Mortality Costs of and Policy Responses to the COVID-19 Pandemic in Côte d'Ivoire

Hermann Pythagore Pierre Donfouet
Ndoh Ashken Sanogo
Jean-Noel Amantchi Gogoua
Opope Oyaka Tshivuila Matala
Adama Traore
Gaston Sorgho

Abstract

Côte d'Ivoire, the largest economy in the West African Economic and Monetary Union, was hit by COVID-19, which claimed many lives. This paper estimates COVID-19 mortality costs over time using the value of a statistical life. Using a more conservative estimate of the value of a statistical life income elasticity ranging from 1 to 1.4, the overall COVID-19 mortality costs in Côte d'Ivoire since the pandemic range from US$ 100.4 million to US$ 284.3 million. Considering age-related adjustments, a 3 percent discount rate, and a value of a statistical life income elasticity of 1 to 1.4, the COVID-19 costs range from US$ 5.4 million to US$ 15.3 million. Similarly, the COVID-19 mortality costs range from US$ 6.8 million to US$ 19.3 million with a 5 percent discount rate and a value of a statistical life income elasticity of 1 to 1.4. More significantly, the findings suggest that COVID-19 mortality costs started to decline in 2021. To enhance prevention, preparedness, and response to future pandemics, policy makers could consider allocating pandemic funding within national budgets. Exploring potential partnerships with philanthropic organizations and international entities could further enhance domestic resource matching efforts.

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Hermann Pythagore Pierre Donfouet[1*], Ndoh Ashken Sanogo[1,] Jean-Noel Amantchi Gogoua[1], Opope Oyaka Tshivuila Matala[1], Adama Traore[1], Gaston Sorgho[1]

[1]The World Bank Health Nutrition and Population Global Practice, 1818 H Street, NW Washington, D.C. 20433 USA.

*Corresponding author's email: hdonfouet@worldbank.org

1. Introduction

Since its first case of COVID-19,[1] detected on March 11, 2020, Côte d'Ivoire has experienced recurrent waves of the pandemic, with the most recent ending in January 2022. The resurgence in cases has been driven by the spread of highly transmissible COVID-19 variants, low COVID-19 vaccination coverage, increasing social interactions and the inconsistent application of public health measures (e.g., social distancing, handwashing, and mask wearing). There were 88,064 confirmed cases of COVID-19 between January 3, 2020, and February 15, 2023 (WHO., 2022). The highest incidence of COVID-19 cases was observed in December 2021 due to the Omicron variant, while the deadliest wave was associated with the spread of the Delta variant between July and October 2021. As of January 18, 2024, a total of 835 people had died as a result of COVID-19. Although this number of deaths might not seem high compared to the United States (US), where COVID-19 is estimated to have caused 1,161,235 deaths as of January 18, 2024, the mortality costs in Côte d'Ivoire might be high for a nation that is still working to build a strong and resilient health care system and enhance inclusive and sustainable economic growth. Furthermore, since the pandemic began, policy makers in Côte d'Ivoire have lacked evidence of the long-term death costs associated with COVID-19. These estimates could give policy makers a clear picture of the mortality costs associated with COVID-19 over time and help them take a forward approach to better prevent, prepare for, and respond to future pandemics.

The COVID-19 pandemic has spawned a plethora of research articles that assess its costs. According to an estimate by Cutler and Summers (2020), the total cost of the pandemic in the US is estimated at more than $16 trillion, or over 90% of the country's annual gross domestic product. The premature death cost amounted to US$ 4.4 trillion. In Türkiye, Gökler & Metintaş (2022) found that the premature death cost due to COVID-19 was US$ 227,396,694. Even though these studies shed some light on the mortality costs associated with COVID-19, it is not known how these mortality costs change over time.

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[1] COVID-19 has been described in a variety of ways since its inception. It was referred to as a pandemic, health crisis, public health emergency of internal concern, and disaster.

The current study uses the benefit-transfer value of a statistical life (VSL) approach to estimate the COVID-19 mortality costs over time in Côte d'Ivoire. We also review the health policies implemented by policy makers to curb COVID-19 and propose effective health policies to help the country better prevent, prepare for, and respond to future pandemics.

In the next section, we describe the methods used to estimate the mortality costs of COVID-19 over time in Côte d'Ivoire. In Section 3, results are presented whereas in Section 4, the findings are discussed with some policy recommendations. Section 5 concludes.

2. Methods

In this paper, we first estimate the COVID-19 mortality costs in Côte d'Ivoire using the VSL, and then conduct a desk review to better understand the health policies implemented by policy makers to curb COVID-19.

