidence highlights the interconnectedness of health and economic growth, yet governmental budget allocations often neglect these dynamics (Preston, 1975; Sachs, et al., 2001; Suhrcke et al., 2006; Jamison et al., 2013; Bloom et al., 2018). Central to these dynamics is labor productivity. Health investments directly impact a country's labor supply, as the quantity and capabilities of workers depend on their health. The sensitivity of Latin American economies to the level of labor supply makes this a key topic to consider when deciding not only on health policies but also on national priorities. The effect of health impairments on the labor supply can be summarized under the concept of the socioeconomic (SoC) burden of a disease. This concept refers to how a disease decreases labor supply by impairing individuals' capacity to utilize their human capital.

The SoC burden significantly impacts Latin American economies. The incidence and mortality rates of diseases with a high burden, such as neoplasms and cardiovascular diseases, are increasing among working-age populations and are no longer solely affecting elderly groups. This directly impacts both the present and future stability of the labor market. This is aggravated by the demographic composition of Latin America, which is undergoing a shift, characterized by an increasing proportion of older individuals. By 2080, the share of people over 65 years old in Latin America is projected to rise by 20% (OECD & World Bank, 2023), reaching 25% in Argentina, 27% in Mexico and Peru, and over 30% in Colombia, Brazil, Costa Rica, and Chile. It is reflected in the decrease of the number of working-age individuals (aged 15 to 64) per elderly person (aged 65 and older) from 15.9 in 1950 to 8.8 in 2015 and is expected to decline further to 3.2 by 2050. Latin American governments must prioritize policies to enhancing productivity and mitigate the future decline in the working-age population. Promoting labor participation, particularly among women, and reducing rates of premature death, early retirement, presenteeism, and absenteeism are essential measures.

The SoC burden, which results in earlier mortality or premature retirement, coupled with population aging, poses a threat to fiscal sustainability by placing pressure on public pension and healthcare systems. Latin America is particularly vulnerable to this challenge (IMF, 2018), as most countries in the region have relatively generous yet typically underfunded pension systems. If Latin American governments wish to emulate trends seen in other regions, such as Europe, by extending the age at which individuals become economically dependent, it becomes imperative to improve the health of older age groups. This would enable them to effectively compensate for the scarcity of younger workers in the workforce.

The SoC burden of a disease impacts not only the stability of the labor force but also induces numerous negative effects that degrade the well-being of nations. Primarily, it exacerbates socioeconomic and gender inequalities. Diseases with elevated mortality and morbidity rates, such as cardiovascular diseases, disproportionately afflict the most impoverished income groups. The decline in labor supply precipitates a reduction in household income, particularly among the lower income quintiles, thereby increasing their likelihood of descending below the poverty threshold.

Moreover, the SoC burden creates spillover effects on future generations. Families with reduced income have a lower probability of affording higher education for their children, thereby reducing labor opportunities for the next generation. This perpetuates the cycle of intergenerational poverty and limits the potential increase of qualified candidates for industries facing a labor shortage. In Latin America, around 50% of formal firms struggle to find skilled candidates (World Economic Forum, 2017), which hinders production and innovation. The current decrease in labor supply due to the SoC burden is exacerbated by these spillover effects on future generations.

Additionally, alongside exacerbating inequality, the SoC burden of diseases that disproportionately affects lower-income groups dampening productivity in economic sectors traditionally reliant on less skilled labor. Take, for instance, agriculture, a vital sector across much of Latin America, contributing an average of 4.7% to GDP in 2015-17.

Furthermore, informality pervades the Latin American labor market (see Figure 1). Given the informal sector's lack of economies of scale and reliance on lower-skilled labor, it tends to exhibit lower labor productivity (Ohnsorge, et al. 2023). Presenteeism and absenteeism exacerbate this, further diminishing productivity and income levels, heightening the vulnerability of informal workers. Consequently, productivity losses disproportionately impact informal workers, who are more susceptible to job loss or significant income reduction. Adding to this, informal workers often face limited access to public healthcare (Naicker et al., 2021), rendering them more vulnerable to health crises (EU Parliament, 2021).

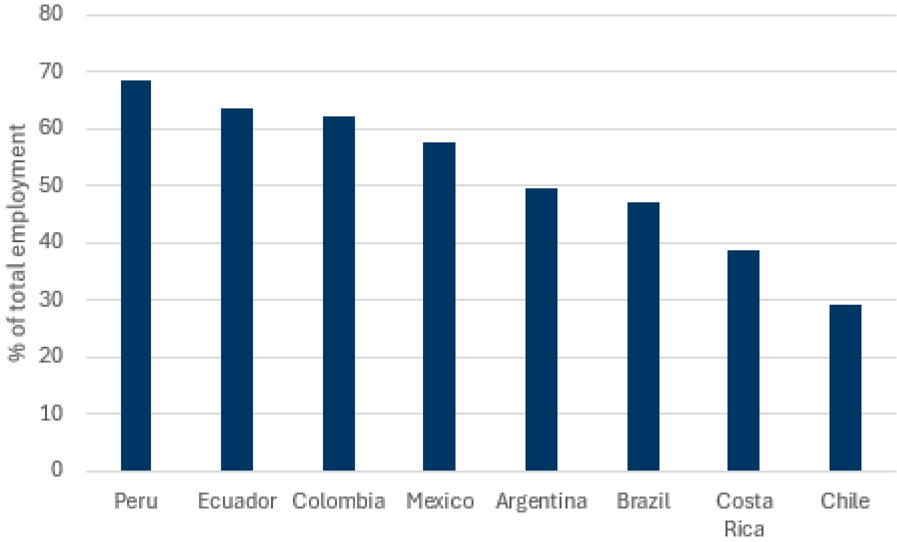

Figure 1. **Informal employment, 2019 (% of total employment)**

Source: World Bank, Informal Economy database, 2019

The SoC burden also contributes to inflationary pressures, stemming from the decrease in labor supply, which in turn raises the costs of goods and services. The decline in labor supply results in a reduction of inputs, leading to increased production costs and a subsequent decrease in the supply of goods and services. Moreover, in sectors where specific skills are in short supply, such as the healthcare sector, employers engage in wage competition to attract scarce employees, further adding to production costs.

In addition, the decrease in household income due to SoC burden, coupled with additional inflationary pressures, restricts access to healthcare for the overall population. In 2019, 32.4% of healthcare spending in Latin America was paid out-of-pocket (OOP) (OECD & World Bank, 2023), pushing 1.7% of the population into poverty and forcing 12.7% further below the poverty line (OECD & World Bank, 2023).

The SoC burden is also highly important for the sustainability of the health system. Falls in labor supply will worsen the public finances by leading to lower tax receipts, and depending on who is withdrawing from the labor force and why, could result in increases in benefits payments. All this will reduce the government's capacity to invest in health. Moreover, inflation represents higher financial pressures to the health economy, decreasing the degree of freedom to fund new more efficient health technologies.

In summary, productivity losses due to health impairments slow down economic growth, potentially leading to stagnation. Likewise, decreases in labor supply exacerbates inequalities affecting vulnerable populations. We present the results of a methodology that combines value chain effects (Input-Output analysis) and health economics to explore how health investments drive economic development by improving population health. This method, based on the concept of human capital (i.e., innate capabilities and acquired skills, knowledge, and motivation), estimates the monetary value of the SoC burden of a disease.

The healthcare sector has traditionally been viewed as non-productive, with investments yielding minimal returns for the economy. It's time to dispel this misconception and raise awareness of the pivotal role healthcare investments play in fostering economic growth, particularly in regions like Latin America, which grapple with severe inequality and struggle to stimulate economic progress here is a tradition of considering effects on the overall economy to inform on public investments, particularly in areas such as security and transport. It has yet to be addressed when informing budget allocations that affect the health sector. Estimating the SoC burden is a crucial initial step in informing policymakers at the national level about the broader economic advantages of investing in healthcare. Moreover, it is essential to highlight the economic significance of healthcare within the sector itself. In Latin America, between 2010 and 2019, health spending grew annually by 4.9%, surpassing the GDP growth rate of 3.1%. However, the question remains: Does the economic value generated by funded health interventions exceed their implementation costs? Surprisingly, this question remains unanswered, despite its critical implications for the future sustainability of the healthcare sector.

We aim to measure the monetary value of the SoC burden of seven diseases: cardiovascular, neoplasms, ischemic heart disease, lower respiratory infections, breast cancer, type 2 diabetes, and migraine; in eight countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, and Peru. Advancements in healthcare, including medical technologies and preventive programs, have the potential to cultivate healthier and consequently more productive societies. This prompts vital questions: What socioeconomic value does healthcare investment yield? What is the societal cost burden associated with various disease areas? Which healthcare strategies, be it prevention, promotion, or treatment, best serve economic development? By gauging the SoC burden, we shed light on these inquiries, aiding policymakers in prioritizing budget allocations both nationally and within the healthcare sector.

2 Methods

2.1 Country and disease selection

The eight countries selected showed the highest GDP and/or GDP per-capita in Latin America (**Figure 2**): Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, and Peru.