The VSL is an individual's marginal rate of substitution between money and the risk of dying over a given time period (Hammitt, 2000). The VSL represents the monetary value of risk reduction that would save one statistical life, rather than an identified life[2] (Andersson, 2008; Lisa A Robinson et al., 2019b). We use the benefit-transfer VSL approach to estimate the mortality costs due to COVID-19 over time in Côte d'Ivoire. The benefit-transfer VSL approach extrapolates from values from higher income countries, adjusting for differences in income, and the rate at which VSL changes as income changes (income elasticity of the VSL). The transfer is based on 2013 estimates for the US. All VSL estimates are adjusted for inflation using the GDP deflator, as well as for future changes in real income. We follow best standard practices by taking into account the low and central values of VSL (Lisa A Robinson et al., 2019a; Lisa A Robinson et al., 2019b). The COVID-19 mortality costs are calculated by multiplying the total COVID-19-related deaths by the

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[2] The word "statistical" refers to small reductions in the likelihood of dying. As stated by Cohen et al. (2015), statistical lives are those that will be lost to known risk factors in the future unless we intervene, but whose identities we will never know, at least for the time being. Identified lives are those whose identities we currently know.

VSL. We use this computation to better understand the value of lives lost as a result of COVID-19 over time. The VSL for Côte d'Ivoire is given by the following formula:

$$VSL_{Cote\ d'Ivoire} = VSL_{USA} \times \left(\frac{GNI_{Cote\ d'Ivoire}}{GNI_{USA}}\right)^{elasticity} \tag{1}$$

With $VSL_{Cote\ d'Ivoire}$ and VSL_{USA}, the VSL for Côte d'Ivoire and the United States, respectively. The GNI is the gross national income, and elasticity[3] is the degree of change in the VSL associated with a change in income.

Furthermore, age is considered because COVID-19 has had a disproportionately negative effect on elderly people. As a result, we estimate a constant value per statistical life year (VSLY) (Aldy & Viscusi, 2007). Following Robinson et al. (2017a), we divide the VSL by the discounted expected life years remaining for an individual at the average age of the population being studied. The VSLY, which is often called the value of a life year, measures how much people are willing to spend for a change in their life expectancy. The VSLY is given by the following formula:

$$VSLY_{Cote\ d'Ivoire} = \frac{r \times (VSL_{Cote\ d'Ivoire})}{[1-(1+r)^{-L}]} \tag{2}$$

With *r* and *L* the discount rate and the remaining life expectancy, respectively.

We apply the standard 3% discount rate and the 5% discount rate that Haacker et al. (2020) advised for low- and lower-middle-income countries. Based on information from the WHO's Global Health Observatory Data Repository, we estimate that the remaining life expectancy is half of Côte d'Ivoire's life expectancy at birth. The COVID-19 mortality costs are calculated by multiplying the VSLY values by the total number of deaths associated with COVID-19.

Lastly, we carried out a desk analysis (World Bank., 2020a, b, 2021, 2022) to comprehend the health policies put in place by policy makers to fight COVID-19, and we provide effective health policy recommendations to assist the policy makers in Côte d'Ivoire in better preventing, preparing for, and responding to future pandemics.

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[3] Using different income elasticity of the VSL values, we examine the uncertainties around the VSL estimates.

In this study, we use a variety of data sets. The WHO database[4] provided the COVID-19 data. The low and central values of the VSL for the US are from Robinson et al. (2017b) and Robinson and Hammitt (2016). The GNI and other data were extracted from the World Bank Development Indictors (WDI).

3. Results

3.1 Estimates of the COVID-19 mortality costs over time

Table 1 shows the historical trend of COVID-19 mortality costs in Côte d'Ivoire. As the income elasticity of the VSL rises over time, regardless of the values of the central US VSL or low US VSL, the VSL for Côte d'Ivoire drops along with mortality costs. The Côte d'Ivoire VSL (**Panel A of Table 1**), for example, swings from US$ 734,103.81 to US$ 259,313.96 based on the central US VSL, indicating a drop of 64.68% of the VSL when the income elasticity of the VSL rises from 1 to 1.4. Similarly, for the year 2020, the mortality costs attributable to COVID-19 drop from US$ 98,369,910.86 to US$ 34,748,070.04, indicating a decrease in the mortality costs attributable to the COVID-19 pandemic of 64.68%. With an income elasticity of the VSL of 1, it is interesting to observe that starting in 2021, COVID-19-related mortality costs dropped precipitously, reaching US$ 90,294,768.92 in 2022. Using an income elasticity of the VSL of 1.4 (**Panel A of Table 1**), the mortality costs due to the COVID-19 pandemic decreased from US$ 148,586,896.52 (2021) to US$ 31,895,616.53 (2022). This decreasing pattern of mortality costs due to COVID-19 is substantiated when the low US VSL estimates are used (**Panel B of Table 1**). With an income elasticity of the VSL of 1, the mortality costs associated with COVID-19 fell beginning in 2021 and reached US$ 42,137,558.83 in 2022.

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[4] Based on data from the WHO database (https://covid19.who.int/data), at the time of writing this paper, the recorded COVID-19 deaths in Côte d'Ivoire were as follows: 134 (2020), 573 (2021), 123 (2022), and 5 (2023). The cumulative total of COVID-19 deaths from 2020 to 2023 is 835. In May 2023, the World Health Organization (WHO) lifted the global health emergency declaration for COVID-19. Furthermore, in 2023, numerous countries discontinued regular tracking and reporting of new COVID infections. As a result, the year 2023 is not included in this study.