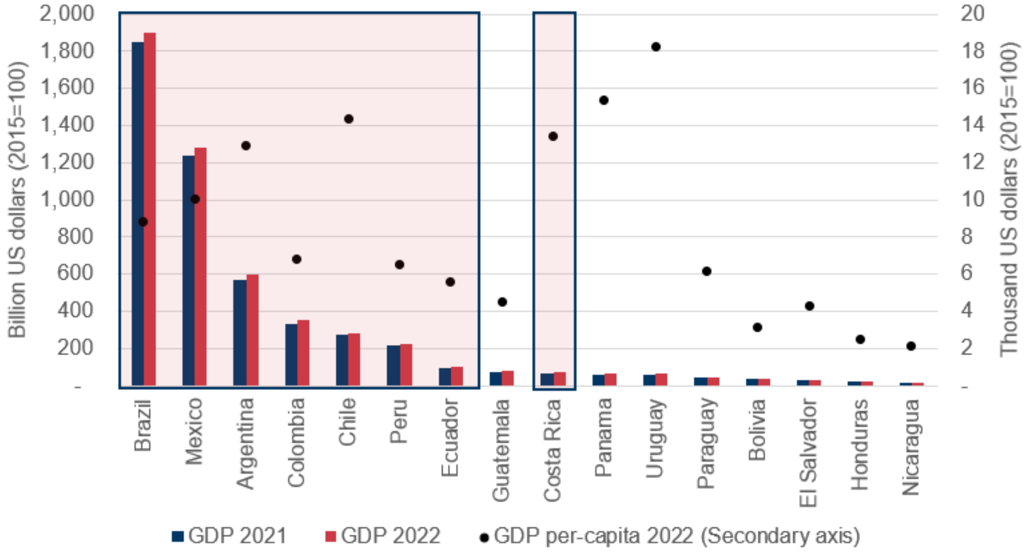

Figure 2. Latin-American countries' GDP total and per-capita
Data from Venezuela no available in the World Bank database. Source: WifOR elaboration. Data World Bank.

We selected seven disease areas based on the Global Burden of Disease Study (GBD) classification, which quantifies the health effects of over 350 causes of health loss, organized into hierarchical nested categories. At the highest level, these causes are divided into broad categories, with each category further broken down into increasingly specific causes. The cause list is mutually exclusive and collectively exhaustive at every level of aggregation.

We chose diseases from three of the four GBD levels, operating under the assumption that higher levels of aggregation encompass a greater number of affected patients. Five dimensions were applied to identify the most relevant disease types for the selected countries: morbidity (incidence and prevalence), mortality, premature death (Years of Life Lost [YLL]), and disease severity (Years Lived with Disability [YLD]). Additionally, we considered other factors pertinent to the Latin American context, such as gender differences (e.g., diseases predominantly affecting women that could exacerbate gender inequalities) and diseases linked to risk factors commonly observed in lower-income populations.

In 2019, the selected diseases were responsible for an important percentage of the total DALYs (Disability-adjusted life years) in our countries: 40.1% in Argentina, 34.9% in Chile, 33.2% in Costa Rica, 33.1% in Brazil, 30.6% in Mexico, 30.5% in Colombia, 29.9% in Ecuador, 28.5% in Peru (Figure 3).

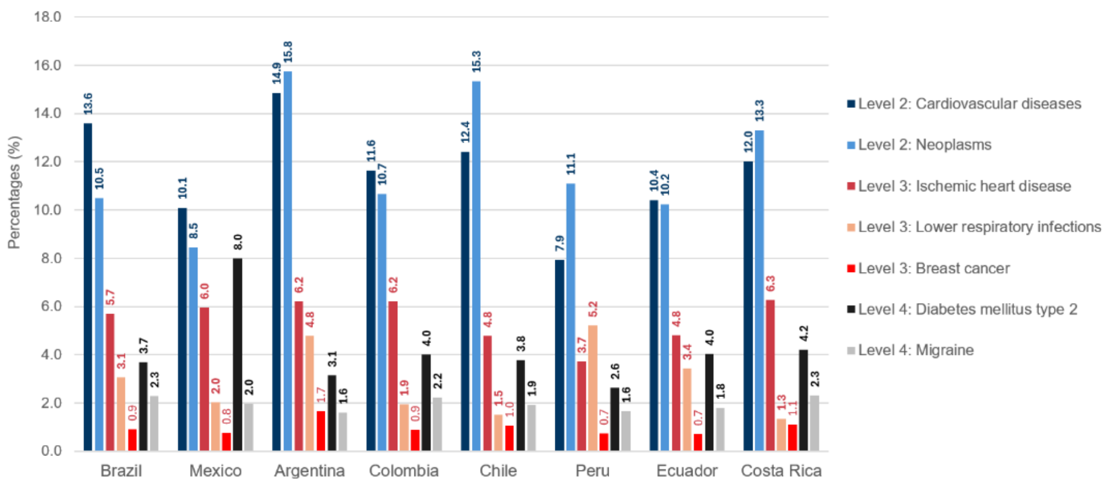

Figure 3. Percentage of DALYs for a particular cause relative to DALYs for all causes, 2019
Ischemic heart disease is a subcategory (Level 3) of Cardiovascular disease (Level 2). Breast cancer (Level 3) is a subcategory of Neoplasms (Level 2). All the other disease areas are classified into different categories.
Source: WifOR elaboration. Data from the GBD 2019 study (available at the IHME website: https://ghdx.healthdata.org/)

2.2 Estimation of the Socioeconomic (SoC) burden

WifOR's methodology goes beyond the traditional paradigm in economic evaluation by addressing productivity losses through a unique blend of value chain effects (Input and Output [IO] analysis) and health economics. It examines how health investments enhance economic development by improving population health. Previous applications and versions of the methodology have been validated in numerus projects, peer review journals publications, conference presentations and books (e.g., Hoffmans 2019 and 2022; Ostwald 2023; a full list will be provided upon request).

First, using Input-Output matrices, we estimate the direct economic effects and calculate spillover effects in adjacent economic sectors and induced effects along value chains. We start by approximating the potential direct economic benefits that would arise if the currently affected population became healthier and continued working, thereby directly contributing to GVA. Next, we calculate the indirect effects resulting from increased intermediate consumption of goods and services by suppliers in adjacent sectors, driven by the direct GVA generated. Finally, we address the induced effects caused by expenditures from incomes generated both directly and indirectly, leading to further consumption. Spillover effects encompass the sum of indirect and induced effects.

Second, we address human capital losses by evaluating health-induced gains in paid and unpaid work activities. Human capital formation also impacts individuals' ability to perform unpaid care and domestic work. Although the magnitude of unpaid work is often overlooked when assessing a country's economy, it is crucial for the well-being of the economy and society (Beyeler, 2019; ILOSTAT 2023). In Latin America, as in other regions, women's disproportionate share of unpaid work limits their ability to participate in the paid economy (Ferrant, Pesando, and Nowacka, 2014). Additionally, older adults' contributions to economic growth significantly include unpaid work (Bloom et al., 2020).

Third, we measure the SoC burden as economic losses for the country, valuing work hours using GVA, which accurately represents a worker's contribution to the economy.

Fourth, we assume that years lost to disability or mortality are nonproductive. Years Lived with Disability (YLDs) capture presenteeism and absenteeism, while Years of Life Lost (YLLs) capture premature mortality. To measure YLL, we use two approaches:

- Human Capital Approach (HCA), which views premature death as an irreplaceable loss of productivity.
- Friction Cost Approach (FCA), which assumes tasks are redistributed within a year.

Detailed methods are included in the appendix (section 7.1).

3 Results

The socioeconomic burden of the seven diseases is highly significant for Latin American economies, averaging 3.9% of the GDP. In 2022, under the conservative FCA substitution assumption, Latin American economies incurred losses ranging from $2.8 billion in Costa Rica to $135.9 billion in Brazil (Figure 4). In terms of relative economic impact, these losses represented 2.5% of the GDP in Peru and 6.4% in Argentina. The impact is even more substantial under the HCA assumption, with losses ranging from 4.5% of the GDP in Colombia to 15.7% in Argentina. In Argentina, the marked difference between the two assumptions is since neoplasms and cardiovascular diseases affect younger populations in this country compared to others in the sample. This results in higher years of life lost (YLLs) as the productivity losses over the lifetime of the affected individuals are greater. A detail per disease on the monetary and relative values can be found in the Annex section 7.2.

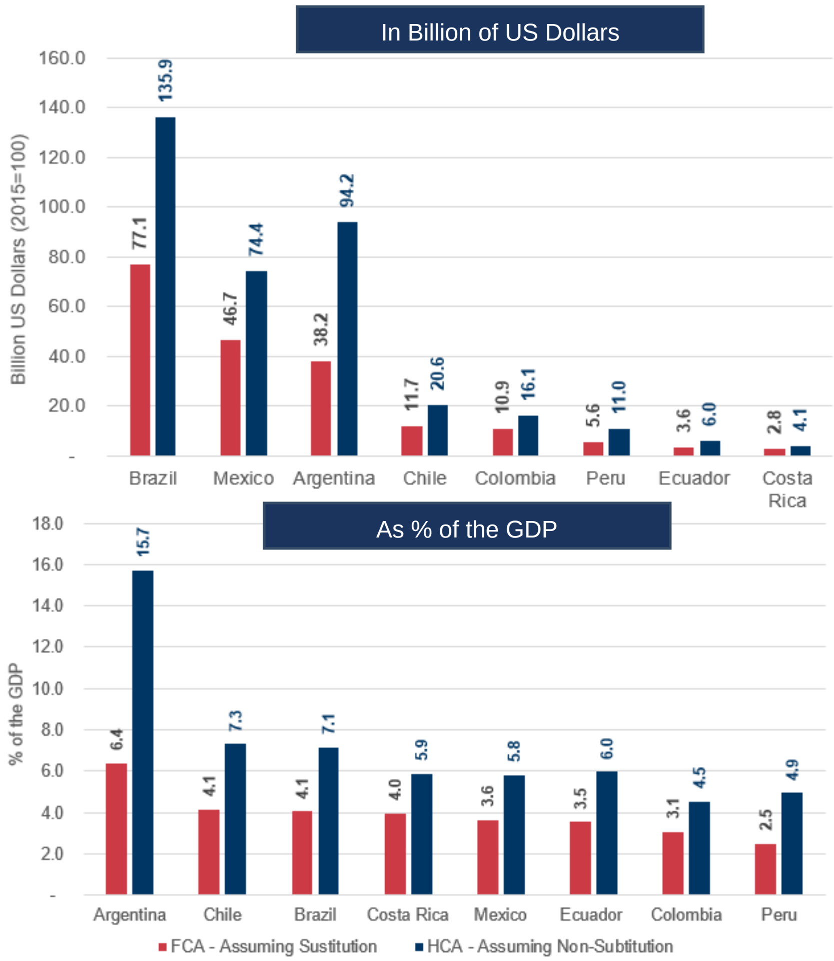

Figure 4. Socioeconomic burden related to the seven selected diseases - 2022
*Monetary data is comprehensively accounted for and presented at the 2015 price levels to be consistent with the constant values supplied by the World Bank.
Source: WifOR elaboration

Figure 5 presents a detailed overview of the socioeconomic burden by disease type under the substitution assumption (FCA) for the period 2011-2022. The increasing burden of type 2 diabetes is particularly concerning. Mexico and Argentina exhibited the highest levels of socioeconomic burden from type 2 diabetes, averaging 1.6%

of their GDP. In Mexico diabetes is at the top of the ranking. Nonetheless, the most significant increase in socioeconomic burden during the study period occurred in Peru, where the monetary value grew from $0.7 billion in 2011 to $1.4 billion in 2022, representing an 113% increase. It was followed by Costa Rica and Colombia, with growth rates between 2011 and 2022 of 96% and 90%, respectively.

Figure 5. Time trends socioeconomic burden for the seven selected disease, FCA Approach – Assuming Substitution
Source: WifOR elaboration.

Under the FCA substitution assumption, migraine, along with diabetes, is one of the most significant diseases in terms of socioeconomic (SoC) burden (**Figure 5**). This is even more remarkable when we consider that migraine is linked only to the SoC burden related to disability, but it is not linked to patient deaths. The burden of migraine is notably high in Argentina and Brazil, where from 2011 to 2022, the SoC burden of migraine averaged 1.8% and 1.6% of GDP, respectively.

Figure 5 depicts a subtle decline in the societal cost (SoC) burden of migraine over time in most countries, with exceptions noted in Peru and Argentina. This decline primarily stems from a slower rate of increase in the monetary value of migraine's SoC burden compared to the growth in GDP. For instance, in Chile, the SoC burden of migraine, as a percentage of GDP, decreased by 6.3%. This is despite the monetary value of migraine's SoC burden increasing from $2.9 billion in 2011 to $3.5 billion in 2022, marking a growth of 21.8%. However, this growth in monetary value lags behind the GDP growth of 32.4%.

The third disease area leading to significant economic losses is cardiovascular diseases (**Figure 5**). The variability among countries in the SoC burden of this disease area is higher than that of migraine and diabetes. Under the Friction Cost Approach, Mexico and Colombia lost approximately 0.5% of their GDP per year, Peru and Ecuador around 0.6%, Costa Rica 0.7%, and Brazil and Chile 0.8%. Argentina experienced particularly high losses, with the economy losing around 1.8% of GDP. Unlike migraine and diabetes, the burden of cardiovascular disease remained relatively stable from 2011 to 2022.

Nonetheless, the burden of cardiovascular disease significantly increases under the Human Capital Approach (see Annexes, section 7.2, **Figure 10**), which assumes non-substitution of lost productivity. Under this assumption, Mexico, Colombia, Peru, Costa Rica, and Ecuador each lost between 1.1% and 1.5% of their GDP annually. Chile and Brazil saw losses equal to 2.2% of GDP, and Argentina faced a substantial loss of 5.3% of GDP.

Like cardiovascular disease, the burden of neoplasms increases significantly under the HCA (see Annexes, section 7.2, **Figure 10**). Neoplasms became the leading cause of economic burden in Peru, Chile, and Argentina. Argentina's results are significantly impacted by the assumption that all remaining productive life years translate into productivity losses for the country.

The significant value stemming from spillover effects within Latin American economies is noteworthy. **Figure 6** illustrates the distribution between direct and spillover effects (indirect and induced effects) of the SoC burden related to paid work for three major diseases: migraine, type 2 diabetes, and cardiovascular disease. Spillover effects range from 0.69 (Peru) to 1.23 times[1] (Brazil) the direct effects. The magnitude of spillover effects in Brazil is relatively higher compared to other countries. It is remarkable that the data suggest almost zero induced effects in Peru.

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[1] It represents the ratio between spillover effects and direct effects. For example, in Brazil, it corresponds to the sum of induced and indirect effects (0.28 induced + 0.31 indirect) divided by direct effects (0.48), resulting in a ratio of 1.23.

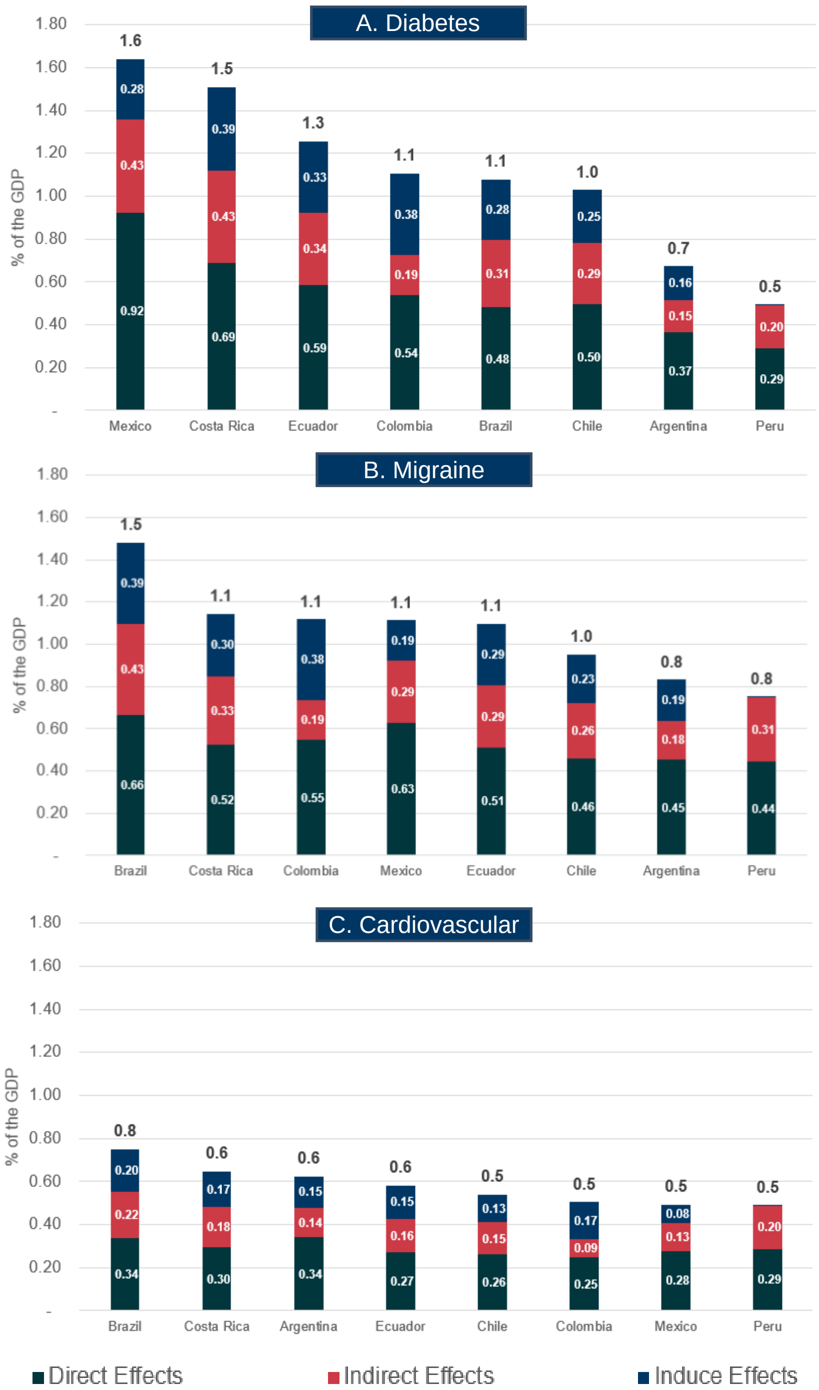

Figure 6. Total SoC burden related to paid work activities – 2022, FCA Approach (Assuming Substitution): Spillover effects related to the three diseases with the highest SoC burden
Source: WifOR Elaboration

To equip policymakers with a comprehensive understanding of the current and medium-term socioeconomic burden dynamics in Latin America, **Figure 7** delineates the five-year cumulative monetary depiction of SoC attributed to seven diseases in the region. This illustration encapsulates multifaceted insights into the outcomes.

- Initially, it's evident that the results spanning the pre-COVID-19 era (2015-2019) closely mirror those inclusive of the pandemic years (2018-2022). Notably, the period from 2018 to 2022 signifies a marginally heightened SoC economic profile across all countries except Argentina.

- Furthermore, productivity losses stemming from paid work significantly outweigh those attributed to unpaid work across all countries, barring Argentina.
- Additionally, the three countries with the highest GDP levels also manifest the highest monetary SoC values: Argentina, Brazil and Mexico. Specifically, Brazil emerges with the highest value, while Costa Rica records the lowest.