Table 1: COVID-19 mortality costs in Côte d'Ivoire over time

		Panel A: Central values		
		Mortality costs		
Elasticity	Value of a statistical life	2020	2021	2022
1	734 103.81	98 369 910.86	420 641 484.50	90 294 768.92
1.4	259 313.96	34 748 070.04	148 586 896.52	31 895 616.53
		Panel B: Low values		
Elasticity	Value of a statistical life	Mortality costs		
1	342 581.78	45 905 958.40	196 299 359.43	42 137 558.83
1.4	121 013.18	16 215 766.02	69 340 551.71	14 884 621.05

Notes: The term elasticity refers to the value of a statistical life (VSL) 's income elasticity, or the proportional change in the VSL brought on by a change in income. All estimates are performed using a central value of VSL=US$ 9 000 000, and USA GNI per capita (PPP, current international US$) = 54 380 for 2013. The low values of VSL are equal to US$ 4,200,000 for the USA. All VSL estimates are adjusted for inflation using the GDP deflator, as well as for potential changes in real income. All estimates are in US$.

Table 2 indicates the costs of COVID-19 deaths since the pandemic began while taking into consideration the fact that the disease disproportionately affects the very old. Two findings emerge from **Table 2**. The mortality costs decreased, regardless of the discount rate applied. For instance, **Panel B of Table 2** shows that the mortality costs associated with COVID-19 range from US$ 31,100,23.79 (2020) to US$ 2,854,723.33 (2022) using a 5% discount rate, low US VSL estimates, and a constant income elasticity of VSL. Furthermore, the findings of the study support a reduction in the costs of COVID-19 deaths beginning in 2021. This observation holds true regardless of the income elasticity of VSL or the discount rate applied.

Table 2: COVID-19 mortality costs in Côte d'Ivoire across time while taking into account age

	Panel A: Central values							
			Mortality costs					
	Value of a statistical life year		3% discount rate			5% discount rate		
Elasticity	3% discount rate	5% discount rate	2020	2021	2022	2020	2021	2022
1	3 9622.38	497 33.86	5 309 399.00	2 2703 624.09	4 873 552.81	6 664 336.68	28 497 499.41	6 117 264.27
1.4	1 3996.16	17 567.93	1 875 485.77	8 019 801.11	1 721 527.99	2 354 102.35	10 066 422.72	2 160 855.14
	Panel B: Low values							
			Mortality costs					
	Value of a statistical life year		3% discount rate			5% discount rate		
Elasticity	3% discount rate	5% discount rate	2020	2021	2022	2020	2021	2022
1	184 90.44	23 209.13	2 477 719.53	10 595 024.57	2 274 324.65	3 110 023.79	13 298 833.06	2 854 723.33
1.4	6 531.54	8 198.37	875 226.69	3 742 573.85	803 379.73	1 098 581.09	4 697 663.93	1 008 399.06

Notes: A constant value per statistical life year (VSLY) is estimated by using two discounting rates: 3% and 5%. Based on information from the WHO's Global Health Observatory Data Repository, we estimate that the remaining life expectancy is half of the Ivoirian life expectancy at birth. The term elasticity refers to the value of a statistical life (VSL) 's income elasticity, or the proportional change in the VSL brought on by a change in income. For 2013, the USA's GNI per capita (PPP, current international US$) was US$ 54 380. This amount is used as the basis for all calculations. The low levels of VSL are equal to US$ 4,200,000 for the USA. All VSL estimates are adjusted for inflation using the GDP deflator, as well as for potential changes in real income. All estimates are in US$.

3.2 Health policies used to curb COVID-19 in Côte d'Ivoire

This subsection presents the results of our desk review of the various policies and instruments employed by Côte d'Ivoire's decision-makers to tackle the COVID-19 outbreak.