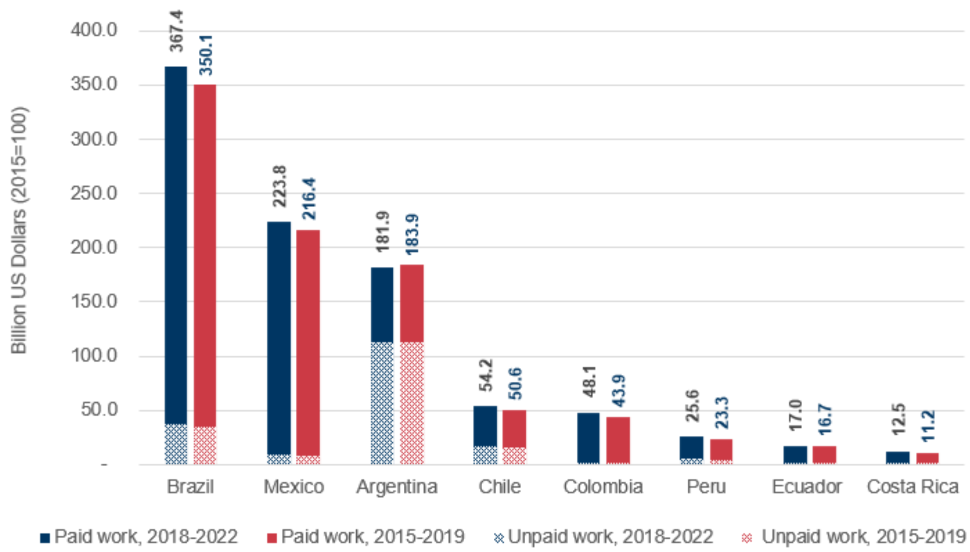

Figure 7. Five years SoC Burden all seven diseases, FCA Approach – Assuming Substitution: Comparison five years before COVID pandemic (2015-2019) with the most recent five-year data available (2018-2022)
*Monetary data is comprehensively accounted for and presented at the 2015 price levels to be consistent with the constant values supplied by the World Bank.
Source: WifOR elaboration

To put the results in perspective, let's take the following steps:

1. **Calculate Average Daily Productivity:** Determine the productivity of an average person in the country by measuring how much, on average, a person contributes per year in terms of paid and unpaid work. This annual productivity is then divided by 365 days to obtain the average productivity per person per day.
2. **Estimate Per-Capita SoC Burden:** Divide the total societal cost (SoC) burden of the five-year period (e.g., 2018 - 2022) by the population over 15 years old to estimate the total SoC burden per capita.
3. **Calculate Additional Work Days Needed:** Divide the per-capita SoC burden by the daily productivity per person. This gives an estimate of the additional number of days each person over 15 years old would need to work to compensate for the losses of the past five years.

The results are presented in **Figure 8**. On average, across the eight countries, every individual aged 15 and older would need to work an additional 11.5 days in 2022 to compensate for the economic losses of the previous five years. Despite having higher-than-average productivity per day and per person, Argentinians (35.6 million people over 15 years old) would need to work almost double the average number of days observed in the sample to compensate for the productivity losses due to the seven diseases. This is due to a significantly higher SoC burden per capita. Conversely, Colombia (40.8 million people) has lower-than-average productivity per day and per person but requires the fewest additional working days to offset the SoC burden in the sample.

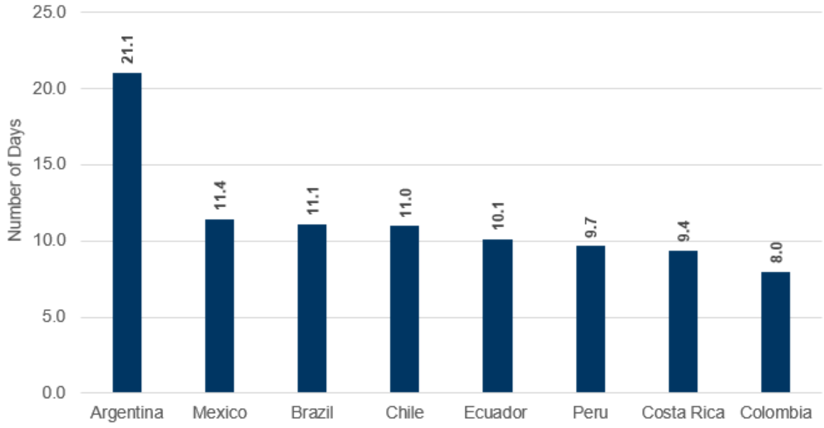

Figure 8. Additional number of days that every person over 15 years old needed to work in 2022* to compensate for the economic losses of the previous 5 years

*To determine the extra workdays needed, we used the economic data from the year 2022 to estimate the GVA per person in paid and unpaid work. This helps us calculate the additional workdays required for individuals over 15 in 2022 to make up for the losses incurred between 2018 and 2022. To put it in perspective, the population over 15 years old is in Argentina 35.6, in Mexico 96.3, in Brazil 171.7, in Ecuador 13.4, in Chile, in Peru 25.2, in Costa Rica 4.1, and in Colombia 40.8 million people.
Source: WifOR elaboration

4 Discussion

4.1 The SoC burden in Latin America

The SoC burden imposed by the seven diseases is profoundly significant for the economies of Latin America. Over the period from 2018 to 2022, this burden ranged from $12.5 billion (Costa Rica) to $367.4 billion (Brazil) under conservative assumptions (i.e., substituting a deceased person after one year), and from $18.8 billion to $648 billion under the non-substitution assumption. Among the sampled countries, Argentina, Brazil, and Mexico experienced the highest monetary economic losses. Illustratively, Argentina's loss in 2022 amounted to approximately 6.4% of the country's total healthcare expenditures, closely mirroring the national commitment to health at 6.2%. In other words, the value lost due to the SoC burden in Argentina could nearly cover the entirety of the country's healthcare expenses.

The results underscore the profound impact of certain diseases on productivity losses within the economy. Specifically, they highlight the escalating impact of diabetes, which is on the rise across all countries. Latin America, in particular, is experiencing a surge in diabetes cases due to factors such as aging populations, lifestyle choices, and obesity rates. The SoC burden of diabetes is of paramount importance due to its chronic nature, substantial treatment and monitoring costs, and its tendency to worsen the burden of other diseases, such as cardiovascular conditions. Our findings indicate that diabetes poses a significant threat to both economic sustainability and the resilience of the healthcare sector. Addressing the challenges posed by diabetes is thus critical for ensuring both individual well-being and the overall health of the economy.

Similarly, migraine emerges as a significant contributor to productivity losses, surpassing cardiovascular issues and neoplasms under the FCA, and matching these diseases' impact levels in most countries under the HCA. This is of considerable concern given that migraine ranks among the leading causes of disability worldwide (Steiner et al., 2020). It is notably prevalent among individuals aged 15-49 years—the working-age population—and disproportionately affects women. Moreover, the prevalence of migraine is notably higher in Latin America compared to other regions. While data specific to Latin America is lacking, studies conducted in other regions indicate that migraine results in a considerable number of absenteeism days, such as the reported 19.5 workdays per year according to Gerth et al. (2012). Of even greater significance is the observation that presenteeism associated with migraine is believed to cause greater productivity declines than absenteeism (Shimizu et al., 2021).

Our findings suggest a slight decline in the relative importance of migraine's societal cost burden in most countries. However, this can be attributed to recent changes in migraine definitions and advancements in understanding the underlying mechanisms that distinguish between headaches and migraines. For instance, the third edition of the International Classification of Headache Disorders (ICHD-3) has introduced more detailed and specific criteria for diagnosing various headache types, including tension-type headaches and migraines. Nonetheless, distinguishing between tension-type headaches and migraines remains challenging due to the lack of specific diagnostic tests, and the coexistence of both conditions further complicates the diagnostic process (Onan et al., 2023).

Cardiovascular diseases and neoplasms demonstrate a substantial burden in terms of the SoC, which has remained relatively constant over time. Their significance increases under the non-substitution assumption, with neoplasms being the most important disease type regarding the creation of SoC in Argentina, Chile and Peru. Due to demographic and social changes over the past two decades, Latin America has experienced an epidemic growth of noncommunicable diseases, among which cardiovascular diseases and neoplasms are the most prevalent. These diseases are the leading causes of death in Latin America (GBD Study, IHME, 2019), affecting not only the older population but increasingly impacting younger age groups as well (Done et al., 2021).

The change in results under the non-substitution assumption indicates the potential impact that the current SoC burden could have on future productivity and, consequently, on the financial sustainability and stability of the labor force in these countries. Moreover, the burden of SoC related to these diseases is not only linked to mortality but also to disability and the severity of consequences following an event. The literature extensively documents the levels of presenteeism, absenteeism, and the barriers to returning to work for those affected by cancer or cardiovascular diseases (Mehnert, 2011; Kotseva et al., 2019). For instance, a study focused on a Brazilian sample observed that less than 50% of stroke survivors returned to work six months after a stroke (Nascimiento et al., 2021). Similar findings have been reported globally; for example, data on myocardial infarction indicates that between 36 and 75 days are lost annually due to hospitalization and sick leave, with an additional 2 to 14 days lost to presenteeism (Marques et al., 2021; Kotseva et al., 2019).

Significant efforts have been made to increase survival rates for these diseases, which has led to their reclassification as chronic illnesses. For example, certain cancer types are now regarded as chronic illnesses (Firkins et al., 2020), affecting patients' quality of life and, consequently, their productivity. For survivors experiencing a considerable decrease in quality of life, this also means additional hours of caregiving, translating into economic losses.