The government set up a National Steering Committee for coordination, COVID-19 prevention, and control to curb the pandemic. This Committee, which was adopted on March 23, 2020, was headed by the Prime Minister, and comprised a secretariat provided by the Ministry of Health (MoH), as well as many subcommittees and action units in each sector. The Steering Committee oversees and offers strategic and policy direction for the government's disaster response. It also coordinates the work of the other committees and mobilizes resources for the government's emergency response plan. The secretariat of the Steering Committee is led by the MoH. The MoH serves as the secretariat for the Steering Committee. At the operational level, the MoH's main body for multisectoral coordination of public health emergency responses, called the Centre for Public Health Emergency Operations (COUSP), which is chaired by the National Public Hygiene Institute, has been activated. The COUSP invited all key stakeholders in health, including the World Bank and World Health Organization, to attend the weekly coordination meeting. The COVID-19 operational response is led by the General Director of Health, who reports to the MoH. Furthermore, the country has taken steps to acquire vaccines as they are developed. Following a slow start, Côte d'Ivoire's COVID-19 vaccination campaign has picked up speed. On March 1, 2021, the vaccination campaign was launched. However, high levels of misinformation, lack of trust in the vaccine, and vaccine hesitancy hampered vaccine uptake, and the vaccination rate remained around 2,000 doses administered per day. Daily vaccination rates rose to over 20,000 by mid-April 2021 at the start of a strong communication and community mobilization effort, and to almost 150,000 by mid-December 2021 after the vaccine campaign was intensified in response to the third wave of the outbreak. COVID-19 vaccine supply was initially unpredictable, owing to limited global vaccine production and inequitable distribution. Since August 2021, supply and donations have increased, and the priority has shifted to improving deployment capacity to meet the 70% coverage target and administer booster doses, as well as strengthening national public health preparedness systems. Only 1.9 million COVID-19 doses were administered in Côte d'Ivoire during the first five months of the campaign. Disruptions in the availability of specific vaccines (e.g., AstraZeneca), combined with inconsistent delivery schedules of available vaccines,

resulted in Côte d'Ivoire having vaccine stock-outs, which harmed the campaign. Vaccine deliveries have increased since August 2021, with 19.7 million doses delivered over 18 months (August 2020-March 16, 2022), and the government has since intensified the vaccination campaign to speed up vaccine deployment. As of February 19, 2023, a total of 25,263,932 vaccine doses[5] have been administered. The country's current challenge is to i) create a growing and consistent demand for COVID-19 vaccinations, (ii) strengthen the resilience of the health system, and (iii) accelerate the Ivorian economy's recovery.

Despite these measures, the fight against COVID-19 has gone through difficulties. Revenues plummeted during the COVID-19 pandemic in 2020, despite a dramatic increase in government spending to address the health and economic effects of the crisis. The COVID-19 pandemic has further highlighted the necessity for government budgets to give health spending priority, but its sustainability will be difficult. Lifesaving has been the top objective during the COVID-19 pandemic's containment phase. In fact, the Ivorian government has reacted by increasing health spending to stop or slow the spread of the virus and treat people in need of medical attention. Development partners have also come together to support the COVID-19 health response in Côte d'Ivoire. Development partners have provided significant resources to manage the COVID-19 pandemic in the country, including rechanneling support from other sectors and providing additional funds. However, as the COVID-19 pandemic stabilizes, fiscal sustainability will likely become a top priority, and financing constraints or debt sustainability may limit the scope for additional health allocations in the government budget. As a result, the country's emergency preparedness capacity should be strengthened.

### 3.3 Addressing future pandemics in Côte d'Ivoire from the health perspective

Addressing future pandemics[6] in Côte d'Ivoire will require the country to act simultaneously on many fronts. From a health perspective, several policy options could be considered to address future pandemics.

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[5] Please see https://covid19.who.int/region/afro/country/ci

[6] It has been estimated that the probability of a future pandemic on the scale of the COVID-19 outbreak or greater is between 2.5 percent and 3.3 percent per year, implying a roughly 50 percent chance that one will occur within the next 25 years (Schady et al., 2023).

Strengthening the health care system might be on the agenda of better pandemic preparedness and response (PPR) capacities. The Ivorian health care system could be strengthened with increased investment in infrastructure, notably at the primary care level. The expansion of primary health care centers countrywide is key for increasing access to health care services. In Côte d'Ivoire, accessibility is still a major barrier to use of health services with one-third (33%) of the population living more than 5 kilometers from a public health facility (MoH., 2019). Improving the quality and number of human resources for health (HRH) will need to be handled along with the incentives to retain them. The country is facing a brain drain of doctors and nurses that needs to be reversed at a time when it faces a shortage of health care workers. The country should continue to invest in improving access to essential medicines and equipment, notably at the primary care level (**Figure 1**).

Figure 1: Breakdown of Government Spending on Health Facility Operations, Drugs, and Infrastructure, 2017
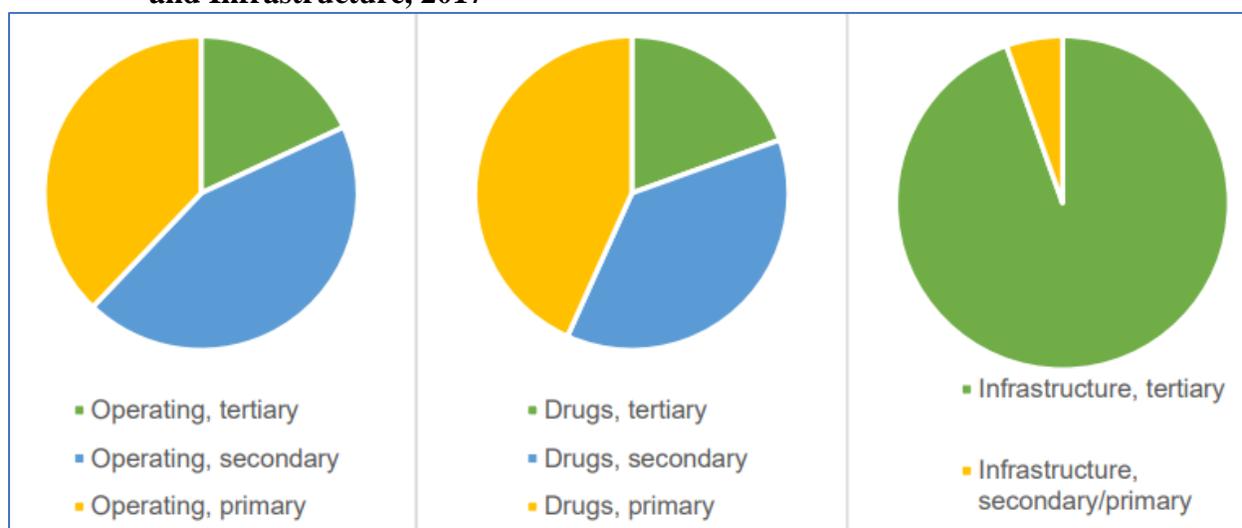
Source : Duran et al. (2020).