The findings highlight significant potential spillover effects (indirect and induced effects), wherein the health status of workers across sectors profoundly influences the growth potential of each sector within the value chain. Despite this interconnectedness, prevailing industry policies have predominantly concentrated on mitigating productivity losses solely among their own employees. It's imperative for industry policies to extend their purview and actively engage in mitigating productivity losses across the entire value chain.

Recommendations for labor market interventions are crucial. Understanding the distribution of economic sectors affected by diseases with a high SoC burden is paramount for targeted public health interventions, particularly focusing on vulnerable socioeconomic groups. Raising awareness of health's pivotal role as a determinant of productivity within each economic sector is vital. The industry suffers losses when both current employees and potential workforce members are unable to work efficiently due to health issues. Therefore, integrating health considerations into labor market interventions can yield substantial benefits for both industry and society at large.

4.2 Limitations

The current overall estimations of the SoC burden lack granularity in understanding which skill levels of workers or economic sectors are particularly affected by the reduction in labor supply. Additional evaluations are imperative to delve into the intricacies of the SoC burden between economic sectors.

Furthermore, the study overlooks the additional reduction in labor supply associated with increased caregiving responsibilities. Caring for older individuals, the chronically ill, or those with disabilities results in a considerable increase in caregiving hours, which directly impacts labor supply. The significant role of family-based caregiving, particularly borne by women, in Latin America remains to be addressed.

Moreover, due to underreporting from informal employees, surveys may fail to accurately capture the distribution between unpaid and paid work time. Informal workers may hesitate to accurately report their time usage, and the survey definitions may not fully align with the region's characteristics. This discrepancy underscores the need for improved methodologies to capture the true dynamics of paid and unpaid work in Latin America.

Peru exhibits notably low values of the SoC related to induced effects, which could be attributed to a crucial factor: while World Bank data accounts for informal labor values per country, the databases underpinning the Input and Output analysis solely reflect the formal economy. In essence, if the rise in household income predominantly channels into consumption within the informal sector, this crucial economic activity may elude capture by the methodology employed to measure spillover effects. Thus, the discrepancy in Peru's SoC estimations underscores the importance of accounting for informal sector dynamics to gain a comprehensive understanding of the true economic impact. Given the substantial role of the informal economy in Latin America, it's conceivable that the estimated SoC still represents a conservative estimation, even under the non-substitution assumption. Therefore, additional efforts aimed at capturing the value chain connections within the informal economy are imperative for a more accurate assessment.

Lastly, our reliance on data from the Global Burden of Disease study offers the advantage of facilitating cross-country comparisons and consistent metrics to assess the population's diminished capacity to utilize their capital. However, it's crucial to acknowledge limitations in the accuracy and standardization of reported data across different countries.

5 Conclusion

Decreases in labor supply not only hinder economic growth but also exacerbate inequalities and adversely affect vulnerable populations. This prompts key questions: What is the socioeconomic value of investing in health, and which healthcare strategies effectively promote economic development? By quantifying the socioeconomic burden of a disease area, we shed light on these critical inquiries and empower policymakers to prioritize budget allocations effectively. This strategic approach ensures that investments in healthcare yield not only improved health outcomes but also significant economic benefits, fostering economic growth and enhancing the well-being of all citizens.

The seven diseases' SoC burden is highly relevant to the Latin American economies. In Argentina the total SoC burden in 2022 was equal to 6.4% of the GDP or $38.2 billion. In terms of GDP, Argentina's SoC burden is the highest in the sample. Notably, the younger population is more affected by cardiovascular disease and neoplasms than in other countries in the region, leading to a significant difference between the SoC estimated under substitution and non-substitution assumptions.

The total SoC burden in Brazil was in 2022 4.1% of the GDP or $77.1 billion. In Brazil, the SoC burden of migraines is the highest. Even though migraines are not typically associated with mortality, when the non-substitution assumption is considered, migraine-related losses are comparable to those of neoplasms. Additionally, Brazil's strong value chain connections suggest higher benefits from the spillover effects of a healthier population.

In 2022, the total SoC burden in Mexico was 3.6% of the GDP or $46.7 billion. Mexico is particularly affected by diabetes in both disability and mortality-related SoC burdens, with an increasing trend over time.

In the case of Colombia, the total SoC burden was 3.1% of the GDP or $10.9 billion in 2022. In Colombia, the four main diseases (cardiovascular, neoplasms, migraines, and diabetes) result in similar SoC losses, particularly when we consider the non-substitution assumption. Colombia also has the lowest per-capita losses, reflected in the fewest additional working days needed to offset the SoC burden in the sample.

In Chile, the economy lost 4.1% of the GDP or $11.7 billion in 2022. Unlike most selected countries, in Chile neoplasms became the leading cause of SoC burden under the non-substitution assumption, which indicates a significant effect of neoplasms in working-age population. Diabetes and migraines also play central roles in creating SoC burdens in Chile, with diabetes surpassing migraines over the last decade.

The losses in Ecuador amounted to 3.5% of the GDP or $3.6 billion in 2022. In Ecuador, similar than Chile, the SoC burden of diabetes has consistently increased over time, surpassing migraines and even overtaking cardiovascular diseases and neoplasms under the non-substitution assumption.

In Costa Rica the SoC burden of the seven disease areas in 2022 were equal to 4.0% of the GDP or $2.8 billion. Together with Ecuador, Costa Rica showed the lowest economic losses in monetary terms in the sample. In Costa Rica, the increasing trend in diabetes SoC burden has led to values surpassing the other three major disease areas (cardiovascular, neoplasms, and migraines).

Finally, in Peru the economic losses summed $5.6 billion in 2022. Peru exhibited the lowest SoC as a percentage of GDP in the sample, with 2.5% in 2022 under the substitution assumption. The lower induced effect potential in Peru's value chain may be attributed to the significant role of the informal sector, which is not captured by the input-output analysis. Additionally, like Chile, neoplasms are the leading cause of SoC under the non-substitution assumption.

The examples presented in this study underscore that the healthcare system should be regarded as a long-term investment rather than a short-term expense. Traditional metrics like the number of patients treated or ICU beds occupied are important, but they do not capture the full impact of healthcare investments. When a significant portion of the population is affected by illness, not only are there direct costs related to medical treatment or health outcomes, but there are also important economic losses related to a reduction in labor supply. Employees who are sick or caring for sick family members may take more time off work, work less effectively, or even exit the workforce altogether. This reduces the available labor force, hampers economic output, and slows economic growth. Therefore, investing in health promotion, disease prevention, and effective healthcare systems is critical. By preventing diseases and managing health conditions more effectively, countries can maintain a healthier, more productive workforce. Moreover, healthier populations can contribute more effectively to economic activities, fostering innovation and growth. This creates a virtuous cycle where economic development and health improvements reinforce each other. Thus, the healthcare system should be seen not only as a means of treating diseases but also as a foundational pillar for sustainable economic development and enhanced productivity.

6 References

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7 Annexes

7.1 Methodology

We measure the Socioeconomic burden of six diseases selected based on the IHME Database, considering mortality and morbidity indicators as well as equality and policy interest. They are categorised according to the Global Burden of Disease (GBD) hierarchical nested categories

- Level 2: Cardiovascular disease and Neoplasms
- Level 3: Ischemic heart disease, Breast Cancer and Lower respiratory infections
- Level 4: Diabetes mellitus type 2 and Migraine

We have chosen to focus on the eight countries with the highest GDP or GDP per-capita in Latin America: Argentina (ARG), Brazil (BRA), Chile (CHL), Colombia (COL), Costa Rica (CRI), Ecuador (ECU), Mexico (MEX), and Peru (PER), as they represent key economic and health indicators in the region.

7.1.1 Inputs

The economic variables were extracted from the World Bank data (Version: Last Updated the 21.02.2024). We evaluate the period 2011 - 2022.

Table 1. Economic variables from the World Bank

World Bank name and code of the variables used	From here on the variables are named as:
Gross value added at basic prices (GVA) (constant 2015 US$) [NY.GDP.FCST.KD]	GVA.2015Pr
Population, female (% of total population) [SP.POP.TOTL.FE.ZS]	Pop.Male.Per
Population, male (% of total population) [SP.POP.TOTL.MA.ZS]	Pop.Fem.Per
Population ages 15-64, total [SP.POP.1564.TO]	Pop.1564.T
Population ages 65 and above, total [SP.POP.65UP.TO]	Pop.60m.T
Employment to population ratio, 15+, total (%) (modeled ILO estimate) [SL.EMP.TOTL.SP.ZS]	EmplToPop.15m.T.Per
GDP (constant 2015 US$) [NY.GDP.MKTP.KD]	GDP.2015Pr

Throughout the model, monetary data is comprehensively accounted for and presented at 2015 price levels to ensure consistency with the constant values provided by the World Bank.

Time used surveys

We selected the Time Used Survey information for the most recent year, available on the United Nation website. For each country, we selected the surveys for those years for which the same age group (over 15 yeas old) was available for the two variables of interest:

Average number of hours spent on unpaid domestic and care work, by sex, age and location (Hours per day): This indicator is defined as the time spent in a day on unpaid domestic and care work by men and women.

Average number of hours spent on total work (paid and unpaid), by sex (Hours per day): This indicator is defined as the time spent in a day on paid and unpaid work by women and men to produce of goods and services for own final use or for the use of others.

We selected data for individuals over 15 years old to match our study population. However, for Costa Rica and Peru, there are no “time used total” values available for this age group. Therefore, we used data from the age group over 12 years old.

Spillover effects and multipliers

The assessment of direct and spillover effects is conducted and validated using Input-Output (IO) modeling (Conway, 2022; Porter, 1985). We employed a well-established and validated algorithm by WifOR, which is based on IO analysis and utilizes the WIOD and EORA databases. Essentially, each economic sector is interconnected with others, as the production of goods and services relies on intermediate inputs.

We calculate the country-specific Leontief inverse of the IO matrix (Leontief, 1986), which illustrates how one unit of output in one sector increases intermediate output across all other sectors. By introducing sector quotas, which describe the gross value added (GVA) and employment per unit of output in each sector, we can estimate the value creation and employment contribution of adjacent sectors. Additionally, we account for the mechanisms leading to the provision of wages, which subsequently stimulate consumption demand for goods and services within the domestic economy. These induced consumption effects are consistently captured by incorporating household consumption into the Leontief inverse (Leontief, 1986).

The analysis is performed by country and according to the NACE Rev.2 classification.

From the IO analysis the following elements are extracted and used in the model:

- Direct Multipliers per revenue (hereafter DirMult.Rev): These represent the direct GVA (GVA is understood as revenue minus intermediate consumption) generated by each sector for every 1 million USD increase in revenue (revenue is know as Gross Output, Total Value of Sales, or Production Value). This growth is catalyzed by an influx of healthier individuals engaging in the market.
- Indirect Multipliers per revenue (hereafter IndirMult.Rev): These denote the upstream indirect impact on the country’s GVA for every 1 million USD increase in sector revenue (output). This escalation is driven by heightened intermediate consumption of goods and services from suppliers in adjacent economic sectors.
- Induced Multipliers per revenue (hereafter InducMult.Rev) illustrate the upstream induced impact on the country’s GVA for every 1 million USD revenue increment in each sector when the revenue increase is triggered by expenditures on directly and indirectly generated incomes.
- Gross Value Added (GVA) per economic sector (million USD) (hereafter GVA.PSector): Considering the IO matrices from the country, the GVA is estimated per economic sector. Sectors are identified using the NACE Rev.2 classification.
- Employees per economic sector (Million of people) (hereafter EMP.PSector): Considering the IO matrices from the country, the number of employees per economic sector (NACE Rev.2 classification) is estimated.

Deaths, DALYs, YLL and YLD

We used data from the Institute for the Health Metrics and Evaluation (IHME). They provided data used from the Global Burden of Disease Study (GBD) 2021 version, including the 2022 extension. The data were extracted on April 17, 2024.

Data were extracted for males, females, and combined, by five-year age groups and for all ages. The number of deaths, disability-adjusted life years (DALY), years of life lost (YLL), and years of life with disability (YLD) for the period 2011-2019 were obtained for each of the eight countries and the seven-disease mentioned above.

7.1.2 GVA effects from paid work

The objective is to estimate the effects on the economy of the GVA produced by **employed person** that participate in the economy. According to the World Bank, employed person is defined as “persons of working age who, during a short reference period, were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period (i.e., who worked in a job for at least one hour) or not at work due to temporary absence from a job, or to working-time arrangements”.

The SoC burden is measured in terms of economic losses for the country, and not based on what the individual generates for themselves. Therefore, work hours are valued using Gross Value Added (GVA), which is a more comprehensive indicator of economic performance than wages alone. GVA accurately portrays the value contributed by a worker to the overall economy. By considering the effect of GVA on the person employed, we are considering the productivity per-capita of an employed person. In this sense, the estimation of the momentary value of the burden of a disease will reflect the effect of reducing the capacity of working of the productive people in the economy.

We evaluate three types of GVA effects that are derived from paid work:

- **Direct Effects - Immediate Economic Impact:** The direct economic impact results from increased paid work due to improved health. For example, avoiding a cardiovascular event allows a person to continue working, thereby contributing to the economy's gross value added (GVA). Their participation in the labor force increases the output in their economic sector, provided other required inputs are available.
- **Indirect Effects - Value Chain Impact:** Indirect effects refer to the increased intermediate consumption of goods and services from suppliers in adjacent economic sectors, triggered by the GVA generated directly. These effects arise within the value chain due to procurement (intermediate consumption) in other sectors.
- **Induced Effects - Income and Consumption:** Induced effects are caused by the expenditures of incomes generated directly and indirectly, leading to further consumption.
    - Avoided Income Reduction: Individuals and their families who avoid negative health events (e.g., stroke) do not suffer from a reduction in income.
    - Increased Labor Demand: The indirect effects raise the demand for labor in adjacent sectors, thereby increasing disposable income for consumption.

Direct effects

Direct effects are monetized using the average gross value added (GVA) per employed person in the economy. For each country (c) and year (t), this is calculated by dividing the total GVA by the employed population aged over 15 years.:

Equation 1

$$DirectEffect.PerEmployee_{c,t} = GVA.2015Pr.PerEmployee_{c,t} = GVA.2015Pr_{c,t}/Employees.15m_{c,t}$$

Where:

$$Employees.15m_{c,t} = EmplToPop.15m.T.Per_{c,t} * (Pop.1564.T_{c,t} + Pop.60m.T_{c,t})$$

Indirect effects

We estimate the indirect effects by considering the interconnections between economic sectors, as the production of goods and services in each sector relies on the provision of intermediate inputs. As demonstrated in the previous section, the direct effects are measured as the additional average GVA per employed person that could potentially be generated if an individual does not suffer from the disease.

To ensure consistency, we calculate the indirect effects based on the impact per additional dollar of GVA created, rather than per additional dollar of revenue, which is the standard definition used for indirect multipliers. To transform the IndirMult.Rev (indirect multiplier per revenue increase) into IndirMult.GVA (indirect multiplier per GVA increase), we used the following formula for each country (c) and economic sector (s):

Equation 2

$$IndirMult.GVA_{c,s} = (IndirMult.Rev_{c,s} - DirMult.Rev_{c,s})/DirMult.Rev_{c,s}$$

To capture the indirect multiplicative effects across all sectors comprehensively, we utilized the indirect total economy-wide average multiplier (hereafter TAv.MultIndir.GVA) for each country (c). It is derived by taking the indirect GVA effects in the economy (i.e., the sum of the indirect effect by economic sector) and dividing them by the total GVA in the economy. The latest is extracted from the sum of the GVA produced by each economic sector according to the IO analysis.

Equation 3

$$TAv.MultIndir.GVA_c = sum_{s=1}^{S}(GVA.PSector_{c,s} * IndirMult.GVA_{c,s})/sum_{s=1}^{S}(GVA.PSector_{c,s})$$

Only cross-sectional data, not time series data, is available for multipliers and GVA per sector. We assume that the multipliers and the GVA per sector distribution remain constant over time. Therefore, we applied the average indirect GVA multiplier (TAv.MultIndir.GVA) to the direct effects estimated from the time series data provided by the World Bank. Consequently, the indirect effects are calculated by multiplying the TAv.MultIndir.GVA by the direct GVA effects in the economy.

Equation 4

$$IndirectEffect_{c,t} = DirectEffect_{c,t} * TAv.MultIndir.GVA_c$$

Induced effects

Direct and indirect effects happens in more than one sector, which created induced effects in different part of the value chain. Once again, we need to estimate the induce effect per additional dollar of GVA, and not per additional dollar of increase in sector revenue:

Equation 5

$$InducMult.GVA_{c,s} = (InducMult.Rev_{c,s})/DirMult.Rev_{c,s}$$

To capture the multiplicative effects across all sectors comprehensively, we utilized the induced total economy-wide average multiplier (TAv.MultInduc.GVA) for each country (c):

Equation 6

$$TAv.MultInduc.GVA_c = sum_{s=1}^{S}(GVA.PSector_{c,s} * InducMult.GVA_{c,s})/sum_{s=1}^{S}(GVA.PSector_{c,s})$$

Similar than in the indirect effect case, we assume that these multipliers and the GVA per sector distribution remain constant over time. Consequently, the induced effects are calculated as:

Equation 7

$$InducedEffect_{c,t} = DirectEffect_{c,t} * InducTotalAvgMult.GVA_c$$

Total paid work effects

The average potential paid work effects of having a healthier person is equal to the sum of the three effects:

Equation 8

$$PaidW_{c,t} = DirectEffect_{c,t} + IndirectEffect_{c,t} + InducedEffect_{c,t}$$

7.1.3 GVA effects from unpaid work

To our knowledge, there are currently no estimations available regarding the monetary value contributed by one year of unpaid work. Hence, we begin our analysis by considering the GVA produced within an economy in relation to the number of paid hours. We operate under the assumption that an individual's productivity remains consistent across both paid and unpaid hours. Consequently, we approach the monetary value of the annual unpaid work of a country by multiplying the annual GVA (per country (c) and year (t)) by the ratio of time spent on unpaid work activities to that spent on paid work activities (hereafter **WorkTime Ratio**). Should this ratio exceed one, we infer that production during unpaid hours may surpass the proportional GVA generated within the paid economy.

The Work Time Ratio is estimated as the ratio between unpaid work hours per person and the paid work hour per persons both adjusted by gender differences (details on the data used in section 7.1.1).

Equation 9

$$WorkTimeRatio_{c,t} =$$

$$Pop.Male.Per_{c,t} * UnpaidHours.Male_{c} + Pop.Fem.Per_{c,t} * UnpaidHours.Female_{c} /$$

$$Pop.Male.Per_{c,t} * PaidHours.Male_{c} + Pop.Fem.Per_{c,t} * PaidHours.Female_{c}$$

We estimate the average productivity per person of unpaid work activities by dividing the GVA of unpaid work by the number of employed persons.