Surveillance and early detection of cases, along with improving disease control measures will be instrumental in ensuring an effective PPR mechanism. Despite the efforts made during the COVID-19 pandemic, the country surveillance and early detection mechanism is not robust enough. To make sure the current early warning systems function properly to identify outbreaks early, they should undergo some stress tests. Early outbreak detection and the execution of disease control measures within communities, particularly in distant regions, are seriously threatened by the difficulties of understaffed primary health care facilities. The nation might expand public-private partnerships to take advantage of resources from the private sector to invest in enhancing

laboratory capabilities for infectious disease diagnosis and testing. The Pasteur Institute is under extreme strain as a result of the COVID-19 pandemic because it is virtually the only laboratory that conducts reliable COVID-19 testing. By collaborating with the business sector, it will be possible to strengthen laboratory networks and enhance investments in reagents and equipment while also providing more financing for staff training.

Côte d'Ivoire may increase its involvement in PPR international cooperation. Under the auspices of the Africa CDC, Côte d'Ivoire might collaborate with African and other international partners to improve its coordination mechanisms for responses, information sharing, and the launch of African-led initiatives for vaccine development. The creation and dissemination of vaccinations for potential pandemics ought to be Côte d'Ivoire's top priorities. This entails making investments in R&D, forming alliances with vaccine producers, and assuring equal access to vaccines.

These policy options will not be successful in tackling future pandemics if the country keeps the same trend in the fiscal allocations to the health sector. General government health expenditure has continuously been very low, below 6% of general government expenditure (**Figure 2**). Similarly, as shown by **Table 3**'s sixth column**,** over time domestic general government health expenditure as a share of GDP has been very low (below the recommended 5% benchmark suggested by Mcintyre et al. (2017) for achieving universal health coverage).

Furthermore, the COVID-19 pandemic has also demonstrated that spending on primary health care (PHC) can lessen the pandemic's devasting effects. Countries with strong PHC (the Republic of Korea and Viet Nam) were able to react to the pandemic more quickly and successfully. This is because PHC is a powerful tool for managing public health initiatives to combat infectious diseases (Hanson et al., 2022). Nonetheless, Côte d'Ivoire does not significantly fund PHC. According to **Table 3**, there is a positive association between total PHC spending and GDP per capita: when GDP per capita rises, more money is invested in total PHC spending. While it has remained constant over time, the PHC (government and donors) expenditure as a percentage of GDP is quite low (below 2%), indicating that prioritizing PHC investments in order to be ready for future pandemics could be a top priority.

Figure 2: Domestic general government health expenditure (% of general government expenditure)
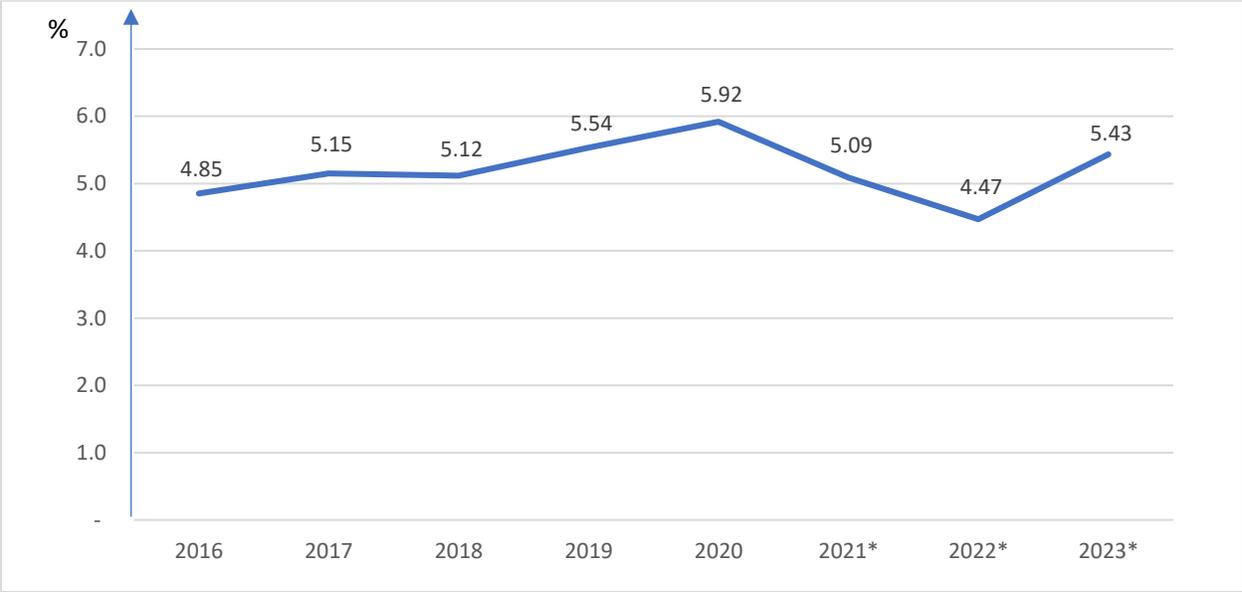
Notes: The World Bank Development Indicators (WDI) and Ministry of Finance (MoF) (data from 2021, 2022, and 2022 are extracted from the MoF website) are used to draw the figure.

Table 3: Primary health care financing in Côte d'Ivoire

	GDP per capita	Level of spending per capita (US$)			Share of spending (%)					
Year	GDP per capita, PPP (current international $)	Total PHC expenditure	Domestic general government expenditure on PHC per capita	External expenditure on PHC per capita	Domestic general government health expenditure as a share of GDP	PHC (government and donors) as a share of GDP	PHC spending as a share of current health spending	Domestic general government spending on PHC as a share of total PHC spending	Domestic general government spending on PHC as a share of domestic general government expenditure on health	External spending on PHC as a share of total PHC spending
2016	4650.67	52.1	13.5	9.6	0.9	1.2	78.5	26.0	79.4	18.4
2017	4750.94	53.6	15.7	8.5	0.9	1.2	78.1	29.4	79.9	15.8
2018	5067.86	57.1	16.5	8.2	0.9	1.1	80.4	29.0	80.2	14.4
2019	5343.00	59.8	17.2	10.7	1	1.2	80.9	28.8	80.2	17.9

Notes: PHC means primary health care. The GDP per capita data are from the World Bank Development Indicators (WDI). The data on primary health financing are from the Global Health Expenditure Database (GHED).

There is a pressing need to free up financial resources so that Côte d'Ivoire could enhance funding for the health sector and be more prepared for pandemics. By expanding the tax base, enhancing tax collection and compliance, and enacting additional taxes, such as health taxes on alcohol, tobacco, and other unhealthy goods, the government may generate more money for the health sector while earmarking some of these taxes for the PPR. Furthermore, the government could work to increase the efficiency and effectiveness of health spending by making the most of the available resources. This could entail enhancing public financial management in the health sector, particularly the procurement processes and accountability.

4. Discussion

Using a more conservative estimate of the VSL (low values) and a VSL income elasticity ranging from 1 to 1.4, the overall COVID-19 mortality costs in Côte d'Ivoire since the pandemic began range from US$ 100,440,938.78 to US$ 284,342,876.66. The COVID-19 costs range from US$ 5,421,180.27 to US$ 15,347,068.75 when age-related adjustments, a 3% discount rate, and a VSL income elasticity of 1 to 1.4 are taken into account. In the same vein, COVID-19 mortality costs range from US$ 6,804,644.09 to US$ 19,263,580.17 with a 5% discount rate and a VSL income elasticity of 1 to 1.4. More importantly, starting from 2021, the results of the study suggest a decline of the COVID-19 mortality costs. This decrease could be attributed to the government's health policies aimed at reducing COVID-19. As outlined by the World Bank (World Bank., 2021) when the COVID-19 pandemic started, the policy makers in Côte d'Ivoire took forceful action by closing land, air, and marine borders. Sports events, festivals, and meetings with more than 50 people were postponed, and non-essential enterprises, schools (including pre-schools and universities), were closed. All confirmed and probable COVID-19 cases were quarantined in government-run facilities, social distancing, and mask use were actively promoted. Côte d'Ivoire was among the first countries to receive the first wave of COVAX vaccines on February 26, 2021, and carried out its first mass vaccination campaign in December 2021. As of January 22, 2023, Ivoirians have received a cumulative total of 25.26 million COVID-19 vaccine doses. This accounts for 12% of the total population, who have received at least one booster dose of a COVID-