Equation 10

$$UnpaidWork.PerEmployee_{c,t} = (GVA.2015Pr_{c,t} * WorkTimeRatio_{c,t}) / Employees.15m_{c,t}$$

GVA Unpaid Activities Adjustment Ratio

The estimation of unpaid work solely through Equation 10 assumes not only equivalent productivity per person in both paid and unpaid tasks but also equates the monetary value of an hour of paid work with that of unpaid work. However, considering the nature of activities involved in unpaid work—such as meal preparation, household upkeep, pet care, and family-related errands—it's reasonable to anticipate a divergence in monetary valuation from average paid work tasks, even if productivity levels were assumed to be identical. If unpaid work were to be outsourced in the paid market, its valuation would likely differ significantly.

To approach the monetary valuation of an unpaid work hour, we considered the GVA contribution of economic sectors whose outputs are like those related to unpaid work. In the NACE Rev.2 the closed sector corresponds to Sector T (Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use). We selected Sector T and called it for simplicity Unpaid Substitution Economic Sector (USES).

To estimate the monetary valuation of unpaid work, we used data extracted from the IO method along with annual data from the World Bank. First, we determine the proportion of GVA contributed by the Unpaid Sector (USES) relative to the total GVA across all economic sectors (from the IO analysis). Second, assuming this ratio remains constant over time, we multiply it by the annual GVA figures reported by the World Bank (GVA.2015PR) to obtain the yearly GVA for the USES sector. Third, we calculate the proportion of employees working in the USES sector compared to total employment across all sectors. Again, assuming this ratio remains stable over time, we multiply it by the annual number of employees to determine the workforce size within the USES sector. Finally, by dividing the GVA for the USES sector by the employed persons within it, we arrive at the GVA per person employee in the USES sector.

Equation 11

$$GVA.2015Pr.PerEmployee.USES_{c,t} =$$

$$(GVA.PSector.USES_{c,USES} / sum_{s=1}^{S}(GVA.PSector_{c,s})) * GVA.2015Pr_{c,t} /$$

$$(EMP.PSector.USES_{c,USES} / sum_{s=1}^{S}(EMP.PSector_{c,s})) * Employees.15m_{c,t}$$

Where GVA.PSector.USES corresponds to the GVA in the USES sector and EMP.PSector.USES to the number of people employed in the USES sector.

It is worth noting that the GVA and the number of employees estimated based on the IO analysis differ from those reported by the World Bank. A key difference for this study is that the IO analysis considers only the formal economy, whereas the World Bank data includes adjustments for output produced in the informal economy. Given the significant size of the informal economy in Latin America and the nature of activities conducted within it, a limitation of this study is the assumption that the proportion of total GVA and employees contributed by the USES is the same with or without the informal sector.

Once we established the value per individual in the USES Sector, we calculated the ratio between the GVA) per person in the USES Sector and the GVA per person in the overall population. This ratio, termed the GVA Unpaid Activities Adjustment Ratio (GVA.Unpaid.AdjRatio), highlights the disparity in monetary value between an hour of paid work and activities typically associated with the Unpaid Sector (e.g., household chores and caregiving). This ratio indicates the relative contribution of unpaid work activities compared to paid activities:

Equation 12

$$GVA.Unpaid.AdjRatio_{c,t} = GVA.2015Pr.PerEmployee.USES_{c,t}/GVA.2015Pr.PerEmployee_{c,t}$$

We then applied the ratio to adjust the average unpaid work productivity per employed person estimated before.

Equation 14

$$UnpaidWork.Adj.PerEmployee_{c,t} = UnpaidWork.PerEmployee_{c,t} * GVA.Unpaid.AdjRatio_{c}$$

7.1.4 Health outcome metrics and the SoC burden

We assume that individuals contribute economically through their combined engagement in paid and unpaid work throughout the year, and any years lost due to disability or mortality are considered non-productive, lacking economic contribution. We follow the conceptual framework applied by the GBD study to calculate the Disability-adjusted Life Years (DALYs). Specifically, we focus on estimating the two metrics that comprise DALYs: Years Lived with Disability (YLDs) and Years of Life Lost (YLLs). These metrics are evaluated separately and then integrated to quantify the monetary burden across various disease types.

Maximum productive age

Before diving into the details of the monetization of the YLD and the YLL, it is key to introduce the concept of the maximum productive age. Given that we are interested in the number of productive life years loss per person, instead of using solely the life expectancy, we consider an upper limit of age after which is assumed that the person is not contributing anymore to the country economy.

For **the paid work** activities we considered the retirement age to estimate the productivity losses. In many of the selected countries, the retirement age typically stands at 65. However, instead of solely considering the retirement age at 65, we factored in productivity losses up to the age of 69 (with the last age group included being the 65-69 age group). This approach was guided by several observations:

- It's a prevalent practice in Latin America for individuals to remain active in the workforce past the traditional retirement age.
- Given demographic shifts resulting in an aging population, it's reasonable to anticipate an increase in the retirement age.
- While approximately 20% of individuals over 70 remain employed, we interpret this phenomenon as a response to deficiencies in the social protection system rather than a genuine reflection of productivity losses for the country.

Second, regarding **unpaid work**, we assumed a maximum productive lifespan of 85 years.

This comprehensive approach allows for a more nuanced understanding of workforce dynamics and productivity when considering unpaid and paid work contributions.

Years of Life with Disability (YLDs)

The YLD metric reflects the morbidity of diseases by quantifying the additional health that would have been experienced if not for the condition causing disability. YLDs account for the severity by capturing an illness's impact on quality of life before it resolves or leads to death. They measure the number of years that could have been lived in full health but were instead spent in states of less than full health.

We used the YLD values reported by the GBD study, categorized by disease, country, and year. We assume that YLDs capture the non-productive time due to presenteeism and absenteeism related to the debilitating effects of diseases. For individuals afflicted by a disease in period t, this metric gauges the extent of additional health that would have been enjoyed during that period had the condition not been present. Similarly, its monetization assesses the productivity that would have occurred if these patients hadn't experienced the disease in period t. The monetary value (MVal.YLD.PerEmployee) is approximated by multiplying the average unpaid and paid work productivity of an individual by the country- and time-specific value of the YLD.

We start with unpaid work:

Equation 15

$$MVal.YLD.UnpaidW.PerEmployeer_{c,t} = UnpaidWork.Adj.PerEmployee_{c,t} * YLD_{c,t}$$

Then, we estimate the monetary value of productivity losses related to paid work in a similar way, with the exception that we count only the YLD for the group of the population that is working. We multiply it by the employment to population ratio.

Equation 16

$$MVal.YLD.PaidW.PerEmployeer_{c,t} = PaidW.PerEmployee_{c,t} * YLD_{c,t} * EmplToPop.15m.T.Per_{c,t}$$

Then, the total monetary value of the socioeconomic burden related to presenteeism and absenteeism is represented by the following equation:

Equation 17

$$MVal.YLD.PerEmployeer_{c,t} = MVal.YLD.UnpaidW.PerEmployeer_{c,t} + MVal.YLD.PaidW.PerEmployeer_{c,t}$$

Years of Life Lost (YLLs)

YLL represents the number of years lost due to premature mortality. As we aim to assess productive life years lost, we derive YLL estimates from mortality data by age group, country, and year as reported by the GBD study. We employ two distinct estimation methods for YLLs: the Friction Cost Approach (FCA) and the Human Capital Approach (HCA)

Friction Cost Approach (FCA) – Assuming Substitution

Here we take a conservative stance that closely mirrors the Friction Cost Approach (FCA), which assumes that within a certain period, the tasks of the deceased are either assumed by another individual, absorbed through technological advancements, or adapted within the production process. This perspective is particularly relevant in nations contending with high unemployment rates.

We presume that the period required to substitute the work of the deceased patient is **one year**. Therefore, the productivity losses equate to one year per deceased person. Productive Years of Life Lost (PYLLs) are defined by country (c), time (t), and age group as follows:

Equation 18

$$YLLFCA_{c,t} = sum_{a=1}^{A}(Deaths_{c,t,a})$$

Where for unpaid work the older age group is 80 to 84, and for paid work is 65 to 69.

Consequently, the monetary value of the YLLFCA for unpaid and paid work are equal to:

Equation 19

$$MVal.YLLFCA.UnpaidW.PerEmployeer_{c,t} = UnpaidWork.Adj.PerEmployee_{c,t} * YLLFCA_{c,t}$$

Equation 20

$$MVal.YLLFCA.PaidW.PerEmployeer_{c,t} = PaidW.PerEmployee_{c,t} * YLLFCA_{c,t} * EmplToPop.15m.T.Per_{c,t}$$

Accordingly, the monetary value of the SoC burden related to mortality and based on FCA is equal to:

Equation 21

$$MVal.YLLFCA.PerEmployeer_{c,t} = MVal.YLLFCA.UnpaidW.PerEmployeer_{c,t} + MVal.YLLFCA.PaidW.PerEmployeer_{c,t}$$

Human Capital Approach (HCA) - Assuming non-substitution

It assumes the irreplaceable loss of an individual's productivity upon premature death. Therefore, it is estimated by considering the number of years between the year of death and the maximum productive age (i.e., 84 for unpaid work and 69 for paid work), following the next steps:

- Age Group Middle Points: For the number of deaths reported for each five-year age group, we assume that all deaths occur, on average, at the midpoint of the age group. We use the smallest available age group distribution, specifically five-year intervals as provided by GBD data. For instance, all deaths occurring in year t for the age group 20-24 are linked to age 22.5, the midpoint of this group.
- Calculating YLLs: We then calculate the number of years between the midpoint of the age group and the maximum productive age. For example, for the 20-24 age group, we count 46.5 Years of Life Lost (YLL) for paid work (69 - 22.5 = 46.5) and 61.5 YLLs for unpaid work (84 - 22.5 = 61.5). These are referred to as YLLpaid and YLLunpaid, respectively.
- Monetary Value of Lost Productivity: The number of deaths is multiplied by the YLLs (YLLpaid or YLLunpaid) and the monetary value of unpaid or paid work activities. For simplicity, we assume that the average monetary value of productivity per individual in the year of death (i=1) can be extrapolated to the years when the individuals could not contribute to the GVA because of his/her premature death (i=2, …, i=I, where I represents YLLpaid or YLLunpaid).
- Discount Rate Application: A discount rate of 3.5% is applied to the future productivity values to account for the time value of money.