19 vaccine.[7] Some evidence suggests that social isolation, lockdowns, and COVID-19 vaccination could save lives. Despite the significant societal costs associated with social distancing due to decreased economic activity, Thunström et al. (2020) discovered that social distancing could save approximately 1.24 million lives. According to Greenstone and Nigam (2020), social distancing policies would prevent 1.7 million deaths compared to the unmitigated scenario, and the benefits would be worth about U$8 trillion. Acemoglu et al. (2021) found that lockdowns that target different age group are more cost beneficial than uniform lockdowns. Bermingham et al.'s (2021) studies suggested that the first vaccine dose reduced the risk of COVID-19 death by 52.6% among individuals aged 80 years. In Another study (Rahmani et al., 2022), it is indicated that that immunizing against COVID-19 with BNT162b2 mRNA, mRNA-1273, and ChAdOx1, as well as using these three components in combination, was associated with favorable effectiveness against SARS-CoV2 incidence rate, hospitalization rate, and mortality rate in the first and second doses in various populations.

The calculation of COVID-19 mortality costs over time provides us with a number of valuable lessons. With these estimates, policy makers could take stock in order to make an informed decision on preventing, preparing, and responding to future pandemics. Côte d'Ivoire has a weak public health system that is unprepared to handle potential pandemic threats, as evidenced by its low overall global health security index score of 31.2[8] (out of a possible score of 100). Consequently, there is an urgent need to provide funds specifically for health security. Thus, there is a dire need to make a dedicated financial investment in health security. Policy makers in Côte d'Ivoire could, therefore, allocate pandemic funds in national budgets and explore opportunities to collaborate with philanthropic and multilateral organizations to increase domestic resource matching. As a result of their collaboration, for every dollar spent by policy makers in Côte d'Ivoire on pandemic preparedness and response, the matching donor contributes U$2 (a 2:1 matching ratio). Policy makers could use these funds to invest more in the surveillance system, allowing outbreaks to be contained before they spread. Furthermore, modern, and strong laboratory

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[7] https://data.who.int/dashboards/covid19/vaccines?m49=384&n=c

[8] The data are from the 2021 Global Health Security index (https://www.ghsindex.org/country/cote-divoire/). The data suggest that Côte d'Ivoire has low score in preventing (12.4), detecting (29.6), responding (35.3), health (17.1), norms (47.7), and risk (45.2).

networks in all provinces could be established to improve the country's diagnostic capacity for new diseases. Other potential investment areas include improving human health resources and manufacturing vaccines and other critical medicines at home. With the establishment of the Financial Intermediary Fund (FIF[9]), the government might use it to bolster their pandemic preparedness and response capacities.

The current study, however, one major limitation. The COVID-19 non-fatal economic losses are disregarded. COVID-19 is well known for its non-fatal dimensions, which include fever, loss of smell/taste, fainting, chronic fatigue syndrome, kidney damage, post-intensive care syndrome to name a few. COVID-19's non-fatal dimensions come at a high price (Kniesner & Sullivan, 2020). As a result, the current COVID-19 mortality costs reported in this study are a conservative estimate.

5. Conclusions

The findings of this study indicate that regardless of the techniques employed to estimate the COVID-19 mortality costs, there is a drop in COVID-19 mortality costs in Côte d'Ivoire starting in 2021. To better prevent, prepare for, and respond to future pandemics, policy makers could include pandemic funding in national budgets and look into possible partnerships with philanthropies and international organizations to improve domestic resource matching.

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[9] On June 30, 2022, the World Bank Board of Directors approved the creation of the FIF, a new pandemic fund. Through investments and technical assistance at the national, regional, and international levels, it is a dedicated long-term finance to build pandemic preparedness and response capabilities in low-and middle-income countries.

Abbreviations

FIF: Financial Intermediary Fund

GNI: Gross national income

MoF: Ministry of Finance

MoH: Ministry of Health

PHC: Primary Health Care

VSL: Value of statistical life

USA: United States of America

WDI: World Bank Development Indicators

Authors' contributions

HPPD conceived the idea of the paper, drafted the paper, led the data analysis and interpretation of the results and discussions as well, and approved the manuscript before submission. NAS and JNAG contributed to the data analysis, interpretation of the results and discussions as well, and approved the manuscript before submission. OOTM, AT, and GS reviewed the paper, discussed the policy implication of the paper, and approved the manuscript before submission. All authors read and approved the final manuscript.

Availability of data and materials

All data used and analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

All authors declare no competing interest.

Disclaimer

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References

Acemoglu, D., Chernozhukov, V., Werning, I., & Whinston, M.D. (2021). Optimal targeted lockdowns in a multigroup SIR model. *American Economic Review: Insights, 3*, 487-502.

Aldy, J.E., & Viscusi, W.K. (2007). Age differences in the value of statistical life: revealed preference evidence. *Review of Environmental Economics and Policy, 1*, 241–260.

Andersson, H. (2008). Willingness to pay for car safety: evidence from Sweden. *Environmental and Resource Economics, 41*, 579-594.

Bermingham, C., Morgan, J., Ayoubkhani, D., Glickman, M., Islam, N., Sheikh, A., et al. (2021). Estimating the effectiveness of first dose of COVID-19 vaccine against mortality in England: a quasi-experimental study. *American journal of epidemiology, 192*, 267–275.