We applied the following equations:

Equation 22

$$MVal.YLLHCA.UnpaidW.PerEmployeer_{c,t} =$$
$$sum_{a=1}^{A}[sum_{i=1}^{YLLunpaid}[Deaths_{c,t,a} * UnpaidWork.Adj.PerEmployee_{c,t} * (1/(1+DiscRate)^{i})]]$$

Equation 23

$$MVal.YLLHCA.PaidW.PerEmployeer_{c,t} =$$
$$sum_{a=1}^{A}[sum_{i=1}^{YLLpaid}[Deaths_{c,t,a} * PaidWork.Adj.PerEmployee_{c,t} * EmplToPop.15m.T.Per_{c,t} * (1/(1+DiscRate)^{i})]]$$

Where a = age group, i= each year of productive life lost (i= 1…YLLunpaid or YLLpaid), c= country, t= to the evaluated year, and DiscRate =3.5%.

Finally, the monetary value of the SoC burden related to mortality and based on HCA is:

Equation 24

$$MVal.YLLHCA.PerEmployeer_{c,t} = MVal.YLLHCA.UnpaidW.PerEmployeer_{c,t} + MVal.YLLHCA.PaidW.PerEmployeer_{c,t}$$

7.1.5 Total Socioeconomic (SoC) Burden

We estimate the total SoC burden by adding the productivity losses linked to the YLLs and the YLD per year(t) and country (c).

Equation 25

$$MVal.Total.PerEmployee_{c,t} = MVal.YLD.Total.PerEmployee_{c,t} + MVal.YLL.Total.PerEmploye_{c,t}$$

Equation 25 was estimated in two ways: 1) using YLL based on the FCA and 2) YLL based on the HCA.

The following figure summarize the method followed for this analysis:

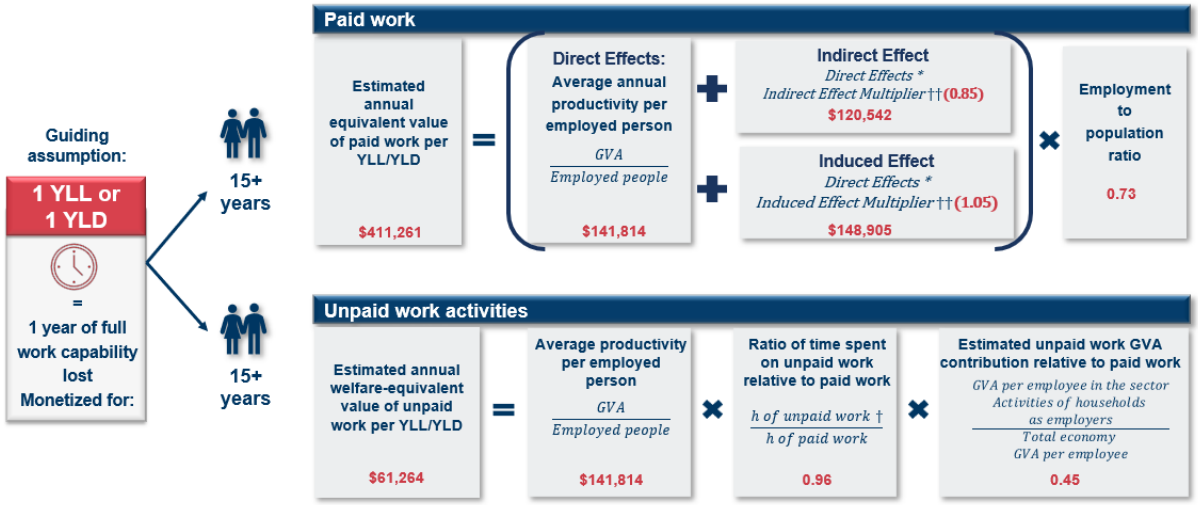

Figure 9. WifOR methodology to measure the SoC impact of a disease in a particular country summarized
Source: WifOR, 2024

7.2 Additional Figures and Tables

Table 2. Socioeconomic burden related to the seven selected diseases in Billion US dollars*, 2022

GBD Level	Disease Area	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	Mexico	Peru
Friction Cost Approach (FCA)									
Level 2	Cardiovascular diseases	11.0	16.2	2.4	1.8	0.5	0.7	6.7	1.4
	Neoplasms	5.4	6.6	1.5	1.0	0.3	0.3	3.0	0.7
Level 3	Ischemic heart disease	1.6	3.6	0.4	0.4	0.1	0.1	1.8	0.3
	Lower respiratory infections	1.0	0.8	0.1	0.0	0.0	0.0	0.3	0.1
	Breast cancer	0.9	1.1	0.2	0.2	0.1	0.0	0.6	0.1
Level 4	Diabetes mellitus type 2	10.4	22.9	4.2	4.0	1.1	1.4	21.9	1.4
	Migraine	10.6	30.7	3.6	4.0	0.8	1.2	14.8	2.0
Total		**38.2**	**77.1**	**11.7**	**10.9**	**2.8**	**3.6**	**46.7**	**5.6**
Human Capital Approach (HCA)									
Level 2	Cardiovascular diseases	30.7	41.0	5.4	3.7	0.9	1.5	16.3	3.0
	Neoplasms	32.3	31.9	6.6	3.8	1.0	1.4	13.4	3.4
Level 3	Ischemic heart disease	9.9	14.7	1.8	1.4	0.3	0.6	8.2	1.0
	Lower respiratory infections	7.7	5.7	0.5	0.4	0.1	0.2	2.6	0.9
	Breast cancer	3.9	4.1	0.6	0.5	0.1	0.1	1.8	0.3
Level 4	Diabetes mellitus type 2	13.0	26.6	4.5	4.2	1.2	1.6	27.4	1.7
	Migraine	10.6	30.7	3.6	4.0	0.8	1.2	14.8	2.0
Total		**94.2**	**135.9**	**20.6**	**16.1**	**4.1**	**6.0**	**74.4**	**11.0**

*Monetary data is comprehensively accounted for and presented at the 2015 price levels to be consistent with the constant values supplied by the World Bank.

Note: Ischemic heart disease is a subcategory (Level 3) of cardiovascular disease (Level 2). Breast cancer (Level 3) is a subcategory of neoplasms (Level 2). All the other disease areas are classified into different categories.

Source: WifOR elaboration

Table 3. Socioeconomic burden related to the seven selected diseases as the percentage of the GDP, 2022

GBD Level	Disease Area	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	Mexico	Peru
Friction Cost Approach (FCA)									
Level 2	Cardiovascular diseases	1.8	0.9	0.9	0.5	0.7	0.7	0.5	0.6
	Neoplasms	0.9	0.3	0.5	0.3	0.4	0.3	0.2	0.3
Level 3	Ischemic heart disease	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.1
	Lower respiratory infections	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	Breast cancer	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
Level 4	Diabetes mellitus type 2	1.7	1.2	1.5	1.1	1.6	1.4	1.7	0.6
	Migraine	1.8	1.6	1.3	1.1	1.2	1.2	1.1	0.9
Total		**6.4**	**4.1**	**4.1**	**3.1**	**4.0**	**3.5**	**3.6**	**2.5**
Human Capital Approach (HCA)									
Level 2	Cardiovascular diseases	5.1	2.2	1.9	1.0	1.3	1.5	1.3	1.3
	Neoplasms	5.4	1.7	2.3	1.1	1.5	1.4	1.0	1.5
Level 3	Ischemic heart disease	1.6	0.8	0.6	0.4	0.5	0.6	0.6	0.4
	Lower respiratory infections	1.3	0.3	0.2	0.1	0.1	0.2	0.2	0.4
	Breast cancer	0.7	0.2	0.2	0.2	0.2	0.1	0.1	0.1
Level 4	Diabetes mellitus type 2	2.2	1.4	1.6	1.2	1.7	1.6	2.1	0.8
	Migraine	1.8	1.6	1.3	1.1	1.2	1.2	1.1	0.9
Total		**15.7**	**7.1**	**7.3**	**4.5**	**5.9**	**6.0**	**5.8**	**4.9**

*Monetary data is comprehensively accounted for and presented at the 2015 price levels to be consistent with the constant values supplied by the World Bank.
Note: Ischemic heart disease is a subcategory (Level 3) of cardiovascular disease (Level 2). Breast cancer (Level 3) is a subcategory of neoplasms (Level 2). All the other disease areas are classified into different categories.

Source: WifOR elaboration

Figure 10. Time trends socioeconomic burden for the seven selected disease, HCA Approach – Assuming Non-substitution

*Note that given the higher values observed for Argentina, we used a different scale than for the other countries

Source: WifOR elaboration.

WifOR is an independent economic research institute that originated from a spin-out of the Department of Public Economics and Economic Policy at the Technical University of Darmstadt, Germany. We see ourselves as an academic partner and think tank on a global scale. WifOR's fields of research include Economic, Environmental and Social Impact Analyses as well as Labour Market and Health Economy research.

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