Cohen, I.G., Daniels, N., & Eyal, N.M. (2015). *Identified versus statistical lives: an interdisciplinary perspective*. Oxford, United Kingdom: Oxford University Press.

Cutler, D.M., & Summers, L.H. (2020). The COVID-19 pandemic and the $16 trillion virus. *JAMA, 324*, 1495-1496.

Duran, D., Sieleunou, I., & Ozaltin, E. (2020). *Health Systems Assessment for Cote d'Ivoire: Accelerating Reforms Toward Universal Health Coverage*. Washington, DC: The World Bank.

Gökler, M.E., & Metintaş, S. (2022). Years of potential life lost and productivity costs due to COVID-19 in Turkey: one yearly evaluation. *Public health, 203*, 91-96.

Greenstone, M., & Nigam, V. (2020). Does social distancing matter? *University of Chicago, Becker Friedman Institute for Economics Working Paper*.

Haacker, M., Hallett, T.B., & Atun, R. (2020). On discount rates for economic evaluations in global health. *Health Policy and Planning, 35*, 107-114.

Hammitt, J.K. (2000). Valuing mortality risk: theory and practice. pp. 1396-1400): Environmental Science and Technology.

Hanson, K., Brikci, N., Erlangga, D., Alebachew, A., De Allegri, M., Balabanova, D., et al. (2022). The Lancet Global Health Commission on financing primary health care: putting people at the centre. *The Lancet Global Health, 10*, e715-e772.

Kniesner, T.J., & Sullivan, R. (2020). The forgotten numbers: A closer look at COVID-19 non-fatal valuations. *Journal of Risk and Uncertainty, 61*, 155-176.

Mcintyre, D., Meheus, F., & Røttingen, J.-A. (2017). What level of domestic government health expenditure should we aspire to for universal health coverage? *Health Economics, Policy and Law, 12*, 125-137.

MoH. (2019). *Financement de la santé : Dossier d'investissement 2020-2023*. Abidjan: Ministère de la Santé.

Rahmani, K., Shavaleh, R., Forouhi, M., Disfani, H.F., Kamandi, M., Oskooi, R.K., et al. (2022). The effectiveness of COVID-19 vaccines in reducing the incidence, hospitalization, and mortality from COVID-19: A systematic review and meta-analysis. *Frontiers in public health, 10*, 1-25.

Robinson, L.A., & Hammitt, J.K. (2016). Valuing reductions in fatal illness risks: Implications of recent research. *Health Economics, 25*, 1039-1052.

Robinson, L.A., Hammitt, J.K., Chang, A.Y., & Resch, S. (2017a). Understanding and improving the one and three times GDP per capita cost-effectiveness thresholds. *Health Policy and Planning, 32*, 141-145.

Robinson, L.A., Hammitt, J.K., Jamison, D.T., & Walker, D.G. (2019a). Conducting benefit-cost analysis in low-and middle-income countries: introduction to the special issue. *Journal of Benefit-Cost Analysis,* 10, 1-14.

Robinson, L.A., Hammitt, J.K., & O'Keeffe, L. (2017b). Valuing Mortality Risk Reductions in Global Benefit-Cost Analysis. *Guidelines for Benefit-Cost Analysis,* Working Paper No. 7.

Robinson, L.A., Hammitt, J.K., & O'Keeffe, L. (2019b). Valuing mortality risk reductions in global benefit-cost analysis. *Journal of Benefit-Cost Analysis,* 10, 15-50.

Schady, N., Holla, A., Sabarwal, S., Silva, J., & Yi Chang, A. (2023). *Collapse and Recovery: How the COVID-19 Pandemic Eroded Human Capital and What to Do about It*. Washington, DC: The World Bank.

Thunstrom, L., Newbold, S., Finnoff, D., Ashworth, M., & Shogren, J. (2020). The benefits and cost of flattening the curve for COVID-19. *Journal of Benefit-Cost Analysis,* 11, 1-17.

WHO. (2022). SITREP COVID-19. February 15, 2023. Geneva: The World Health Organization.

World Bank. (2020a). Cote d'Ivoire COVID-19 Emergency Response and System Preparedness Strengthening Project. Project Appraisal Document Report No: PAD3834. Washington, D.C.: The World Bank.

World Bank. (2020b). Strategic Purchasing and Alignment of Resources & Knowledge in Health Project (SPARK-Health) (P167959). Report number: RES42888. Washington, D.C.: The World Bank.

World Bank. (2021). Cote d'Ivoire COVID-19 Emergency Response and System Preparedness Strengthening Project. Project Appraisal Document. First additional financing. Report No: PAD4419. Washington, D.C.: The World Bank.

World Bank. (2022). Cote d'Ivoire COVID-19 Emergency Response and System Preparedness Strengthening Project, Project Appraisal Document. Second additional financing. Report No: PAD4736. Washington, D.C.: The World Bank.